



Trace Mineral Status in Parbhani District of Maharashtra

Singare et al.

## Status of Copper, Iron, Manganese and Zinc in Soil, Fodder and Blood Serum of Cattle from Parbhani District of Maharashtra

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### ABSTRACT

The present investigation was carried out to study the mineral status of soil, fodder and blood serum of cattle from Parbhani district of Maharashtra. Total 183 each of soil, sorghum straw and blood serum samples were collected and analyzed for their mineral contents and its significance viz. Cu, Fe, Mn and Zn. The results revealed that except DTPA-Zn (88% samples) in soils, Parbhani district was found sufficient in DTPA- Cu (100% samples), DTPA- Fe (75% samples) content and DTPA- Mn, whereas same trend was reflected in case of mineral concentration of straw where 95.7% straw samples were found deficient in total Zn. In case of total Mn 34.9% straw samples were found deficient, while other minerals like total Cu (90.7% samples) and total Fe (100% samples) were observed to be sufficient in sorghum straw tested. In case of serum mineral concentration serum Fe (100% samples) and serum Zn (100% samples) were found sufficient, while 32% serum samples were found deficient in Cu content. Inconsistent results were observed regarding correlation between mineral contents of soil, straw and blood serum of cattle. Copper and zinc showed positive correlation, whereas iron showed negative correlation between soil and plant. In contrast to plant and serum, all three minerals showed negative correlation. Between soil and serum iron and zinc showed positive correlation whereas, copper showed negative correlation. Based on the results it was concluded that for improvement in production and reproduction efficiency the cattle of Parbhani district need to be supplemented with copper, manganese and zinc by formulating area specific mineral mixture using highly bio-available mineral salt.

**KEYWORDS:** Copper, Fodder, Iron, Manganese, Serum of cattle, Soil, Zinc.

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### INTRODUCTION

All human beings and animals need nutrients, vitamins, minerals and water for proper growth and development. Minerals occupy an important place in animal nutrition for production as well as health (McDonald et al., 2009). Animals require some of the same micronutrients as plants (Cu, Fe, Mn, Mo and Zn) plus Co, I and Se. Though all trace minerals are required to carry out the optimum functions of the animal body but iron, copper and zinc are extremely important for the animals as they play vital physiological roles in livestock (Kumar et al., 2008). However, malnutrition (under nutrition) is a very common feature in Indian human population and even in livestock population. May be we have achieved

food security however we are yet nutritionally unsecure. The livestock population is too suffering due to malnutrition in general and under nutrition in particular. The livestock population of Maharashtra depends upon the feed and fodder available with the farmers. It is expected that soil as a source of nutrient if deficient in nutrient, the fodder grown in the same soil will have insufficient amount of that particular nutrient. This will cause under nutrition/ mineral imbalances in the livestock fed on this fodder. Therefore, knowledge of mineral requirements of forage plants and grazing animals is essential to understand the complex interactions between the mineral elements. Keeping this in view, a study was undertaken to assess of micro nutrient status in soil,

fodder and serum of dairy cattle in Parbhani District of Maharashtra.

## MATERIALS AND METHODS

The study was conducted in Parbhani district of Maharashtra. Parbhani district consists of nine tahsils. From three to five villages of tahsil and two to five farmer from village samples of soil, fodder and blood serum of cow were collected. Total 183 soils, 183 fodder (sorghum straw) and serum samples were collected from Parbhani district. Soil samples at 0-15 cm depth were collected from selected farmer's field from where sorghum fodder was harvested for feeding cattle and labelled properly. DTPA (Di-ethylene tri amine penta acetic acid) extractable soil micronutrients were estimated by the method given by Lindsay and Norvell (1978). Sorghum straw serves as the main source of dry fodder in this district in summer season. Sorghum straw samples used for feeding to cattle were collected from the same field. The straw samples were drawn at the time of soil and blood collection. Blood samples were collected from cattle to which sorghum fodder grown on same soil was fed. Approximately 10 ml blood was collected from each cow in clean, sterilized test tube without anticoagulant for harvesting the serum. The sorghum straw samples and serum samples were digested using improved  $\text{HNO}_3/\text{H}_2\text{O}_2$  (5:4) method given by Pequerulet al. (1993). Digested samples were analyzed for their mineral (Cu, Fe, Mn, and Zn) concentrations by the atomic absorption spectrophotometry. The

correlation between soil, fodder and serum was worked out as per the method given by Panse and Sukhatme (1985).

## RESULTS AND DISCUSSION

Overall results of soil, sorghum straw and serum analysis (Table 1) for status of copper from Parbhani district revealed that DTPA extractable copper ranged from 0.27 to 5.64 mg kg<sup>-1</sup> with an average of 2.34 mg kg<sup>-1</sup>. Compared to critical level of 0.2 mg kg<sup>-1</sup> of copper in soil, all soil samples were found sufficient with respect to copper content. Sufficiency of copper in soil was also reported by Yadav and Khirwar (1999), Ramana et al. (2000), Gowda et al. (2002) and Gowda et al. (2003). Copper concentration of sorghum straw observed to vary from 3.20 to 67.58 mg kg<sup>-1</sup> with an average of 28.30 mg kg<sup>-1</sup> in sorghum straw samples from Parbhani district. It was found sufficient in 90 per cent fodder samples analyzed. It clearly indicates reflection of soil copper in fodder. Still 10 per cent straw samples were found deficient with respect to total copper concentration. As contents of mineral elements is often inversely related to plant maturity (Mc Dowell et al., 1983) which could be responsible for lower level of total copper in fodder analyzed. Shukla et al. (2009) also found deficiency of copper in paddy straw though it was sufficient in soil and reported that typical soil condition that might be restricting uptake and accumulation of copper in plants, particularly high iron concentration in soil must have resulted in low copper availability in plants.

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Table 1. Concentrations of Cu in soil, sorghum straw and blood serum of cattle in different tahsils from Parbhani district

Sr. No.	Name of tahsil	Soil Cu mg kg <sup>-1</sup>	Cu content of sorghum straw mg kg <sup>-1</sup>	Serum Cu content µg ml <sup>-1</sup>
1	Jintur	2.20-4.24 (2.79)	19.35-67.58 (39.72)	0.20-1.30 (0.64)
2	Parbhani	0.27-2.25 (1.51)	32.53-67.58 (46.35)	0.40-2.40 (0.92)
3	Pathri	2.24-2.61 (2.42)	30.50-46.50 (38.27)	0.30-0.80 (0.57)
4	Selu	1.18-5.64 (3.24)	19.25-49.75 (34.60)	0.40-0.90 (0.65)
5	Sonpeth	1.25-2.77 (2.08)	3.20-52.70 (18.33)	3.0-6.0 (4.83)
6	Purna	1.38-2.41 (1.96)	6.80-20.80 (11.56)	1.40-4.60 (2.83)
7	Gangakhed	1.69-3.39 (2.22)	14.0-47.70 (18.86)	0.70-11.0 (2.49)
8	Manwat	1.50-2.98 (2.25)	9.0-36.0 (16.44)	2.70-12.20 (8.06)
9	Palam	1.80-2.91 (2.45)	6.20-14.90 (9.04)	1.0-3.20 (1.79)
	Parbhani district	0.27-5.64 (2.34)	3.20-67.58 (28.30)	0.20-12.20 (2.27)

In case of serum copper concentration ranged from 0.20 to 12.20 µg ml<sup>-1</sup> with a mean value of 2.27 µg ml<sup>-1</sup>. Serum copper was recorded deficient to the tune of 32 per cent in cattle of Parbhani district. High level of iron in diet of cattle could be responsible

for lower levels of serum copper as reported by Noaman (2013). Jena et al. (2012) also observed deficiency of serum copper due to poor biological availability of cooper although copper content in feeds and fodder was marginally higher.

Table 2. Concentrations of Fe in soil, sorghum straw and blood serum of cattle from different tahsils from Parbhani district

Sr. No.	Name of tahsil	Soil Fe mg kg <sup>-1</sup>	Fe content of sorghum straw mg kg <sup>-1</sup>	Serum Fe content µg ml <sup>-1</sup>
1	Jintur	9.98-14.40 (11.84)	186.75-445.25 (278.83)	25.80-64.0 (41.79)
2	Parbhani	8.26-15.52 (11.61)	275.0-429.50 (342.21)	15.80-64.80 (33.95)
3	Pathri	10.26-17.95 (14.44)	201.75-375.50 (300.96)	25.0-37.0 (30.21)
4	Selu	10.18-25.48 (16.24)	78.50-340.0 (225.66)	20.30-34.0 (26.99)
5	Sonpeth	2.17-4.01 (2.89)	162.0-617.80 (334.28)	23.10-55.80 (29.85)
6	Purna	3.51-8.22 (5.62)	222.50-553.40 (413.09)	10.90-67.0 (25.19)
7	Gangakhed	2.74-6.73 (4.90)	400.0-835.40 (548.52)	9.20-72.60 (27.20)
8	Manwat	2.78-6.90 (4.16)	314.60-663.40 (457.93)	17.80-78.30 (41.24)
9	Palam	2.24-5.48 (3.75)	282.70-678.90 (538.84)	4.90-70.0 (19.13)
	Parbhani district	2.17-25.48 (9.15)	78.50-835.40 (372.69)	4.90-78.30 (31.32)

The content of DTPA - Fe found to vary from 2.17 to 25.48 mg kg<sup>-1</sup> (9.15mg kg<sup>-1</sup>) in soils of Parbhani district (Table 2). About 75 per cent soil samples were found to contain normal amount of available iron. The sufficient iron concentration in soil was also reported by Gowda et al.(2003), Kalita et al.(2003), Sharma et al. (2003).The iron content of sorghum straw and serum Fe concentration found to range from 78.50 to 835.40 mg kg<sup>-1</sup> (372.69 mg kg<sup>-1</sup>) and 4.90 to 78.30 µg ml<sup>-1</sup> (31.32 µg ml<sup>-1</sup>), respectively. These results indicated its adequacy in fodder and serum samples from Parbhani district. Results indicated that straw samples contained higher levels of total iron as compared to critical level of 50.0 mg kg<sup>-1</sup> for plant iron content. The fodder proved to be rich source of iron in spite of marginal deficiency of iron in soils. This might be due to high level of Fe in soil as well as efficient uptake of iron from soil to plants as reported by Kalita et al. (2003).

Kumar et al. (2002) also reported many fold higher concentration of iron in fodder. Dhore and Udar (2007), Sunder et al. (2007), Garg et al.(2010) and Fardous et al. (2011) also observed higher level of iron in feeds and fodder. Higher concentration of iron in serum of cows was recorded. This might be due to the abundance of element Fe in fodders grown on naturally Fe rich soil as reported by Singh et al. (2011). Similar results were also reported by Das et al. (1997), Das et al. (2002), Sharma et al. (2003), Bhat et al. (2011a), Yatoo et al. (2011) and Panda et al. (2015).

Tahsil wise range and mean values of manganese content in soil, sorghum straw and serum of cattle were presented in table 3. The manganese concentration of soils of Parbhani district observed to be ranged from 2.86 to 24.33 mg kg<sup>-1</sup> (13.69 mg kg<sup>-1</sup>). It was recorded sufficient in all (100 per cent) soil sample analyzed.

Table 3. Range and average of Mn in soil, sorghum straw and blood serum of cattle from different tahsils from Parbhani district

Sr. No.	Name of tahsil	Soil Mn (mg kg <sup>-1</sup> )	Mn content of sorghum straw (mg kg <sup>-1</sup> )	Serum Mn content (µg ml <sup>-1</sup> )
1	Jintur	13.50-21.40 (16.20)	23.0-60.0 (39.73)	0.10-1.40 (0.57)
2	Parbhani	10.83-19.17 (14.21)	32.0-90.50 (48.68)	0.80-2.40 (1.66)
3	Pathri	14.20-18.32 (15.93)	25.25-63.50 (41.64)	1.0-2.0 (1.43)
4	Selu	8.13-24.33 (13.58)	8.0-48.0 (28.82)	0.60-2.0 (1.10)
5	Sonpeth	9.01-15.78 (13.32)	19.10-88.90 (42.67)	1.0-3.90 (2.03)
6	Purna	10.50-20.92 (14.71)	22.60-55.70 (42.99)	2.30-7.60 (4.38)
7	Gangakhed	12.68-20.68 (16.25)	30.0-186.30 (87.84)	1.70-6.80 (4.04)
8	Manwat	7.51-19.47 (10.70)	29.40-99.60 (68.11)	0.90-5.0 (2.59)
9	Palam	2.86-7.98 (5.12)	37.70-94.30 (63.18)	1.30-11.0 (2.91)
Parbhani district		2.86-24.33 (13.69)	8.0-186.30 (51.17)	0.10-11.0 (2.14)

Adequate concentration of manganese in soil was also observed by Kumar et al. (2002), Kalita et al. (2003) and Dhore and Udar (2007).Concentration of manganese in sorghum straw samples found to range 8.0 to 186.30 mg kg<sup>-1</sup> with mean value of 51.17

mg kg<sup>-1</sup>. It was recorded deficient in 34 per cent straw samples analyzed for their Mn content. Deficiencies of microelements in fodders may partially due to soil pH (Das et al., 2003) which was found alkaline in present investigation. As increase

in soil pH causes decrease in relative availability of some of essential micro elements to plants. In case of serum samples manganese content of serum ranged from 0.10 to 11.0  $\mu\text{g ml}^{-1}$  with an average of 2.14  $\mu\text{g ml}^{-1}$ . It was found sufficient in 91 per cent serum samples while 9 per cent serum samples were found deficient with respect to serum manganese content. Though 34 per cent straw samples were

found deficient, adequacy of manganese in serum of cattle was observed. This might be due to effective utilization of fodder by cattle of this region. Reddy (2005) also found normal range of serum Mn though 50 per cent fodders were deficient in their manganese concentration. This is in agreement with the findings of Kumar et al. (2002), Gowda et al. (2002) and Sunder et al. (2007).

Table 4. Concentrations of Zn in soil, sorghum straw and blood serum of cattle from different tahsils from Parbhani district

Sr. No.	Name of tahsil	Soil Zn	Zn content of sorghum straw	Serum Zn content
		mg kg <sup>-1</sup>	mg kg <sup>-1</sup>	$\mu\text{g ml}^{-1}$
1	Jintur	0.25-0.60 (0.33)	17.15-31.05 (22.98)	1.50-7.60 (4.60)
2	Parbhani	0.23-0.93 (0.42)	20.50-35.45 (23.81)	1.90-7.30 (3.79)
3	Pathri	0.30-0.59 (0.41)	19.0-25.60 (22.45)	3.0-4.60 (3.59)
4	Selu	0.26-0.61 (0.37)	15.50-35.25 (23.09)	2.50-4.80 (3.76)
5	Sonpeth	0.39-0.84 (0.58)	5.10-15.40 (11.57)	9.60-41.90 (18.85)
6	Purna	0.42-0.62 (0.51)	7.80-18.60 (12.09)	1.60-8.30 (4.77)
7	Gangakhed	0.30-1.02 (0.55)	11.0-19.20 (15.61)	1.40-8.0 (4.39)
8	Manwat	0.28-0.91 (0.49)	10.70-36.0 (20.49)	8.80-34.80 (23.23)
9	Palam	0.42-0.59 (0.53)	11.80-22.10 (15.19)	5.20-11.70 (8.11)
Parbhani district		0.23-1.02 (0.45)	5.10-36.0 (19.50)	1.40-41.90 (7.65)

Zinc status of soil, sorghum straw and blood serum samples (Table 4) from Parbhani district revealed that concentration of zinc varied from 0.23 to 1.02 mg kg<sup>-1</sup> (0.45 mg kg<sup>-1</sup>), 5.10 to 36 mg kg<sup>-1</sup> (19.50 mg kg<sup>-1</sup>) and 1.40 to 41.90  $\mu\text{g ml}^{-1}$  (7.65  $\mu\text{g ml}^{-1}$ ), respectively in soil, fodder and blood serum samples collected from Parbhani district. Considering 0.60 mg kg<sup>-1</sup> as critical level of zinc for soil it was found deficient in soil to the extent of 88 per cent. This might be attributed to use of micronutrient free fertilizers to field crops, low organic carbon content, alkaline pH and calcareousness. Zinc deficiency is wide spread in India and world. The results were in agreement with the findings of Sharma et al. (2006), Dhore and Udar (2007), Khan et al. (2013) and

Panda et al. (2015). In case of straw 96 per cent samples showed deficiency of zinc. This was due to deficiency of zinc in soil reflected as such in plant. Deficiency of zinc in straw is attributed to soil factors like alkaline pH, high CaCO<sub>3</sub> and low available zinc in soil (Das et al. 2003, Bhat et al. 2011a, Bhat et al. 2011b) and plant factors like plant maturity, higher concentration of Fe in feeds and fodder (Gowda et al. 2002; Maan et al. 2003; Sunder et al. 2007). It was quite interesting to note that all serum samples were found sufficient with respect to zinc content though straw samples were deficient in zinc content. It might be due to minute requirement of Zn by the animals or it might be a result of better utilization from fodder and its incorporation in blood. Similarly

forage Zn concentrations were below the requirement for grazing ruminants but animal tissue levels did not indicate zinc deficiency earlier (Kumar et al.2002). It was evident from the results that though serum samples did not indicate its deficiency but there was wide spread deficiency of zinc in soil and straw. As minerals might be mobilized from target tissue,

during low dietary intake and complex interrelationships that exists between soil, plant and animal. Hence, regular supply of minerals through balanced diet containing mineral rich feeds and fodders or mineral mixture in animal ration is necessary.

Table 5. Correlation coefficients between soil, plant and animal for Cu, Fe, Mn and Zn

Minerals	Soil-Plant	Plant -Animal	Soil-Animal
Cu	0.047	-0.474**	-0.037
Fe	-0.636**	-0.108	0.067
Mn	-0.089	0.376**	-0.040
Zn	0.314**	-0.238**	0.213**

\* Significant at 5% level

\*\* Significant at 1% level

The correlation between soil, plant and animal for their mineral contents was worked out (Table 5). It was observed that copper had positive correlation between soil and plant (0.047) while it showed negative significant (-0.474\*\*) correlation between plant and animal and negative (-0.037) correlation between soil and animal. The iron content of soil and sorghum straw was found negatively and significantly correlated (-0.636\*\*) while iron content of sorghum straw and blood serum of cow was found negatively correlated (-0.108). The correlation between soil and blood serum of cow for their iron content showed positive (0.067) correlation. Manganese showed negative and non-significant correlation between straw and serum (-0.089) and between soil and serum (-0.040) while it was found significantly and positively correlated between straw and serum (0.376\*). In case of zinc, the correlation between zinc content of soil showed significant and positive correlation with straw zinc content (0.314\*\*) and blood serum of cow (0.213\*\*), respectively. The zinc content of straw was found negatively and significantly correlated with zinc content of blood serum of cow (-0.238\*\*).The results of the study emphasized involvement of different factors which affect the availability of micro minerals from soil to plants and then to animals. This might be due to complex reactions occurring at plant nutrient absorption sites and also during different metabolic processes continuously taking place in plants as reported by Mengel and Kirkby (1987). Low

concentration of particular mineral in soil will lower the mineral content in plant grown on such soil; however, the soil rich in a particular mineral may not result in its higher level in plant, due to uptake mechanism existing in the roots (McDowell and Arthington, 2005). Similar inconsistency was also observed regarding correlation of fodder nutrient with nutrient content in serum of cattle. This might be due to many of the complex metabolic processes are taking place in animal digestive system, where many of digestive enzymes are not only acting on the organic complexes to release the energy but also they are altering utilization and absorption of inorganic minerals. Hence, repeated sampling in different seasons and detailed animal nutrition studies are required in relation to various soil types, fodders, climatic condition, animal type etc., to understand complexity of soil-plant-animal relationship (Ramana et al. 2001).

## CONCLUSIONS

Based on these results, for better health and productivity of the cattle in Parbhani district of Maharashtra need to be supplemented with copper, manganese and zinc in their daily diet by formulating area specific mineral mixture using highly bio-available mineral salt.

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