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RESEARCH ARTICLE

Micromineral status of soil, fodders and cattle from Idukki and Ernakulam districts of Kerala state, India and their interrelation

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Abstract

Minerals are inorganic dietary constituents required for various metabolic processes in the body. Availability of minerals to animals in appropriate quantities is a major factor determining the health and productivity. Keeping it in view, a baseline survey was conducted in different blocks of Idukki (Idukki, Thodupuzha and Elamdesom) and Ernakulam (Vazhakulam and Muvattupuzha) districts of Kerala state. The aim of the study was to assess the major micro-minerals i.e., copper (Cu), Zinc (Zn) and Iron (Fe) status of soil, plant/fodder and cattle in two districts of Kerala. Soil (n=150), Fodder (n=150) and Serum (n=160) samples from cattle were collected from two districts of Kerala. Minerals in soil, plant/fodder (composite) and serum were estimated by AAS (Atomic Absorption Spectrophotometry). The average Cu, Zn and Fe contents of soil in two representative districts of Kerala were found to be 1.47±0.11, 1.81±0.11 and 37.59±1.0 µg/gm, respectively. The percent of soil deficient in Cu, Zn and Fe were 31.7%, 34.2% and 0%, respectively. Similarly, the average Cu, Zn and Fe contents of fodder were 9.29±0.21, 41.16±1.8 and 710.70±14.48 µg/gm with deficiency of 38.66%, 38% and 0%, respectively. The overall prevalence of Cu, Zn and Fe deficiency in serum samples of cattle were 46.87%, 40.00% and 15%, respectively and in the two representative districts of Kerala. Significant correlation was observed at 1% and 5% level for Cu, Zn and Fe concentrations in soil-fodder-bovine serum in almost all districts.

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Introduction

Minerals are chemical constituents used by the body in many ways. Minerals are one of the important nutritional components having significant role in the health, production, reproduction and immune defense of the animals. Although they yield no energy, they have important roles to play in many activities in the body factors (Soetan et al., 2010). Dairy animals most commonly suffer with the nutritional deficiencies due high production and deficient feeding ultimately leading to poor reproductive performance (Sudhir et al., 2011). The functions performed by minerals can only be fulfilled if the finite amounts ingested are sufficient to keep pace with growth and development of the body and the reproduction of the species and to replace minerals that are lost either as harvested products or insidiously during the process of living. Poor animal performance and reproductive problems in livestock are associated with micro-mineral deficiencies (Underwood, 1977; Sharma et al., 2003).

Mineral deficiency remains at the top of the problem across states in India. The mineral profile of animal body is mainly influenced by mineral status of soil and fodder in a particular geographical area. Soil, plant and management factors can influence the amount of minerals in feedstuff (Sharma et al., 2002). Kerala state has tropical type climate with temperature varying between 21°C to 36°C with minimum seasonal variation and livestock sector contributing about 40% of the agricultural GSDP. While the national level milk production is showing an ascending trend, the total milk production of the State is showing a declining trend from 27.18 lakh tonnes in 2001-

02 to 20.63 lakh tonnes during 2005-06 and increased to 21.18 lakh tonnes during 2006-07 and to 26.43 lakh tonnes in 2010-11 (Economic review, 2011). Infertility is frequent in Kerala which may be due mineral deficiency. As mineral deficiencies in animal rations varies with agro climatic conditions, mapping of such deficiencies needs to be done across such identifiable zones, to develop area specific mineral mixtures for supplementing the ration of animals for improved growth, milk production and reproductive efficiency.

Materials and Methods:

A survey was conducted in two phases in 2 districts of central Kerala (India) viz., Idukki and Ernakulam to record the mineral status in soil, fodder and serum of cross bred cattle. The study area included three blocks of Idukki district namely Idukki, Thodupuzha and Elamdesom and two blocks of Ernakulam district namely Vazhakulam and Muvattupuzha. A total of 150 samples of soil and 150 samples of fodder grown in the same fields were collected. Blood samples were collected using standard protocol. In second phase, the collected samples were processed and mineral profile was analysed. Minerals viz. zinc (Zn), copper (Cu) and iron (Fe) were estimated in soil, fodder and serum samples after digestion. The samples of soil, fodder and serum were digested by the method of Franeck (1992), Trolson (1969), Kolmer et al., (1951) respectively. Mineral content in soil, fodder and serum samples was estimated by atomic absorption spectrophotometer (AAS) (ECIL 4141, Hyderabad, India). All the collected samples of soil, fodder and serum were analysed individually. Data collected from this study were analyzed as per the method described by Snedecor and Cochran (1994) for mean, standard error, analysis of variance (ANOVA) and correlation coefficient by standard't' test. Prevalence percentage was estimated using critical levels of Cu, Zn and Fe in their respective samples.

Result

The mineral content of soil and fodders of two districts of central Kerala is presented in table 1 and their deficiency prevalence in table 2.

The overall prevalence of copper deficiency in two districts of Kerala was 31.7%. The overall mean(±S.E) soil copper (µg/gm) value in five blocks of Idukki and Ernakulam districts of Kerala was 1.47±0.11. The overall prevalence of fodder copper deficiency in different blocks of Idukki and Ernakulam districts of Kerala was 38.66%. The overall mean fodder copper (µg/gm) value in five blocks of Idukki and Ernakulam districts of Kerala was 9.29±0.21 as compared to critical limit of 8 ppm (NRC, 2001). Garg et al., (2007) reported lower Cu concentration in dry and green fodders (7.34 µg/gm) compared to concentrates (15.19 µg/gm) in Kolhapur district of Maharashtra. Mean soil Cu concentration in soils of Kerala was above the critical limit of 0.65 µg/gm of soil (Mc Dowell, 1987). The overall prevalence of serum copper deficiency in two districts of Kerala was 46.87%. The overall mean(±S.E.) serum Cu concentrations (µg/ml) in lactating cattle, non-lactating cattle and calves of Idukki and Ernakulam district of Kerala were 0.66±0.03, 0.70±0.04 and 0.66±0.05, respectively.

The overall prevalence of soil zinc deficiency in two districts of Kerala was 34.2%. The overall mean(±S.E.) soil zinc (µg/gm) value in five blocks of Idukki and Ernakulam districts of Kerala was 1.81±0.11. The mean concentration of soil zinc in soil samples was above the critical limit of 1.00 ppm reported by Cox and Kamprath (1972). The overall mean fodder zinc (µg/gm) value in five blocks of Idukki and Ernakulam districts of Kerala was 41.16±1.8 as against the critical limit of 30 µg/gm (NRC, 2001). The overall prevalence of fodder zinc deficiency was 38%. The overall prevalence of Zn deficiency in fodder samples was comparatively higher than the same in soil samples of Kerala. The overall prevalence of serum Zinc deficiency in two districts of Kerala was 40.00%. The overall mean(±S.E.) serum Zn concentrations (µg/ml) in lactating cattle, non-lactating cattle and calves of Idukki and Ernakulam district of Kerala were 0.63±0.03, 0.78±0.05 and 0.74±0.06, respectively. The micro-mineral concentrations of serum Cu, Zn and Fe in cattle of two representative districts of Kerala is presented in table 3 and their deficiency prevalence is depicted in table 4.

Table 1: Mean±S.E values of soil minerals (µg/g) and fodder minerals (µg/g) from different blocks of Idukki and Ernakulam districts of Kerala

Districts	Blocks	Soil-Cu	Soil-Zn	Soil-Fe	Fodder-Cu	Fodder-Zn	Fodder-Fe
Idukki	Idukki	1.21 ± 0.33^{b}	2.01 ± 0.30^{a}	39.23 ± 2.1^{a}	8.13 ± 0.27^{c}	44.60 ± 3.7^{a}	770.00 ± 30.8^{a}
	Thodupuzha	1.53 ± 0.21^{ab}	2.03 ± 0.28^{a}	40.07 ± 2.1^{a}	9.39 ± 0.50^{abc}	41.70 ± 3.8^{a}	791.00 ± 27.68^{a}
	Elamdesom	1.84 ± 0.30^{a}	2.21 ± 0.17^{a}	44.40 ± 2.3^{a}	10.41 ± 0.60^{a}	45.90 ± 4.1^{a}	813.00 ± 25.94^{a}

Ernakulam	Vazhakulam	1.47±0.18^{ab}	1.18±0.15^{b}	29.05±1.4^{b}	9.81±0.50^{ab}	33.20±3.8^{b}	586.00±16.13^{b}
	Muvattupuzha	1.25±0.23^{b}	1.37±0.10^{b}	33.15±1.6^{b}	8.70±0.33^{bc}	40.40±4.2^{ab}	593.50±14.09^{b}
Overall mean±S.E		1.47±0.11	1.81±0.11	37.59±1.0	9.29±0.21	41.16±1.8	710.70±14.48

Mean±S.E in a column with different superscripts a,b differ significantly (P<0.05)

Table 2: Prevalence of soil and fodder mineral deficiency in different blocks of Idukki and Ernakulam districts of Kerala

Districts	Blocks	No. of samples	Soil-Cu	Soil-Zn	Soil-Fe	Fodder-Cu	Fodder-Zn	Fodder-Fe
Idukki	Idukki	30	12(40%)	9(30%)	0(0%)	15(50%)	11(36.66%)	0(0%)
	Thodupuzha	30	9(30%)	9(30%)	0(0%)	11(36.66%)	9(30%)	0(0%)
	Elamdesom	30	8(26.6%)	8(26.6%)	0(0%)	9(30%)	8(26.66%)	0(0%)
Ernakulam	Vazhakulam	30	9(30%)	15(50%)	0(0%)	11(36.66%)	16(53.33%)	0(0%)
	Muvattupuzha	30	10(35%)	12(40%)	0(0%)	12(40%)	13(43.33%)	0(0%)
Overall prevalence		150	48(31.7%)	53(34.2%)	0(0%)	58(38.66%)	57(38%)	0(0%)

Fig in parenthesis indicate % deficiency

Table 3: Mean±S.E values of serum Copper, Zinc and Iron of cattle from different blocks of Idukki and Ernakulam districts of Kerala

Blocks		Copper			Zinc			Iron		
Districts		Lactating	Non Lactating	Calf	Lactating	Non-Lactating	Calf	Lactating	Non-Lactating	Calf
Idukki	Idukki	0.61±0.09^{a}	0.53±0.08^{b}	0.54±0.14^{b}	0.69±0.06^{a}	0.72±0.11^{a}	0.80±0.17^{ab}	1.91±0.06^{a}	2.29±0.16^{a}	1.44±0.14^{ab}
	Thodupuzha	0.69±0.08^{a}	0.83±0.07^{a}	0.64±0.17^{a}	0.72±0.08^{a}	0.81±0.15^{a}	0.54±0.11^{b}	1.87±0.12^{a}	2.07±0.27^{ab}	1.25±0.20^{ab}
	Elamdesom	0.78±0.09^{a}	0.85±0.04^{a}	0.80±0.12^{a}	0.77±0.08^{a}	0.95±0.12^{a}	1.02±0.15^{a}	1.82±0.09^{a}	2.22±0.23^{a}	1.66±0.36^{a}
Ernakulam	Vazhakulam	0.62±0.06^{a}	0.71±0.15^{ab}	0.74±0.09^{a}	0.46±0.06^{b}	0.65±0.06^{a}	0.49±0.07^{b}	1.55±0.08^{b}	1.54±0.12^{b}	1.06±0.10^{b}
	Muvattupuzha	0.66±0.08^{a}	0.62±0.09^{ab}	0.60±0.11^{a}	0.50±0.09^{b}	0.80±0.13^{a}	0.87±0.14^{ab}	1.46±0.09^{b}	1.63±0.16^{b}	1.09±0.09^{ab}
Overall mean±S.E		0.66±0.03	0.70±0.04	0.66±0.05	0.63±0.03	0.78±0.05	0.74±0.06	1.71±0.04	1.92±0.09	1.27±0.08

Mean±S.E in a column with different superscripts a,b,c differ significantly (P<0.05)

Table 4: Prevalence of serum Copper, Zinc and Iron deficiency in cattle of different blocks in Idukki and Ernakulam districts of Kerala

Districts		Idukki			Ernakulam		Overall prevalence
	Blocks	Idukki	Thodupuzha	Elamdesom	Vazhakulam	Muvattupuzha	
Cu	Lact	8/15 (53.33%)	9/15 (60%)	7/15 (46.6%)	8/15 (53.3%)	6/15 (40%)	38/75 (50.66%)
	Non-lact	7/9 (77.77%)	3/9 (33.33%)	1/9 (11.11%)	5/9 (55.55%)	4/9 (44.44%)	20/45 (44.44%)
	Calf	3/8 (37.5%)	5/8 (62.5%)	2/8 (25%)	4/8 (50%)	3/8 (37.5%)	17/40 (42.5%)
	Overall deficiency	18/32 (56.25%)	17/32 (53.12%)	10/32 (31.25%)	17/32 (53.12%)	13/32 (40.62%)	75/160 (46.87%)
Zn	Lact	4/15 (26.6%)	3/15 (20%)	6/15 (40%)	8/15 (53.3%)	7/15 (46.6%)	28/75 (37.33%)
	Non-lact	3/9	4/9	2/9	5/9	4/9	18/45

		(33.33%)	(44.44%)	(22.22%)	(55.55%)	(44.44%)	(40%)
	Calf	3/8 (37.5%)	5/8 (62.5%)	1/8 (12.5%)	6/8 (75%)	3/8 (37.5%)	19/40 (47.50%)
	Overall deficiency	10/32 (31.25%)	12/32 (37.5%)	9/32 (28.12%)	19/32 (59.37%)	14/32 (43.75%)	64/160 (40%)
Fe	Lact	0/15 (0%)	2/15 (13.33%)	0/15 (0%)	1/15 (6.66%)	1/15 (6.66%)	4/75 (5.33%)
	Non-Lact	1/9 (11.11%)	2/9 (22.22%)	2/9 (22.22%)	1/9 (11.11%)	1/9 (11.11%)	7/45 (15.55%)
	Calf	2/8 (25%)	2/8 (25%)	3/8 (37.5%)	4/8 (50%)	2/8 (25%)	13/40 (32.5%)
	Overall deficiency	3/32 (9.37%)	6/32 (18.75%)	5/32 (15.62%)	6/32 (18.75%)	4/32 (12.5%)	24/160 (15%)

Fig in parenthesis indicate % deficiency

Discussion

The finding of lower fodder zinc may be attributed to lower values of zinc in soil and higher value of iron in soil samples in these districts. Excess iron inhibits the utilization of zinc and copper by plant and thus result in secondary deficiency in plants (Underwood and Suttle, 2001). Similar to Cu, the mean concentration of Zn in the plasma samples of bovine was lowered in lactating cattle as compared to their non-lactating counterparts. This may be due to drain of Zn in the developing foetus in pregnancy and in milk during lactation. Bahram et al., (2011) lower level of serum Zn in pregnant cattle as compared to calves.

Soil iron concentration was higher than required in all the two districts. The mean concentration of Iron in soil samples of both districts of Kerala was adequate to high as compared to critical limits of 20 ppm suggested by NRC (2001). The overall prevalence of iron deficiency in soil samples of Kerala was 0% and the prevalence of iron deficiency in bovines of two districts of Kerala (15%) was negligible. Iron deficiency in cattle calves were found to be high, which may be due to fact that the young animals have higher requirements than adult as suggested by Judson and Mc Farlane, 1998. Concentration of Fe in soil-fodder-cattle revealed significant and positive correlation at 1% and 5% level in all five blocks of two representative districts of Kerala studied.

Conclusion

It can be concluded that soil, fodder and cattle are highly deficient in Copper followed by Zinc. Also the status of micro-minerals was found to be interrelated.

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