Indian Journal of Animal Sciences **79** (3): 306–310, March 2009

Status of soil, fodder and serum (cattle) mineral in high rainfall area of NE region

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Received: 27 October 2007; Accepted: 3 October 2008

ABSTRACT

A study was conducted to record the mineral status in soil, fodder and serum from 4 districts of Tripura state, viz. West, South, North and Dhalai Tripura. Soil samples from these districts showed an overall average prevalence of phosphorus, zinc, copper and cobalt deficiency. Similarly, overall prevalence of calcium (Ca), magnesium (Mg), phosphorus (P), zinc (Zn), copper (Cu), iron (Fe), cobalt (Co), and selenium (Se) deficiency in fodder was 8.24%, 9.61%, 27.47%, 44.78%, 30.21%, 4.12%, 39.28%, and 4.67% respectively. The overall prevalence of serum P, Zn, Cu, Co, and Se deficiency was 30.03%, 36.75%, 35.96%, 38.73% and 6.32% respectively. Cattle of Tripura State were highly deficient in phosphorus. Soil, fodder and cattle of Tripura State were highly deficient in zinc followed by copper and cobalt.

Key words: Cattle, Fodder, Macro mineral, Micro mineral, Serum, Soil, Tripura

Livestock depend on forages for their mineral requirements, which are deficient in several minerals content as because they grow on a deficient soil (Sharma *et al*. 2005). In cattle under field conditions reproductive failure is a major problem due to hormonal imbalance, reproductive diseases and deficiency or imbalances of minerals (Prasad and Rao 1997). Soil mineral content keeps on changing due to pressure on land for maximum crop production, fertilizer application, natural calamities, which may alter their contents in feeds, fodders and their status in animals thereby exhibiting an area specific problem (Underwood and Suttle 1999).

As mineral deficiency is an area problem (McDowell 1985) so with this objective, a study was conducted in different districts of Tripura state, as very scanty information is available of this state about the mineral status of soil, plants and animals.

MATERIALS AND METHODS

To record the mineral profile in soil, fodder and serum cattle, a study was conducted in the 4 districts of state of Tripura i.e. west, south, north and Dhalai (latitude 22° 56" and 24° 34" North, longitude 91° 0" and 92° 22" East, with average rain fall 2000 mm and a temperature range from 35.23° to a minimum of 7.43° C).

Collection of soil samples: Composite soil samples were collected from different sites of various farms of 4 different districts of Tripura. Soil samples (330) were collected. Soil sample approximated 100 g were collected from the various fields where fodder was cultivated. The collected soil samples were dried in a hot air oven at 100°±5°C overnight and then were ground and stored after labeling in an airtight polythene packet for laboratory analysis.

Collection of fodder samples: The various fodder samples collected include fodders, which were being fed to the cattle from the animal owners as well as those collected from standing crops in the fields. Samples (364) of various fodders were collected. The collected fodder samples were dried in a hot air oven at 100°±5°C overnight, ground, labeled and properly stored in airtight polythene bags for laboratory analysis.

Collection of serum samples: Blood (10 ml) was collected from jugular vein, with the help of Teflon needle, in a sterilized test-tube without any anticoagulant for harvesting the serum. The tube containing blood was kept at room temperature (20° to 22° C) without disturbing it. After 2–4 h, the clot was broken with the help of pasture pipette and serum was collected using micropipette in micro-centrifuge tubes and properly labeled. The serum samples were centrifuged and stored at –4°C in refrigerator.

Laboratory analysis: Digestion of soil samples was done

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as per Franeek (1992). The fodder samples were digested by the method of Trolson (1969). Serum sample was digested as per procedure described by Kolmer *et al*. (1951). Mineral content was estimated by atomic absorption spectrophotometer.

Estimation of phosphorus from soil and fodder: Phosphorus was estimated by the method of Talapatra *et al*. (1940).

Estimation of serum inorganic phosphorus: The serum inorganic phosphorus was estimated as per Taussky and Shorr (1953). Phosphorus in the form of inorganic phosphate was allowed to react with molybdic acid, producing the phosphomolybdate complex. This was reduced to a blue-compound that is proportional to the phosphorus concentration.

For statistical analyses the data were processed as per the Snedecor and Cochran (1994) for mean, standard error, analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Soil minerals: The average value (%) of soil calcium was nonsignificantly (P<0.05) high (Table 1) in all the districts when compared to the normal value of 0.3%. The mean value of soil phosphorus (%) in Tripura state was significantly (P<0.05) low (normal value 0.25%) in all the districts of Tripura state (Table 1). The overall calcium and magnesium (normal value 0.20%) content in soil of Tripura state was high, which may be due to the type of soil and agro-climatic condition of the state. Baruah *et al*. (2000) estimated the different macro- and micro-mineral status of soil in the Hills of Guwahati in Assam, found that Ca, Mg were well within the normal range while inorganic phosphate was deficient. Significantly (P<0.05) lower average value (ppm) of soil zinc was recorded in all the districts surveyed, when compared to normal (1.5 ppm). Zinc and copper contents of soil were lower than the critical level but iron and molybdenum were higher than the critical values as given by McDowell (1985). Soil leaching, long-term cropping may be the probable reasons for depletion of soil minerals which is in corroboration with the finding of Sharma *et al*. (2004).

Significantly (P<0.05) lower average value (ppm) of soil cobalt was recorded in all the 4 districts. The cobalt content in the soil of all the 4 districts surveyed was deficient i.e. below the critical value (0.5 ppm) as reported by McDowell (1985). Sarkar *et al*. (1992) also reported similar finding in soil of West Bengal. The prevalence of cobalt deficiency was also observed by Sahoo *et al*. (2007). No deficiency of soil selenium was recorded in all the districts of Tripura. Peterson (1990) reported that if selenium level is below 0.2 ppm it is considered as selenium deficiency.

Fodder minerals: The average value (%) of fodder calcium was within the normal range (0.7%) in all the 4 districts. The maximum average concentration of magnesium (%) was recorded in South Tripura district and minimum in North Tripura district (Table 2). Higher calcium level in the tree leaves was also reported by Dhok *et al*. (2005). The low prevalence of the calcium and magnesium deficiency is due to the fact that soil of this area is also less deficient in Ca and Mg. Low deficiency of fodder Ca and Mg was reported by Baruah *et al*. (2000) from the hilly regions of Assam.

Significantly (P<0.05) lower average value of fodder phosphorus was recorded in all the districts of Tripura state. Prevalence of fodder phosphorus deficiency was 27.47% in the state of Tripura with mean value of 0.11% as against the critical limit of 0.20% (McDowell 1985). Phosphorus deficiency in these areas may be due to excessive use of inorganic fertilizers and pesticides as these interfere with the absorption of minerals by fodders. Sharma *et al*. (2002) reached into similar conclusions. Significantly (P<0.05) lower average values of fodder zinc were recorded in all the 4 districts of Tripura (Table 2). The concentration of zinc in fodder of Tripura state was 22.02 ppm, which is much below the critical level of 30.00 ppm (NRC 2001). Low soil content of zinc may be reflected in fodders grown on deficient soils

Table 1. Soil minerals (mean and SE) in various districts of Tripura

Districts	Ca (%)	Mg (%)	P (%)	Zn (ppm)	Cu (ppm)	Fe (ppm)	Co (ppm)	Se (ppm)
Normal range	0.3 %	0.20 %	0.25 %	1.5 (ppm)	2.5 (ppm)	50 (ppm)	0.5 (ppm)	0.5 (ppm)
West	1.66± 0.17	0.81 ±0.03	0.17* ±0.03	0.73* ±0.15	1.84 ±0.51	55.87 ±0.35	0.11* ±0.001	0.44 ±0.01
South	1.78 ±0.25	0.64[b] ±0.03	0.09* ±0.04	1.12*[b] ±0.16	0.71*[b] ±0.43	49.61 ±0.56	0.15* ±0.003	0.46 ±0.01
North	1.26 ±0.14	0.64[b] ±0.02	0.20* ±0.01	0.77* ±0.17	1.35 ±0.39	55.28 ±0.54	0.18*[b] ±0.012	0.42 ±0.01
Dhalai	1.98 ±0.16	0.75 ±0.04	0.14*[b] ±0.06	1.07*[b] 1.82*	1.82* ±0.52	59.96 ±0.61	0.21*[b] ±0.006	0.43 ±0.01

*Values differ significantly (P<0.05) as compared to the normal; values with a superscript differ significantly (P<0.05) within the column.

Table 2. Fodder minerals (mean and SE) in various districts of Tripura

Districts	Ca (%)	Mg (%)	P (%)	Zn (ppm)	Cu (ppm)	Fe (ppm)	Co (ppm)	Se (ppm)
Normal range	0.7%	0.3	0.2%	30 (ppm)	8 (ppm)	50 (ppm)	0.1 (ppm)	0.2 (ppm)
West	0.80 ±0.05	0.29 ±0.03	0.14* ±0.09	22.30* ±2.39	5.72* ±2.63	89.50 ±18.15	0.04* ±0.01	0.29 ±0.01
South	0.76[b] 0.04	0.43[b] ±0.04	0.10*[b] ±0.09	23.31* ±2.28	6.65*[b] ±2.51	88.39 ±17.30	0.05* ±0.02	0.28 ±0.01
North	0.73[b] ±0.01	0.28 ±0.04	0.11* ±0.09	25.15* ±2.28	4.41* ±2.51	47.67[b] ±17.30	0.08*[b] ±0.01	0.27 0.01
Dhalai	0.81 ±0.01	0.31 ±0.03	0.09*[b] ±0.08	17.32*[b] ±2.10	6.43*[b] ±2.31	87.49 ±15.92	0.07* ±0.02	0.28 ±0.01

*Values differ significantly (P<0.05) as compared to the normal; values with a superscript differ significantly (P<0.05) within the column.

and thus zinc deficiency in fodder may be attributed to their low content in soil of the surveyed region. Sharma and Joshi (2005) have observed significant deficiency of zinc in fodder of 10 districts of northern India. Garg *et al*. (2004), recorded low zinc level in almost all the feedstuff of Kutch district of Gujarat.

The highest fodder copper concentration (ppm) was observed in South Tripura district (6.65±2.51). The concentration of copper in fodder of Tripura state was 5.80 ppm, which is much below the critical level of 8 ppm (NRC 2001). The iron content in most of the feedstuffs was above the critical level of 50 ppm (NRC 2001). Maximum levels of iron in feedstuffs have also been reported by Mandal *et al*. (1996), which might be due to its high uptake, by plants from the soil. Earlier reports by McDowell (1985) also indicated that plants grown on acid soil often contained quite high level of iron. The maximum concentration of fodder cobalt (ppm) was 0.06±0.01 in North Tripura district. The average value (ppm) of fodder cobalt was significantly (P<0.05) low in all the districts surveyed as compared to the normal value of 0.1 ppm. In the present study, prevalence of fodder cobalt deficiency was 39.28% in Tripura with the concentration of cobalt in fodder of Tripura state was 0.06 ppm, which is much below the critical level of 0.10 ppm (NRC 2001). Das *et al*. (1997) reported mean values of forage cobalt in grasses and shrubs of Midnapur districts as 0.09 and 1.45 ppm respectively. The average value of fodder selenium (ppm) was maximum in West Tripura district (0.29±0.01). The concentration of selenium in fodder of Tripura state was 0.28 ppm against the critical limit of 0.2 ppm (NRC 2001). A similar finding was reported by Hussain (2006) in the fodder of Vidharbha region of Maharashtra.

Serum minerals: The values of serum minerals (cattle) in various districts of Tripura are given in the Table 3. The overall average concentration of serum calcium in lactating cattle was 8.59±6.07 (mg/dl) in Tripura state. Mean value of serum calcium of lactating cattle of the state showed significantly (P<0.05) low values when compared to the normal (11.28 mg/dl). This might be probably due to the requirement of this mineral dependent on the level of productivity and the physiological status (Mcdowell 1985). The overall mean values of serum magnesium (mg/dl) in

Table 3. Serum (lactating cattle) minerals (mean and SE) in various districts of Tripura

Districts	Ca (%)	Mg (%)	P (%)	Zn (ppm)	Cu (ppm)	Fe (ppm)	Co (ppm)	Se (ppm)
Normal range	11.28 (mg /dl)	3.27 (mg /dl)	6.17 (mg /dl)	1.01 (ppm)	0.65 (ppm)	5.21 (ppm)	0.05 (ppm)	0. 03 (ppm)
West	8.43* ±6.05	3.04± 0.76	4.23* ±0.43	0.64* ±0.03	0.45± 0.02*	12.60 ±2.65	0.04 ±0.02	0.027 ±0.06
South	8.59* ±6.34	3.73± 0.45	4.48* ±0.31	0.31* ±0.02	0.32± 0.04*[b]	11.09 ±1.95	0.03*[b] ±0.02	0.024 ±0.02
North	9.51* ±5.20	2.94± 0.94	4.07* ±0.42	0.19*[b] ±0.07	0.35± 0.05*	27.47[b] ±8.02	0.02*[b] ±0.01	0.030 ±0.04
Dhalai	7.85*[b] ±6.70	2.15± ±0.70	4.25* ±0.36	0.51* ±0.06*[B]	0.46± 0.06	16.07 ±4.24	0.03*[b] ±0.01	0.026 ±0.01

*Values differ significantly (P<0.05) as compared to the normal; values with a superscript differ significantly (P<0.05) within the column.

lactating were 2.96±0.71. The mean values of serum magnesium were within the normal limit in all the districts surveyed. The level of magnesium in serum was within the normal range (Baruah *et al*. 2000). Similar findings have also been reported by Sharma and Joshi (2006). The overall mean of serum phosphorus (mg/dl) in lactating was 4.25±0.38. The mean value of serum phosphorus was significantly (P<0.05) low. The mean value of serum phosphorus was significantly lower than that of the normal (6.17 mg/dl) in all the districts (Table 3). Baruah *et al*. (1998), reported lower phosphorus values during winter in Jersey cattle of Assam region.

The mean value of serum zinc was significantly (P<0.05) lower than that of the normal (1.01 ppm) in lactating cattle of all the districts. Zinc was deficient and prevalence of its deficiency in cattle of Tripura state was 36.75%. This may be due to low content of zinc in feed and fodder of the region. The average serum zinc content of bovines in Tripura state was in the range of 0.41–0.72 ppm as against the critical limit of 0.6–1.01 ppm suggested by McDowell (1985). The overall average concentration of serum copper and cobalt (ppm) in lactating cows was 0.39±0.04 and 0.03±0.01 respectively. Significantly (P<0.05) lower values of these were observed lactating cattle of all the 4 districts. Molybdenum and sulfate form thiomolybdates in the rumen when fed in excess. Thiomolybdate form complex with Cu at both the gastro- intestinal and tissue level rendering it unavailable to the animal (AlIen and Gawthorne 1987, Suttle 1991). Lower Cu concentrations are related not only to generally lower dietary Cu intake but also they may be due to reduced Cu utilization by the animals. The overall average value of serum cobalt in cattle of Tripura state was in range of 0.02 to 0.03 ppm. McDowell (1985) reported critical level of cobalt as 0.05–0.07 ppm. Sharma and Joshi (2004) also reported deficiency of cobalt in soil, fodder and serum samples in cattle of Garwhal region of Uttaranchal state. Baruah and Baruah (1998) have reported serum cobalt level in healthy Jersey heifer range from 0.05–0.07 ppm in different seasons in Assam. The overall mean serum selenium concentration of cattle of Tripura state was in the range of 0.26 to 0.29 ppm as against the critical level of 0.03 ppm as suggested by McDowell (1985).

The present study indicated that there is a significant deficiency of P, Zn, and Cu in the soil, fodder, serum (cattle) of Tripura state. The amount of Ca, Mg, Fe and Se is adequate in these samples. It is envisaged to formulate an area specific mineral mixture on the basis of the deficiency obtained to increase the productivity of the bovines of this region.

ACKNOWLEDGEMENT

Authors are highly thankful to the Director, Indian Veterinary Research Institute (IVRI), Izatnagar, for his kind cooperation during the course of this work.

REFERENCES

Allen J D and Gawthorne J M. 1987. Involvement of the solid phase rumen digesta in the interaction between copper, molybdenum and sulphur in sheep. *British Journal of Nutrition* **58**: 265–76.

Baruah A, Baruah K K and Bhattacharya B N. 2000. Certain macro and micro minerals in prepuberal jersey heifer in relation to soil and forage. *Indian Journal of Animal Sciences* **70**: 93–5.

Baruah A and Baruah K K. 1998. Molybdenum status of soil, forage and serum of prepuberal jersey heifers in different districts of Assam. *Indian Journal of Animal Sciences* **51**: 37.

Baruah A, Baruah R N, Baruah K K, Goswami J N, Baruah KMK, Baishya N and Goswami R N. 1998. Effect of seasons and location on serum macro minerals in pre-puberal Jersey heifers. *Indian Veterinary journal* **75**: 1095–98.

Dhok A P, Rekhate D H and Wankhade S G. 2005. Mineral status of goats in relation to common the lower fed in Akola district. *Indian Journal of Animal Sciences* **75**: 77–80.

Franeck M A. 1992. Soil lead value in small town environment. A case study from mt. Pleasant Michigan. *Environmental Pollution* **76**: 251–57.

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. *Indian Journal of Animal Nutrition* **21**: 8–12.

Hussain K. 2006. 'Soil-fodder-animal, mineral interaction with special reference to bio-chemical profile in bovines of Vidharba region of Maharastra and efficacy of formulated mineral mixture and production.' Ph.D. thesis, Submitted to Deemed University IVRI, Izatnagar, Bareilly, Uttar Pradesh.

Kolmer J A, Spanbling E H and Robinson H W. 1951. *Approved Laboratory Technique*. Appleton Century Crofts, New York.

Mandal A B, Yadav P J, Sunaria K R, Kapoor V and Maan N S. 1996. Levels of micronutrients in soil, feed, fodder and animals of North East transition and dry zones of Karnataka. *Indian Journal of Animal Nutrition* **18**: 235–42.

McDowell L R. 1985. *Nutrition of Grazing Ruminants in Warm Climates*. Academic Press, New York.

NRC. 2001. *Nutrient Requirements of Dairy Cattle*. 7th rev. edn. National Academic Science, Washington, D.C.

Petersen M K. 1990. *Considerations in Trace Mineral Supplementation*. Great Plains Beef Cattle Handbook GPE–1302.

Prasad K S N and Rao S V N. 1997. Blood mineral profile of anestrous and repeat breeder crossbred cows. A field study. *Indian Journal of Animal Nutrition* **14**: 135–37.

Sahoo N, Rout P R, Samal P C, Parida G S and Sardar K K. 2007. Trace elements in soil, pasture and serum of grazing cattle. *Indian Veterinary Journal* **84**: 326–27.

Sharma M C and Joshi C. 2006. Haematobiochemical, vitamin and hormone profile of macro-mineral deficient cattle of Northern India. *Indian Journal of Animal Sciences* **76**: 727–32.

Sharma M C and Joshi C. 2005. Therapeutic efficacy of zinc sulphate used in clustered model treatment in alleviating zinc deficiency in cattle and its effect on hormones, vitamins and production parameters. *Veterinary Research Communication* **28**: 7–20.

Sharma M C, Joshi C and Kumar K. 2005. Micromineral- their deficiency disorders and treatment: A review. *Indian Journal of Animal Sciences* **75**: 246–57.

Sharma M C, Joshi C and Sarkar T K. 2002. Therapeutic efficacy of minerals supplement in macro minerals deficient buffaloes and its effect on haematobiochemical profile and production. *Asian-Australasian Journal of Animal Science* **15**(9): 1278–87.

Sharma M C, Yadav M P and Joshi C. 2004. *Minerals: Deficiency Disorders, Therapeutic and Prophylactic Management in Animals*.1st edn, pp 43–48 IVRI, Izatnagar.

Snedecor G W and Cochran W G. 1994. *Statistical Methods*. Iowa State University Press, Ames, Oxford and IBH, New Delhi.

Suttle N F. 1991. The interactions between copper, molybdenum and sulphur in ruminant nutrition. *Animal Nutrition Review* **11**: 121–140.

Talapatra S K, Roy S C and Sen K C. 1940. Estimation of phosphorus, chlorine, cacium, magnesium, sodium and potassium in feeding staff. *Indian Journal of Veterinary Science and Animal Husbandry* **10**: 243.

Taussky H H and Shorr E. 1953. A macro colorimetric metric method for the determination of inorganic phosphorus. *Journal of Biological Chemistry* **202**: 675–85.

Trolson J E. 1969. *Outline for in vitro Digestion of Forage Samples*. Research Station. Shift Current, Saska, Shawan, Canada.

Underwood E J and Suttle N F. 1999. *The Mineral Nutrition of Livestock*. 3rd edn. CABI Publishing (UK).

Vijchulata P. 1995. Blood plasma mineral and fertility of dairy cows in central Thailand. *Australian Journal of Animal Science* **8**: 263–65.