

Status of Microminerals Deficiency in Cattle with Relation to Soil and Fodder from Pathanamthitta and Kottayam Districts of Kerala State, India

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Abstract

Mineral status of soil-plant-animal is interrelated and deficiency or excess in one may affect the status of other. Availability and balance of micro-minerals to animals is a major factor determining the health and productivity. Keeping it in view, a baseline survey was conducted in different blocks of Pathanamthitta (Mallapally, Ranni and Ilanthoor) and Kottayam (Vazhoor and Kanjirapally) 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 in soil, composite fodder and cattle in the districts of Kerala. Soil (n=115), Fodder (n=110) and Serum (n=182) samples from cattle were collected for the study. Micro-minerals in soil, composite fodder and plasma were estimated by atomic absorption spectrophotometry. The average Cu, Zn and Fe contents of soil in two representative districts of Kerala were found to be 1.59 ± 0.09 , 1.25 ± 0.03 and 27.81 ± 0.50 $\mu\text{g/gm}$, respectively. The percent of soil deficient in Cu, Zn and Fe were 27.8%, 33.0% and 2.61%, respectively. Similarly, the average Cu, Zn and Fe contents of fodder were 10.46 ± 0.35 , 28.93 ± 0.51 and 354.35 ± 12.37 $\mu\text{g/gm}$ with deficiency of 30.9%, 36.4% and 3.6%, respectively. The overall prevalence of Cu, Zn and Fe deficiency in serum samples of cattle was 35.7%, 47.3% and 11.00 % respectively 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 plasma in almost all the blocks under study. Future efforts should consider these micro-elements supplementation in feeding ration of cattle and to formulate area specific mineral mixture.

Keywords: Cattle, Copper, Continuum, Iron, Kerala, Zinc

Introduction

Micro-minerals are required in small quantities but are essential for the optimal body functions of animals (Sharma *et al.*, 2003). Significance of micro-mineral nutrition with respect to growth, production, reproduction and immunity in cattle has been extensively reviewed (Bhalakiya *et al.*, 2019; Sharma *et al.*, 2008). Trace minerals like Cu, Co, Se, Mn, I, Zn, and Fe can influence the reproductive performance of dairy cattle. Micro-minerals are involved in several- biological processes, such as component of metallo-enzymes and enzyme co factors. These works both as activator of enzymes involved in intracellular detoxification mechanism of free radicals and in stabilization of secondary molecules. Nutrition of grazing animal is a complicated interaction of soil, plants and animals. Several factors directly or indirectly influence the level of minerals in plants and hence the amount available for the animals. The soil occupies a strategic position in the chain of nutrients flow to plant, animal and eventually to man. The extent and pattern of mineral deficiencies and excess in plants vary in different agro-climatic conditions (Singh *et al.*, 2011). In Kerala livestock production has been traditionally practiced mainly as an extensive, low input subsistence system integrated with crop production. Limited research work conducted in the state had indicated areas of mineral imbalance. Also, there were numerous problems of health and reproduction in bovines in different region of the state. Therefore, it is necessary to generate area-wise information on mineral status so as to identify the deficiencies or toxicities. Therefore, this study was conducted to determine the status and correlation of micro-minerals in soil, fodder and animals in Pathanamthitta and Kottayam districts of Kerala state as well as to evolve suitable strategies for their adequate supplementation.

Materials and Methods

A survey was conducted in different blocks of Pathanamthitta (Mallapally, Ranni and Ilanthoor) and Kottayam (Vazhoor and Kanjirapally) districts of Kerala state to record the micro-mineral status in soil, fodder and serum of cattle. Cattle population in these districts were mostly crosses of Holstein Friesian and Jersey.

Sample Collection

The study was undertaken in 2 phases in the different blocks of two representative districts of Kerala. In the first phase, two selected districts of Kerala were surveyed and a total 115 samples of soil and 110 samples of fodder grown in the same field were collected. Blood samples were collected without using anticoagulant for harvesting serum. A total of 182 blood samples from cattle were collected from two districts of Kerala. While collecting the blood samples the information of breed, age and physiological status were recorded. The serum samples were centrifuged and stored at -4° C in refrigerator.

Mineral Estimation

Important micro-minerals zinc (Zn), copper (Cu) and iron (Fe) were estimated in soil, fodder and plasma samples after digestion. The samples of soil, fodder and serum were digested by the method of Franek (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 plasma were analysed individually.

Statistical Analysis

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 t- test. Prevalence percentage was estimated using reported critical levels of Cu, Zn and Fe in their respective samples.

Results and Discussion

The micro-mineral content of soil and fodders of two representative districts of Kerala is presented in Table 1. The micro-mineral content of serum collected from cattle of two representative districts of Kerala is presented in Table 2 and their overall deficiency prevalence in soil, fodder and cattle in Table 3.

Table 1: Mean (\pm SE) values of soil and fodder micro-minerals ($\mu\text{g}/\text{gm}$) from different blocks of two districts of Kerala

Districts	Blocks	Soil (n=115)			Blocks	Fodder (n=110)		
		Cu	Zn	Fe		Cu	Zn	Fe
Pathanamthitta	M (n=20)	1.64 \pm 0.24 ^a	1.24 \pm 0.08 ^a	27.65 \pm 1.14 ^a	M(n=21)	10.53 \pm 0.87 ^a	28.86 \pm 1.57 ^a	368.52 \pm 29.43 ^a
	R (n=20)	1.56 \pm 0.21 ^a	1.29 \pm 0.07 ^a	28.45 \pm 0.94 ^a	R(n=19)	10.68 \pm 0.94 ^a	29.84 \pm 0.89 ^a	331.95 \pm 31.88 ^a
	I(n=20)	1.59 \pm 0.23 ^a	1.19 \pm 0.09 ^a	26.65 \pm 1.11 ^a	I(n=20)	10.31 \pm 0.88 ^a	28.50 \pm 1.17 ^a	353.35 \pm 30.91 ^a
Kottayam	V(n=30)	1.49 \pm 0.15 ^a	1.22 \pm 0.06 ^a	26.97 \pm 1.16 ^a	V(n=25)	10.34 \pm 0.66 ^a	28.60 \pm 0.96 ^a	348.52 \pm 23.80 ^a
	K(n=25)	1.71 \pm 0.19 ^a	1.33 \pm 0.07 ^a	29.36 \pm 1.09 ^a	K(n=25)	10.47 \pm 0.68 ^a	28.96 \pm 1.06 ^a	366.08 \pm 25.89 ^a
Overall mean		1.59 \pm 0.09	1.25 \pm 0.03	27.81 \pm 0.50		10.46 \pm 0.35	28.93 \pm 0.51 ^a	354.35 \pm 12.37

Values in column with different superscript differ significantly ($P<0.05$); Where M is Mallapally, R is Ranni, I is Ilanthoor, V is Vazhoor and K is Kanjirapally blocks

Table 2: Mean (\pm SE) values of serum micro-minerals ($\mu\text{g}/\text{ml}$) in cattle from different blocks of two districts of Kerala

Districts	Blocks	Copper			Zinc			Iron		
		Lactatin g	Non-Lactatin g	Calf	Lactating	Non Lactating	Calf	Lactating	Non Lactating	Calf
Pathanamthitta	M	0.61 \pm 0.04 ^a	0.78 \pm 0.06 ^a	0.66 \pm 0.06 ^a	0.57 \pm 0.03 ^a	0.74 \pm 0.09 ^a	0.68 \pm 0.08 ^a	1.61 \pm 0.10 ^a	1.61 \pm 0.10 ^a	1.45 \pm 0.18 ^b
	R	0.68 \pm 0.03 ^a	0.72 \pm 0.05 ^a	0.68 \pm 0.08 ^a	0.61 \pm 0.06 ^a	0.78 \pm 0.10 ^a	0.61 \pm 0.06 ^a	1.59 \pm 0.10 ^a	1.68 \pm 0.12 ^a	1.43 \pm 0.15 ^b
	I	0.64 \pm 0.05 ^a	0.77 \pm 0.05 ^a	0.84 \pm 0.10 ^b	0.62 \pm 0.05 ^a	0.69 \pm 0.07 ^a	0.60 \pm 0.04 ^a	1.63 \pm 0.11 ^a	1.64 \pm 0.10 ^a	1.67 \pm 0.15 ^a
Kottayam	V	0.64 \pm 0.04 ^a	0.69 \pm 0.05 ^a	0.62 \pm 0.04 ^a	0.64 \pm 0.05 ^a	0.70 \pm 0.08 ^a	0.65 \pm 0.04 ^a	1.58 \pm 0.09 ^a	1.70 \pm 0.12 ^b	1.47 \pm 0.11 ^b
	K	0.60 \pm 0.04 ^a	0.74 \pm 0.06 ^a	0.69 \pm 0.04 ^a	0.60 \pm 0.04 ^a	0.80 \pm 0.09 ^b	0.67 \pm 0.07 ^a	1.65 \pm 0.07 ^a	1.73 \pm 0.09 ^a	1.63 \pm 0.14 ^a
Overall mean		0.63 \pm 0.02 ^a	0.74 \pm 0.02 ^a	0.69 \pm 0.03 ^a	0.61 \pm 0.02 ^a	0.74 \pm 0.04 ^a	0.65 \pm 0.03 ^a	1.61 \pm 0.04 ^a	1.68 \pm 0.05 ^a	1.53 \pm 0.06 ^a

Values in the column with different superscript differ significantly ($P<0.05$)

Table 3: Prevalence micro-mineral (%) deficiencies in soil, fodder, cattle from different blocks of two districts of Kerala

Districts	Blocks	Soil			Blocks	Fodder			Blocks	Cattle		
		Cu	Zn	Fe		Cu	Zn	Fe		Cu	Zn	Fe
Pathanamthitta	M(n=20)	35	40	5	M(n=21)	38.1	42.9	4.8	M(n=35)	37.1	51.4	14.3
	R(n=20)	25	30	0	R(n=19)	26.3	36.8	5.3	R(n=31)	32.3	48.4	9.7
	I(n=20)	30	40	5	I(n=20)	35	40	5	(n=32)	34.4	46.9	9.4
	V(n=30)	26.7	36.7	3.33	V(n=25)	28	40	4	V(n=45)	42.3	51.1	13.3
Kottayam	K(n=25)	24	20	0	K(n=25)	28	24	0	K(n=39)	30.8	38.5	7.7
Overall Deficiency%	(n=115)	27.8	33	2.61	(n=110)	30.9	36.4	3.6	(n=182)	35.7	47.3	11
Critical limits	($\mu\text{g}/\text{gm}$)	0.65	1	20	($\mu\text{g}/\text{gm}$)	8	30	50	($\mu\text{g}/\text{ml}$)	0.65	0.8	0.89

Critical limits were used to calculate the percent deficient samples, Where M is Mallapally, R is Ranni, I is Ilanthoor, V is Vazhoor and K is Kanjirapally blocks

The overall prevalence of copper deficiency in soil samples of two representative districts of Kerala was 27.8%. The mean (\pm S.E.) soil Cu concentration ($\mu\text{g}/\text{gm}$) in soils of two representative districts of Kerala was 1.59 \pm 0.09. The overall prevalence of deficiency of Cu in fodder samples of two representative districts of Kerala was 30.9% and the mean (\pm S.E.) concentration of copper in fodder sample was 10.46 \pm 0.35 $\mu\text{g}/\text{gm}$ 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 mean concentration of soil copper of five blocks was not significantly ($P<0.05$) different from each other. Low level of fodder copper in two districts of Kerala may be attributed to lower value of soil copper and higher concentration of soil molybdenum and iron in these districts. The copper contents of soil was marginally deficient as the mean content was lowered as compared to soil copper concentration in eastern Uttar Pradesh reported by Kumar *et al.*, (2007) and Sharma *et al.*, (2006). Copper and Molybdenum antagonism has been reported by (Hall, 2005). The overall prevalence of serum copper deficiency in two districts of Kerala was 35.7%. The average value of serum copper of lactating cattle was 0.63 ± 0.02 as against critical limit 0.65 ppm (McDowell, 1987). Similar findings were also reported by Kumar *et al.* (2008), Sharma *et al.* (2009), Turkar (2010) and Shekhar *et al.* (2017) in Tripura, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh and Bihar, respectively. Deficiency of copper in serum of cattle may be due to poor biological availability of Cu, due to increased lignification in the fodders of tropical countries and susceptibility of Cu to form biologically unavailable complexes (Cu-Fe, Cu-Zn and Cu-phytase) has been reported by Smith and Akinbamijo (2000). Concentration of Cu in soil-fodder-bovine revealed significant and positive correlation in all five blocks of two representative districts of Kerala studied (Table 4).

Table 4: Pearson correlation coefficients of micro minerals of soil-fodder-serum cattle from different blocks in two districts of Kerala

Group	Mallapally	Ranni	Ilanthoor	Vazhoor	Kanjirapally
Copper					
Soil-fodder	0.859**	0.830**	0.747**	0.749**	0.847**
Soil-SC	0.675*	0.658*	0.649*	0.650*	0.648*
Fodder-SC	0.645*	0.678*	0.667*	0.644 *	0.628*
Zinc					
Soil-fodder	0.848**	0.830**	0.844**	0.889**	0.878**
Soil-SC	0.882**	0.775**	0.872**	0.772**	0.751**
Fodder-SC	0.879**	0.868**	0.772**	0.797**	0.775**
Iron					
Soil-fodder	0.820**	0.858**	0.884**	0.798**	0.896**
Soil-SC	0.628*	0.694*	0.623*	0.745**	0.678*
Fodder-SC	0.634*	0.896**	0.656*	0.653*	0.667*

*Significant at $P<0.05$; **Significant at $P<0.01$ and SC: Serum cattle

The mean (\pm S.E.) soil Zn concentrations (µg/gm) in soils of two representative districts of Kerala was 1.25 ± 0.03 . 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 prevalence of zinc deficiency in soil samples of Kerala was 33.0%. The overall mean concentration of Zinc in fodder samples on dry matter basis was 28.93 ± 0.51 µg/gm which is well below the critical limit of 30 µg/gm (NRC, 2001). The overall prevalence Zn deficiency in fodder samples was comparatively higher than the same in soil samples of surveyed districts of Kerala. The overall percent prevalence of deficiency of Zn in fodder samples was 36.4%. The average serum zinc content of cattle in selected districts of Kerala was in the range of 0.61-0.74 ppm as against the critical limit of 0.8 ppm suggested by McDowell (1987). In the present study, overall prevalence of Zn deficiency of cattle in different blocks of Pathanamthitta and Kottayam districts of Kerala was 47.3%. The present investigation is in corroboration with the findings of Sarma (2011). Kaka (2012) also reported 23.57% of Zn deficiency in plasma samples of bovine of Western Maharashtra. 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). The present finding of soil zinc concentration was higher than those reported by Sharma and Joshi (2005) in soil samples of northern India. Concentration of Zn in soil-fodder-bovine revealed significant and positive correlation at 1% and 5% level in all five blocks of two representative districts of Kerala studied.

Soil iron concentration was higher than required in all the five blocks of two representative districts of Kerala. The

overall prevalence of iron deficiency in soil samples was 2.61%, in fodder samples prevalence was 3.6% and the prevalence of iron deficiency in cattle of two districts of Kerala (11.00%) was negligible. Higher concentration of Fe in fodder sample may be due to high uptake of Fe by plants from soil (McDowell, 1992). Only few plasma samples of cattle were found to be below the critical level of 0.89 ppm (McDowell, 1987).

Correlation coefficients of micro minerals in soil-fodder-serum of cattle, in different blocks of Pathanamthitta and Kottayam districts of Kerala have been depicted in table 4. Copper in soil-fodder was significant ($p < 0.01$) correlated in all the blocks of the district Pathanamthitta and Kottayam of Kerala. Similarly, copper in soil-serum (cattle) was significantly ($p < 0.05$) correlated in all blocks. Likewise, in most of the cases correlation between soil-fodder, soil-serum (cattle), fodder-serum (cattle), and in copper, zinc and iron was significant at 1% and 5% in most of the blocks of the two districts of Kerala.

Conclusion

Soil, fodder and cattle in districts Pathanamthitta and Kottayam of Kerala state were found to be highly deficient in zinc followed by copper. Iron deficiencies were negligible to very low in the samples of soil, fodder and animals. Micro-mineral status in soil, fodder and animal were inter-related. The study signifies the need of supplementation of animals in Pathanamthitta and Kottayam districts of Kerala State with area specific mineral mixture to boost the milk production and health of cattle.

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Conflict of Interests

There is no conflict of interest.

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