RESEARCH ARTICLE

Mineral Status of Lactating Jaffarabadi Buffaloes in Their Home Tract: A Field Study

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Abstract

Deficit macro and micro-minerals in the ration of lactating Jaffarabadi buffaloes adversely affects growth, milk production and reproduction efficiency. For present study, four villages from each of 5 talukas were selected at random for taking representative samples of soil, feeds, forages and blood plasma of lactating Jaffarabadi buffaloes. Within the village, help was sought from village milk producers and district animal husbandry officer for identification of 3 farmers and collection of representative samples. All the samples were processed and analysed for chemical composition as well as major macro and micro-minerals, using Microwave Plasma Atomic Emission Spectrometer (MP-AES). Ca content was high in groundnut haulms (0.95%), but maize forage (0.23%), cotton seed cake (0.16%), cotton seed (0.12%) and maize cake (0.25) were found to be below the critical level (0.30%). The P content in concentrate ingredients was high (0.38-0.68%), but low in roughages (0.07-0.20%). Green jowar (0.18%) and maize cake (0.10%) were deficient in Mg. Feeds and forages were found to be adequate in iron. Abundant level of Cu was found in all feeds and forage. Sugarcane was found deficient in all minerals, except iron, and groundnut haulms (20.70 ppm) were found to be deficient in Zn. The blood mineral profile of the majority of lactating Jaffarabadi buffaloes was adequate. From the present study, it was apparent that soil and therefore forages cultivated in particular region were deficient in P and Zn. Same minerals were adequate in concentrate available in this area. So, to fulfil the requirement of deficient minerals there is need to feed concentrate along with area specific mineral mixture to the buffaloes.

Key words: Feeds, Forage, Jaffarabadi buffaloes, Minerals, Soil

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Introduction

India is home to 109.85 million of buffalo population, which contributes to more than 45% of milk from dairy animals (BAHS, 2019). Among them Jaffarabadi is one of the heaviest buffalo breeds in the world. Home tract of this breed is Gir forest of Saurashtra region of Gujarat in India. Buffalo milk is a rich source of nutrients comprising high fat, protein and lactose content thereby fetching higher price and more profit to dairy farmers. Diet plays pivotal role in exploiting genetic potential for maximum milk production in dairy animals. Hence, adequate supply of minerals through diet is imperative (Abd El-Salam and El-Shibiny, 2011), in particular, micronutrients are considered to be inevitable entity for the normal metabolic and physiological processes of animal systems. The importance of minerals in regulating biological systems, growth, milk production and reproduction is well documented (Underwood and Suttle, 1999). However, livestock in India do not get adequate mineral/ vitamin supplements, except for common salt and calcite powder (Garg *et al.,* 2008). Hence, dairy animals solely depend on forages to fulfil their mineral requirements. Numerous studies have reported the forage and blood serum mineral profile of buffalo below the recommended level. Miles and McDowell (1983) demonstrated deficiency of Cu and P in the forage samples collected from the pasture. Soils from all over country have been continuously depleted for Cu, Zn, P and S in soil, plants and dairy cows (Garg *et al*., 2003). The quantity of minerals, thus, present in forages may not be sufficient for optimum growth, milk yield and reproduction

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when those were fed to dairy cows. Minerals of soil enrich the animal body through plants. It is therefore imperious to know mineral status of soil, plant and animal body to avoid macro and micro-minerals deficiency in the ration. Keeping this in view, the present study was undertaken to estimate certain macro- and micro-minerals in soil, forages and blood plasma of lactating Jaffarabadi buffaloes in their home tract of Junagadh district in Gujarat.

Materials and Methods

Area of the Study

The present study was carried out during December 2018 to June 2019 in Visavadar, Junagadh, Mangrol, Manavadar and Mendarda talukas of Junagadh district of Gujarat state, which is home tract of Jaffarabadi buffaloes. These talukas were selected based on presence of large number of lactating Jaffarabadi buffaloes. District is located in western Gujarat and is surrounded by Arabian Sea and Gir forest area. It is located at a longitude of 20.47° N to 21.45° N and latitude of 70.15° E to 70.55° E. It has a tropical wet and dry climate, with three distinct seasons, a mild winter from November to February, a hot summer from March to June, and a monsoon from July to October. Major crops produced in the district are wheat, groundnut and cotton. More than 65% area is covered under oil seed crops, and these mainly include groundnut and cotton.

Sampling Procedures

Four villages were chosen for the study from each taluka in northern, eastern, western, and southern directions. Three farmers were chosen at random from each village with the assistance of the *"Sarpanch"* and a nearby veterinarian making a total of 60 farmers in order to collect representative soil, feed, forage, and blood samples.

Soil Samples

Sixty representative soil samples were collected in air tight polythene bags as per standard procedure for mineral profile analysis from cultivated land where forage was grown. After bringing to laboratory, samples were air dried, grinded, pass through 2 mm sieve and used for minerals analysis. In soil samples, calcium and magnesium were estimated by Versenate EDTA Method (Gupta, 1999). Phosphorus was estimated by Olsen's Method (Olsen *et al.,* 1954). Copper, zinc and iron were estimated by DTPA Extraction method (Lindsay and Norvell, 1978) using Microwave Plasma Atomic Emission Spectrometer (MP-AES).

Feed Samples

One hundred and sixty samples of wet forages, cereal straws/dry forages, concentrate feed ingredients and the compound cattle feed (concentrate mixture) were collected from all over the surveyed area. Wet forage samples were dried in hot air oven at 100°C for 24 h and subsequently ground to 1 mm size. Ground samples of concentrate and forages were stored in airtight bags until further analysis. The samples of feeds, wet forages and dry roughages were analyzed for crude protein (CP), ether extract (EE), crude fibre (CF) and acid insoluble ash (AIA) as per protocol of AOAC (2005). All the samples were also analyzed for calcium (Ca), magnesium (Mg), copper (Cu), zinc (Zn) and iron (Fe) content using MP-AES. Phosphorus (P) was estimated by Vanado-Molybdo phosphoric acid method using spectrophotometer.

Blood Samples

Blood samples were collected from the sixty lactating Jaffarabadi buffaloes in sterilized vacuumed tubes containing lithium heparin and immediately transported to the laboratory in an ice box. The plasma was separated by centrifugation at 3000 rpm (945 g RCF) for 15 min and stored at -20°C until further analysis. The mineral profile of lactating Jaffarabadi buffaloes was examined using one milliliter of blood plasma, with the same procedure as for the analysis of fodder's mineral content.

Chemical Composition of Feeds, Forages and Nutritional Status

The feed and forage samples collected from surveyed area were analysed for chemical composition, and data on nutritional status and feeding practices (Feed intake, frequency of feeding, mineral and salt supplementation) followed by owner of lactating Jaffarabadi buffaloes were as given by Naliyapara *et al.* (2021).

Statistical Analysis

The collated data were analyzed statistically using SPSS software (SPSS 20.00 software for Windows, SPSS Inc., Chicago, IL). Duncan multiple range test was used to compare the means within a group. The difference was considered to be significant if $p<0.05$.

Results and Discussion

Mineral Profile of Soil

Data on macro- and micro-minerals contents observed in soil are given in Table 1. Among the macro-minerals, contents of Ca and Mg in soil were found above critical level, while that of P was found below the critical level suggested by Jackson (1973). In micro minerals, Cu content in the soil was above the critical level, while that of Fe and Zn were below the critical level. Among the all-soil samples analyzed, 100, 54.66 and 65 % of the samples were deficient in phosphorus, iron and zinc, respectively, in Junagadh district. Moreover, the Ca, P, Fe and Zn levels in the soil of 5 talukas varied significantly, while Mg and Cu levels were almost similar.

Mineral Profile of Feeds and Forages

Profile of macro- and micro-minerals estimated from 160 feeds and forage samples are given in Table 1, and information regarding percent deficit or surplus of minerals in various types of samples is given in Table 2. The Ca was found deficient in green maize (0.23%), green jowar (0.18%), gajraj grass (0.24%), cottonseed cake (0.16%), cottonseed (0.12%), sugarcane (0.06%) and maize cake (0.25%). Whereas marvel grass (0.40%), green bajra (1.02%), groundnut haulms (0.95%) and what bran + cotton seed cake (0.36%) were adequate in calcium. The P was found deficient in green maize (0.15%), green jowar (0.17%), marvel grass (0.12%), gajraj grass (0.16%), sugarcane (0.07%) and groundnut haulms (0.12%). Whereas, cottonseed cake (0.44%), cottonseed (0.38%) and what bran + cotton seed cake (0.68%) were adequate in phosphorus. Most of the feedstuffs were found adequate in magnesium,

Table 1: Mineral profile of soil, feeds, forage and blood plasma of lactating Jaffarabadi buffaloes in Junagadh district

Types of samples	Ca	P	Mg	Cu	Fe	Zn
Soil (n=60)	**%**	**ppm**	**%**	**ppm**	**ppm**	**ppm**
	0.98±0.04	24±1.50	0.24±0.02	2.28±0.13	3.71±0.46	1.19±0.13
Critical level*	0.10	45	0.01	1-2	20	1.5
Feeds & Forage (on DM basis)	**%**	**%**	**%**	**ppm**	**ppm**	**ppm**
Green maize (n=11)	0.23	0.15	0.29	10.04	397.42	33.95
Marvel grass (n=14)	0.40	0.12	0.26	38.39	395.97	28.72
Green jowar (n=7)	0.18	0.17	0.18	24.65	178.81	30.57
Gajraj grass (n=5)	0.24	0.16	0.55	14.32	482.56	70.47
Green bajra (n=3)	1.02	0.15	0.45	15.90	904.02	34.45
Sugarcane (n=2)	0.06	0.07	0.05	05.90	81.20	12.03
Groundnut haulms (n=52)	0.95	0.12	0.61	14.75	1431.81	20.70
Jowar hay (n=6)	0.20	0.20	0.23	24.86	212.82	42.91
Cotton seed cake (n=12)	0.16	0.44	0.30	34.25	305.74	45.85
Cotton seed (n=8)	0.12	0.38	0.28	11.21	231.90	43.67
Maize cake (n=4)	0.25	0.41	0.10	05.09	211.52	37.97
Wheat bran + Cotton seed cake (n=36)	0.36	0.68	0.28	146.02	582.66	74.10
Critical Level*	0.30	0.25	0.20	8.00	50.00	30.00
Blood Plasma (n=60)	**mg/dL**	**mg/dL**	**mg/dL**	**ppm**	**ppm**	**ppm**
	12.58±0.41	6.37±0.16	5.61±0.21	1.11±0.13	4.15±0.23	3.30±0.39
Critical Level*	8.0	4.5	2.0	0.6	1.0	0.8

*Critical level in soil (Jackson, 1973), feeds & fodder (McDowell, 1985) and blood (McDowell, 1984).

Table 2: Percent deficit/surplus of minerals in feeds, fodder and lactating Jaffarabadi buffaloes of Junagadh district

	Calcium	Phosphorus	Magnesium	Copper	Iron	Zinc
			Soil (n=60)			
Sufficient	98.34	0	100	96.67	48.34	35
Deficient	1.66	100	0	3.33	51.66	65
			Green forage (n=42)			
Sufficient	42.86	9.53	73.81	90.48	100.00	59.53
Deficient	57.14	90.47	26.19	9.52	0	40.47
			Dry forage (n=58)			
Sufficient	94.83	6.90	100	96.66	100.00	17.25
Deficient	5.17	93.10	0	3.34	0	82.75
			Concentrate (n=60)			
Sufficient	18.34	86.67	83.34	88.34	98.34	91.67
Deficient	81.66	13.33	16.66	11.66	1.66	8.33
			Blood plasma (n=60)			
Sufficient	91.67	98.40	100	63.34	100	91.67
Deficient	8.33	1.60	0	36.66	0	8.33

except, green jowar (0.18%), sugarcane (0.05%) and maize cake (0.10%).

Calcium deficiency in the samples of green forage, dry forage, and concentrate were 57.14, 5.17 and 81.66%, respectively (Table 2). Samples of green forage, dry forage, and concentrate were found to be deficient in phosphorus to varying degrees (90.47 %, 93.10 %, and 13.33 %, respectively). Magnesium deficiency was observed in 26.19 and 16.66 % of the samples of green forage and concentrate, respectively. Findings of the present study were in agreement with the previous reports of Garg *et al.* (2003), Bhanderi *et al.* (2014) and Bhagat *et al*. (2017).

Most of the feedstuffs were found adequate in copper, except sugarcane (5.90 ppm) and maize cake (5.09 ppm). All the feedstuffs were adequate in iron content. The Zn was found at below critical level in marvel grass (28.72 ppm), sugarcane (12.03 ppm) and groundnut haulms (20.70 ppm), whereas other feeds and forages were adequate in zinc. About 9.52%, 3.34% and 11.66% of green forage, dry forage and concentrate samples, respectively, were found deficient in copper. Most of the feedstuffs, except 1.66 % of concentrate samples, were found rich in iron, containing iron above the critical level as suggested by McDowell (1985). The zinc content was found deficient in 40.47%, 82.75% and 8.33% of green forage, dry forage and concentrates, respectively. Findings of the present study were in agreement with the observations of Bhanderi *et al.* (2014) and Bhagat *et al*. (2017).

Blood Minerals

The overall blood mineral profile of lactating Jaffarabadi buffaloes is presented in Table 1. Furthermore, the all minerals, except Zn, varied significantly in the blood plasma of animals of 5 talukas. Macro and micro-minerals concentrations in blood plasma of Jaffarabadi buffaloes were found above critical levels. 91.67 % of lactating Jaffarabadi buffaloes showed normal blood plasma calcium levels. Only 8.33% of buffaloes were found to have levels below the threshold range (Table 2). Panda *et al.* (2015) and Bhagat *et al.* (2017) revealed lower blood calcium in animals from various geographic regions of the country. The findings of the current study were comparable to those of Das *et al.* (2003). Blood phosphorus levels in the buffaloes under study were greater than the critical value recommended by McDowell *et al.* (1984). Results of present study were comparable to those of Garg *et al.* (2008), although Panda *et al.* (2015) and Bhagat *et al*. (2017) observed lower blood phosphorus in dairy animals across various geographical regions of India. All blood plasma samples taken from lactating Jaffarabadi buffalo had magnesium levels above the threshold recommended by McDowell *et al*. (1984) and concurred with those of Bhattacharya *et al.* (2004) and Garg *et al.* (2008). Bhagat *et al.* (2017) however found low blood magnesium levels.

The majority (63.34%) of lactating Jaffarabadi buffaloes showed normal blood plasma copper levels. The mean copper content in blood was in agreement with Bhattacharya *et al.* (2004) and Garg *et al.* (2008), while lower blood copper levels were found in animals by Panda *et al.* (2015). The iron levels in lactating Jaffarabadi buffaloes were found to be higher than the recommended critical values. The current findings were comparable to those of Das *et al.* (2003) and Bhagat *et al.* (2017). The blood plasma zinc levels of lactating Jaffarabadi buffaloes were normal in 91.67 % of the animals. Only 8.33% of buffaloes were found to have blood plasma zinc levels below the threshold range (Table 2), which concurred with Bhagat *et al.* (2017). While Garg *et al.* (2008) and Panda *et al.* (2015) revealed lower blood zinc in animals.

Soil-Plant-Animal Relationship

The relationship of soil to the nutritional values of plant and soil-plant-animal relationships have been emphasized by many workers and had been basis for strategic policies. In present study, soil calcium had a significant (P<0.05) positive relation with that of blood (0.296) and dry forage (0.268) calcium (Table 3). Blood magnesium had significant (P<0.05) positive relation with dry forage magnesium (0.257). Soil iron had significant (P<0.05) positive relation with blood (0.286) iron and highly significant (P<0.01) positive relation with green forage (0.441) iron.

Numerous workers have addressed the correlation between soil and plant nutrition as well as the relationship between plants and animals, which has served as the foundation for strategic initiatives. Findings of Kumaresan *et al.* (2010) contradict the conclusions given by Inbaraj *et al.* (2017), although they did support the calcium relationship. The findings of Kumaresan *et al.* (2010) didn't coincide the magnesium correlation, but were in accordance with Bhat

Table 3: Simple correlation coefficients **(r)** between the soil, green forage, dry forage, concentrate, and blood plasma minerals of lactating Jaffarabadi buffaloes in Junagadh district

Minerals	Soil- Green forage	Soil- Dry forage	Soil- Blood	Blood- Green forage	Blood-Dry forage	Blood- Concentrate
Calcium	-0.134^{NS}	0.268*	0.296*	0.042^{NS}	-0.205^{NS}	-0.008^{NS}
Phosphorus	0.123^{NS}	0.066^{NS}	0.116^{NS}	0.014^{NS}	0.212^{NS}	0.149^{NS}
Magnesium	-0.132^{NS}	-0.016^{NS}	-0.100^{NS}	0.036^{NS}	0.257*	-0.013^{NS}
Copper	0.020^{NS}	0.128^{NS}	-0.003^{NS}	-0.149^{NS}	-0.221^{NS}	-0.145^{NS}
Iron	0.441**	-0.189^{NS}	0.286*	0.036^{NS}	-0.004^{NS}	-0.005^{NS}
Zinc	-0.081^{NS}	0.230^{NS}	0.164^{NS}	-0.061^{NS}	0.173^{NS}	0.038^{NS}

*Significant at 5% level; **Significant at 1% level; ^{NS} Non-significant at 5 % level.

et al. (2011). The copper correlation of the present study is in agreement with Yatoo *et al.* (2011), but contradicted observations of Inbaraj *et al.* (2017). The current study's iron correlations were in agreement with Bhat *et al.* (2011) and Yatoo *et al.* (2011). The current correlations of zinc agreed with those of Bhat *et al.* (2011), Yatoo *et al.* (2011), but contradicted with Inbaraj *et al.* (2017).

Conclusions

It was evident from the current investigation that soil in Junagadh region is deficient in P and Zn. This resulted in P and Zn deficiencies in the fodder crops in that area. These minerals were sufficient in the local concentrate feeds, because of that Jaffarabadi buffaloes' mineral profiles were adequate. It is possible that the low bioavailability of copper in the study area led to copper deficits in some of the animals. To enhance the production and improve the reproduction efficiency there is need to supply the area specific mineral mixture to the animals.

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