



Research Article

SEASONAL CHANGES IN COPPER AND ZINC LEVELS IN SOIL, FEED, FODDER AND SERUM OF LIVESTOCK FROM SANGLI DISTRICT OF MAHARASHTRA

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Abstract: In the current study the Copper (Cu) and Zinc (Zn) content of soil, feed, fodder and serum in Sangli district of Maharashtra during different seasons of the year was estimated by using AAS (Atomic Absorption Spectrophotometry). Overall mean levels of Cu in soil, feed, fodder and serum samples from all tehsils were above the critical value. In this study, overall mean Zn content of samples from all tehsils were above critical value, except overall soil Zn level in Tasgaon tehsil. With regards samples from different seasons (soil, feed, fodder and serum), the Cu levels were above critical values. With regards samples from different seasons (soil, feed, fodder and serum) the Zn levels were above critical values, except some samples (winter season soil of Tasgaon; rainy season soil from Jat, Tasgaon and Palus tehsil samples; rainy season serum Tasgaon). Percent Deficient Samples (PDS) for Cu were 2.74% in soil, 17.58% feed, 17.35% in fodder and 40.48% in serum samples; whereas PDS for Zn were 45.21% in soil, 30.77% feed, 17.35% in fodder and 14.29% in serum samples, respectively. Equal PDS (40.48%) for Cu in serum was seen in all tehsils while highest PDS for Zn in serum was observed in Tasgaon tehsil. In conclusion, it is necessary to supplement these minerals in ration by formulating area specific mineral mixture in order to sustain normal levels and maximize production of cattle.

Keywords: Copper, Zinc, Cattle, Mineral, Sangli

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Introduction

India is leading producer with regards to milk [1]. India with 18% of the world's bovine population has 30 crore bovines [1]. However, it has been reported that individual productivity of animals is low which could be due to malnourishment and mineral deficiency [2]. Minerals have important role in animal nutrition for health and production [3]. Additionally, minerals play significant role in number of digestives, physiological and biosynthetic processes of animal body [4, 5]. Mineral deficiencies can result in suboptimal performances such as poor production and reproductive inefficiencies [5, 6]. The mineral Copper (Cu) has role in immune defense, neutralization of free radicals, growth and reproduction [7, 8]. The mineral Zinc (Zn) is involved in immune functions, reproduction, growth, thyroid hormone secretion and preventing oxidative stress [7, 9]. Both of the above minerals (Cu and Zn) are essential in udder immunity and thus defense against mastitis. Importantly, lower levels of Cu and Zn may result or predispose animals to repeat breeding and anoestrus [7].

In India milk producing animals are maintained mostly on grazing and crop residues available at farm, with little or no supplementation of mineral mixture [10, 11]. It has been reported that Indian cattle reared under smallholder production system are deficient in most of the minerals [12]. The mineral content of soil, feeds and forage is area specific. Hence, it is important to access mineral contents from serum, soil, feed and forages in different seasons to estimate the year-round mineral requirements of livestock of a particular area. The current study was undertaken to estimate the Cu and Zn content of soil, feed, fodder and serum from Sangli district during different seasons of the year.

Materials and Methods

Sample collection

The present study was carried out in Sangli district of Maharashtra. Representative samples of soil, feed, fodder and animal serum were collected randomly from Jat, Tasgaon and Palus tehsils of Sangli district. Soil samples were collected with the help of pickaxe and trowel and processed for analysis of Cu and Zn as described previously [13-15]. Samples of concentrate mixtures/ ingredients and roughages were collected once during each season by visiting individual families. Feed and fodder samples were processed for analysis of Cu and Zn as described previously [13-15]. Serum samples were collected from animals (cattle and buffalo) of each visited farmer family under study, once in each season. The serum samples were stored at -20°C until analysis.

Sample processing, mineral estimation and data analysis

The samples (soil, feed/ fodder and serum) were digested using the method described by Franek (1992)[16], Trolson (1969)[17] and Kolmer et al., (1951)[18] respectively. Simultaneous digestions of reagent blanks were also undertaken. Estimation of Cu and Zn in the samples was done using Atomic absorption spectrophotometer (AAS) (ELICO, Ltd, Hyderabad, India). The percent prevalence was calculated using reported critical values of corresponding minerals in soils, feed, fodder and animal (cattle). Statistical analysis was carried out as per Snedecor and Cochran, 1994 [19] using Web Agricultural Statistical Package (WASP) of ICAR, Goa.

Table-1 Mean \pm SE levels of Copper (Cu) in soil, feed, fodder and serum samples of Kolhapur district during different seasons

Soil (in ppm)					Feed (in ppm)				
Tehsils	Sum	Winter	Rainy	Overall	Tehsil	Sum	Winter	Rainy	Overall
Jat	6.89 \pm 0.3 ^a	6.79 \pm 0.3 ^a	5.56 \pm 0.7 ^b	6.35 \pm 0.3 ^a	Jat	25.27 \pm 0.26 ^a	15.60 \pm 0.33 ^b	14.08 \pm 2.91 ^b	18.46 \pm 0.57 ^a
Tasgaon	7.60 \pm 0.1 ^a	7.26 \pm 0.1 ^a	5.89 \pm 1.3 ^b	6.91 \pm 0.5 ^a	Tasgaon	15.28 \pm 4.66 ^a	13.53 \pm 1.26 ^a	13.20 \pm 1.17 ^a	13.97 \pm 2.53 ^b
Palus	7.19 \pm 0.1 ^a	6.75 \pm 0.1 ^b	6.10 \pm 0.2 ^c	6.72 \pm 0.1 ^a	Palus	15.54 \pm 0.18 ^a	11.52 \pm 2.55 ^b	10.20 \pm 1.09 ^b	12.36 \pm 1.02 ^b

Fodder (in ppm)					Serum (in ppm)				
Tehsils	Sum	Winter	Rainy	Overall	Tehsil	Sum	Winter	Rainy	Overall
Jat	25.14 \pm 0.47 ^a	22.98 \pm 3.97 ^a	21.14 \pm 3.08 ^a	23.02 \pm 2.24 ^a	Jat	1.30 \pm 0.40 ^a	0.97 \pm 0.32 ^a	0.83 \pm 0.21 ^a	1.05 \pm 0.18 ^a
Tasgaon	24.80 \pm 1.38 ^a	23.10 \pm 2.19 ^a	21.18 \pm 5.22 ^a	23.63 \pm 3.10 ^a	Tasgaon	0.92 \pm 0.23 ^a	0.86 \pm 0.26 ^a	0.73 \pm 0.24 ^a	0.84 \pm 0.13 ^a
Palus	26.88 \pm 1.75 ^a	23.67 \pm 1.02 ^a	21.89 \pm 5.6 ^a	23.39 \pm 2.75 ^a	Palus	1.53 \pm 0.52 ^a	1.10 \pm 0.28 ^a	0.95 \pm 0.32 ^a	1.17 \pm 0.20 ^a

Similar superscripts in rows indicate non-significant differences whereas, dissimilar superscripts indicate significant differences among the seasons at 5% or 1% level

Table-2 Mean \pm SE levels of Zinc (Zn) in soil, feed, fodder and serum samples of Kolhapur district during different seasons

Soil (in ppm)					Feed (in ppm)				
Tehsils	Sum	Winter	Rainy	Overall	Tehsil	Sum	Winter	Rainy	Overall
Jat	2.99 \pm 0.77 ^a	1.56 \pm 0.14 ^b	1.38 \pm 0.17 ^b	2.00 \pm 0.34 ^a	Jat	51.67 \pm 6.07 ^a	35.36 \pm 5.90 ^b	32.11 \pm 5.71 ^b	37.79 \pm 4.35 ^a
Tasgaon	1.83 \pm 0.93 ^a	1.32 \pm 0.06 ^a	1.00 \pm 0.06 ^a	1.37 \pm 0.32 ^a	Tasgaon	49.62 \pm 3.49 ^a	43.47 \pm 7.03 ^b	39.07 \pm 1.68 ^c	44.50 \pm 3.00 ^a
Palus	3.36 \pm 0.36 ^a	2.47 \pm 1.11 ^b	1.49 \pm 0.28 ^c	2.29 \pm 0.41 ^a	Palus	46.59 \pm 5.73 ^a	34.93 \pm 5.92 ^b	34.14 \pm 12.15 ^b	39.63 \pm 4.12 ^a

Fodder (in ppm)					Serum (in ppm)				
Tehsils	Sum	Winter	Rainy	Overall	Tehsil	Sum	Winter	Rainy	Overall
Jat	68.4 \pm 7.08 ^a	45.58 \pm 1.91 ^b	40 \pm 1.13 ^c	49.30 \pm 3.77 ^a	Jat	2.25 \pm 0.04 ^a	2.13 \pm 0.06 ^a	0.82 \pm 0.06 ^b	1.67 \pm 0.15 ^a
Tasgaon	47.14 \pm 7.60 ^a	43.87 \pm 7.37 ^a	34.16 \pm 4.47 ^b	38.38 \pm 4.18 ^b	Tasgaon	2.14 \pm 0.06 ^a	1.76 \pm 0.06 ^b	0.75 \pm 0.03 ^c	1.46 \pm 0.15 ^a
Palus	51.74 \pm 3.48 ^a	46.2 \pm 5.71 ^a	39.14 \pm 6.50 ^b	34.58 \pm 3.79 ^b	Palus	1.96 \pm 0.17 ^a	1.10 \pm 0.09 ^b	1.10 \pm 0.11 ^b	1.42 \pm 0.12 ^a

Similar superscripts in rows indicate non-significant differences whereas, dissimilar superscripts indicate significant differences among the seasons at 5% or 1% level

Table-3 Percent Deficient Samples (PDS) found in different tehsils of Kolhapur district

COPPER						ZINC					
Tehsil	Critical value	Jat	Tasgaon	Palus	Overall		Critical value	Jat	Tasgaon	Palus	Overall
SOIL	0.6 ppm ^q	00.0 (26)	8.33 (24)	00.0 (23)	2.74 (73)	SOIL	1.5 ppm ^q	30.77 (26)	62.5 (24)	43.48 (23)	45.21 (73)
FEED	8 ppm ^t	12.9 (31)	16.67 (30)	23.33 (30)	17.58 (91)	FEED	30 ppm ^t	32.26 (31)	23.33 (30)	36.67 (30)	30.77 (91)
FODDER	8 ppm ^t	12.9 (31)	18.75 (32)	20.00 (35)	17.35 (98)	FODDER	30 ppm ^t	3.23 (31)	28.13 (32)	20.00 (35)	17.35 (98)
SERUM	0.6 ppm ^q	40.48 (42)	40.48 (42)	40.48 (42)	40.48 (126)	SERUM	0.8 ppm ^q	9.52 (42)	23.81 (42)	9.52 (42)	14.29 (126)

^qMcDowell et al., 1984; ^tMcDowell et al., 1985. Figures shown in parenthesis represent the number of samples.

Results and Discussion

Soil status

Values (mean \pm S.E.) of Cu and Zn in different samples (soil, feed, fodder and animal serum) is presented in [Table-1 and 2], respectively. Further, statistical analysis was carried out using 'Completely randomized Design' (CRD) for evaluating the influence of season. The average Cu and Zn levels of soil samples from all the tehsils of Sangli district were compared with the critical level of 0.6 ppm and 1.5 ppm, respectively, as suggested by McDowell et al. [20]. The comparison revealed that mean soil Cu values of all tehsils were above the critical level. In this study, overall soil Cu levels of Tasgaon tehsil were higher compared to other tehsils. Only for Palus tehsil significant differences were observed in mean soil Cu values in three different seasons. Further, rainy season mean soil Cu levels from Jat and Tasgaon tehsil were significantly lower than summer and winter soil values. In all tehsils, highest soil Cu values were seen in summer, followed by winter and then by rainy season. These results are in agreement with previous report from Pune [13-15], Thane creek [21] and Gujarat [22]. Also, these findings are in accord with findings reported from Southwestern Punjab-Pakistan [23] and Tehran-Iran [24]. Both these studies reported higher Cu values in summer than winter. With regards to Zn, overall mean soil Zn values of tehsils, except Tasgaon, were above the critical level (1.5ppm) [20]. The mean soil Zn level in summer season from of all tehsils was above critical value. The winter soil samples of all tehsils were above critical value, except Tasgaon. The rainy season samples from all tehsils were below critical value. Similar to soil Cu pattern, highest soil Zn values were seen in summer, followed by winter and then by rainy season in all tehsils. This soil Zn pattern is in agreement with previous report from Thane creek [21], Satara [14] and Kolhapur [15]. Overall PDS (Percent Deficient Samples) [Table-3] of Cu in soil from Sangli district was 2.74%. Nevertheless, much higher percentage (27.5%) of soil Cu deficiency has been from Kashmir

[25]. In the current study Soil Cu PDS was only observed in Tasgaon tehsil (8.33%). Overall PDS Zn in soil of Sangli district was 45.21% and highest soil Zn PDS were from Tasgaon tehsil (62.5%). For soil Zn, similar deficiencies have been reported from Pune (63.21%) [13], Haryana (59.12%)[26] and Kashmir (60%)[25].

Feed minerals

The average Cu content [Table-1 and 2] of animal feed samples from different tehsils of Sangli district were compared with the critical level (8 ppm) suggested by McDowell et al. [27]. Findings of this study revealed that mean Cu values in feeds of all tehsils were above the critical level. Highest mean Cu value was observed in summer samples of Jat tehsil whereas the lowest mean Cu value was observed in rainy season samples of Palus tehsil. Highest feed Cu values were seen in summer, followed by winter and then by rainy season. This observation is in agreement with previous report from Maharashtra [13-15]. The average Zn content of animal feed samples from different tehsils of Sarata district were compared with the critical level (30 ppm) suggested by McDowell et al. [27]. The overall mean Zn values of feeds samples from tehsils of Sangli district were above the critical level. The highest mean Zn values were seen in summer samples from Jat tehsil. In this study, highest feed Zn values were seen in summer, followed by winter and then by rainy season. Similar results have been reported previously from Maharashtra state [13-15]. Overall PDS [Table-3] of Cu in feed from Sangli district was 17.58%. In this study, highest and lowest Cu PDS was seen in Palus and Jat tehsil, respectively. Overall PDS of Zn in feed from Sangli district was 30.77%. Deficiency of Zn in feed has also been reported from Pune district [13] and Mathura district, India [28]. On the other hand, contrast findings have been reported from Rajasthan; where most of the feeds were not deficient for Zn [29]. Highest PDS of Zn were seen in Palus tehsil. This was followed by Jat (32.26%) and Tasgaon tehsils (23.33%). Lowest PDS was observed in Tasgaon tehsil.

Fodder minerals

The average Cu content (Table 1 and 2) of animal fodder samples from different tehsils of Sangli district were analyzed in comparison with the critical level (8 ppm) suggested by McDowell et al. [27]. Results of this study revealed that overall mean Cu values in fodder of all tehsils were above the critical level. These findings are in agreement with previous report from Maharashtra [13-15]. Highest mean Cu content was observed in summer fodder samples of Palus tehsil whereas the lowest mean Cu was observed in rainy season fodder of Jat tehsil. With regards to the mean Cu levels in fodder samples from all tehsils, non-significant differences were seen in different seasons. The average Zn content fodder samples from different tehsils of Sangli district were above the critical level (30 ppm) [27]. Highest mean Zn level were seen in summer fodder samples from Jat tehsil whereas the lowest mean Zn level were seen in rainy fodder samples from Tasgaon tehsil. In all tehsils, highest fodder Zn values were seen in summer, followed by winter and then by rainy season. This finding agrees with previous findings published from Maharashtra [14, 15]. The Cu & Zn PDS (Table 3) was seen in varying extent in all tehsils of Sangli district. Palus tehsil had the highest Cu PDS level (20.00%). Overall prevalence of both Cu & Zn PDS in fodder of Sangli district was 17.35%. Cu PDS of Sangli district is much lower compared to Cu PDS reported from Northern India (65.63%)[30]. In 2014, a study from Kerala State has reported Cu PDS of 38.66% and Zn PDS of 38% in animal fodder [31]. Highest Zn PDS was seen in Tasgaon tehsil while it was lowest in Jat tehsil.

Serum minerals

Average Cu content [Table-1 and 2] of serum samples of different seasons from different tehsils of Sangli district were above the critical level (0.6ppm) suggested by McDowell et al. [20]. Highest mean Cu content was present in summer samples of Palus tehsil; whereas the lowest mean Cu was observed in rainy season serum of Tasgaon tehsil. For all tehsils, highest mean Cu values were seen in summer, followed by winter and then by rainy season. These results agree with previous findings published from Maharashtra [13-15]. With regards to the mean Cu levels in serum samples from all tehsils, non-significant differences were seen in different seasons. Except for rainy season serum samples from Tasgaon tehsil, the average Zn levels in sera of all seasons from Sangli district were above CV (0.8 ppm) [20]. Mean Zn content of serum samples of summer season from Jat tehsil was highest whereas that of rainy season samples from Tasgaon tehsil was the lowest. Except Palus tehsil, highest serum mean Zn values were seen in summer, followed by winter and then by rainy season. Similar trends of serum Zn levels have been published previously from Maharashtra [13-15]. Overall PDS [Table-3] of Cu & Zn in serum from Sangli district was 40.48% and 14.29%, respectively. In 2014, PDS of 46.87% for serum Cu and 40.00% for serum Zn has been reported from Kerala State [31]. A higher serum Cu PDS has been reported from Northern India (68.71%)[30] and Kashmir valley [32]. Equal PDS (40.48%) for Cu in serum was seen in all tehsils of Sangli district while highest PDS for Zn in serum was observed in Tasgaon tehsil (23.81%). Lower values of Cu & Zn seen in soil, feed, fodder and serum samples in rainy season could be due to leaching of soils [33].

Conclusion

Results of The Current Study revealed seasonal variations in levels of Cu and Zn mineral in soil, feed, fodder and serum samples from Sangli district. Soil, feed, fodders and serum samples of animals of Sangli district were deficient in Cu & Zn to varying extent. Hence area wise supplementation of these minerals may be provided in mineral mixture.

Application of research

Findings of this research can be used for formulation of Sangli specific mineral mixtures.

Research Category: Veterinary Science

Abbreviations: Copper (Cu), Zinc (Zn), Percent Deficient Samples (PDS), AAS (Atomic Absorption Spectrophotometry), Web Agricultural Statistical Package (WASP), completely randomized Design (CRD)

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Research project name or number: Assessment of mineral profile relationship of animals, soil, feeds and fodders in the state of Maharashtra for improvement of livestock production potential.

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Study area / Sample Collection: Sangli district

Cultivar / Variety / Breed name: Domestic cattle

Conflict of Interest: None declared

Ethical approval: Therapeutic intervention at KNP College of Veterinary Science, Shirwal 412 801, Maharashtra Animal and Fishery Sciences University, Nagpur, 440001, India.

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