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RESEARCH ARTICLE

Trace mineral status of soil, feed and animal in Chhattisgarh state (India)

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Abstract

Trace element content of soil, feeds, blood plasma and faeces on randomly selected rural and urban farms was carried out. Since liver has been most reliable source of analyzing the status of Fe, Cu and Zn in grazing goats, the samples were collected from local slaughter house during rainy and dry seasons. In soil mean and range values for Fe and Mn were 202.97 ppm (79-410 ppm) and 61.03 ppm (19-123 ppm), respectively. The results suggested that soil Fe and Mn levels were found to be high. Fe contents of all feeds were extremely high and Mn contents were higher than the dietary requirement. Whereas mean and range values of Cu and Zn concentrations of soil were, 2.91 ppm (1.2-8.11 ppm) and 1.33 ppm (0.6-2.3 ppm), respectively. There were no considerable variations in the concentration of trace elements among the soil samples. However, a large proportion of feed samples were deficient in Cu and Zn. Blood plasma value of Fe in graded Jammunapari goats during rainy season were 2.02 ppm, while in dry season it was 1.83 ppm. In local desi non-descript goats Fe level during rainy season was 1.62 ppm and in dry season it was 1.81 ppm. The effect of season was statistically significant for all trace elements. The results suggested that more than half of animals were found to have low plasma Cu and Zn during the rainy season. Due to lack of any correlations between soil, pasture and blood plasma it is suggested that analyses of soils and pasture are not reliable for assessing the Fe, Cu and Zn status of grazing goats in the plains, plateau or hills. Analyses of liver and blood appear to provide better indices.

Introduction

Increased milk production can be achieved by improving the genetic potential of animal through crossbreeding together with balanced feeding and management. Such balanced feeding should take care of all essential major and minor minerals including protein and energy intake. Low productivity of livestock is multietiological but nutrition is a major cause and marked responses in growth and reproduction have been obtained from mineral supplementation.

With plants this relationship is direct and is simplified by the fact that the plant is stationary. Out of twenty two believed essential mineral elements for animal kingdom, seven are macro and fifteen are micro minerals. For ruminants atleast sixteen mineral elements are generally considered as either nutritionally essential or as a problem in excessive concentration. There are seven major or macro (Ca, P, K, Na, Cl, Mg, S) and eight trace or micro (Fe, I, Zn, Cu, Co, Mn, Mo, Se) minerals (McDowell and Conrad, 1990).

Soil minerals status may be reflected in plants in respect of certain minerals, but not in others. Because, plant minerals is affected by factor such as yield, genetic differences, chemical from of minerals in the soil, pH, degree of aeration and water logging on the land. Plant concentration of minerals is better correlated with dilute acid

extracts of minerals from the soil in respect of iodine, cobalt etc. However, a 'plant available' mineral of the soil is more correlated with plant growth and not necessarily plant concentration regarding several other minerals.

Dietary standards are often expressed as ranges of mineral concentration in feeds recommended against deficiency as well as toxicity. However, any conclusion based on mineral availability based on mineral concentrations in the feed may be misleading. Mineral concentration can be influenced by contamination or selective and preferential eating habits of the animals. Further analytical values do not take into account differences in absorption and utilization of the mineral, their production with other minerals or the presence of certain organic compounds, which may hamper or help minerals availability. In assessment of the mineral status of the animals the approaches adopted are, soil mineral analysis, mineral analysis of feeds and fodder, biochemical analysis of body fluids such as blood, saliva, urine, faeces etc. for minerals, enzymes and hormones, tissue concentration of minerals and enzyme activity, clinical and pathological diagnosis, correlation brought about by supplementation in terms of recovery of health, growth and productivity. A number of trace minerals are important in maximizing reproductive performance (Spears, 2014).

Research institutes in India, or in several other Asian countries, often suffer from a lack of economical and technical resources for research studies on animal nutrition. Thus in newly Chhattisgarh, it is important to determine mineral concentration region-wise, to estimate the mineral needs of livestock in Chhattisgarh, so as to obtain maximum output and prevent deficiency state and related disease conditions in animals.

The varying agro climatic conditions, topography and soil type of Chhattisgarh provide good vegetation for grazing livestock as well as an excellent source of ores. These ores are utilized by the industries for extraction of minerals and the effluents may add its effect in disturbing the soil, water, plant and animal ecosystem. The ores as such may be deficient in one, toxic in other or adequate in some other minerals required for normal functioning and growth of plants and animals. The toxic, deficient or imbalanced minerals of such soil may interact with each other and aggravate the condition of their inadequacy in plants due to their poor uptake. The plants and other vegetation grown in such agro climatic zones may differ from the other parts of the country, limiting the availability of minerals due to livestock and reflecting the production performance of animals and therefore, the socio economic status of the poor farmers. The present study was planned to evaluate the levels of trace (Fe, Mn, Cu and Zn) minerals in soil, plants and animals.

Materials and Methods

The experiment was carried out in the different agroclimatic zone of Chhattisgarh region identified as hill, plain and plateau containing 16 districts.

Hill-Korea, Surguja, Jashpur

Plain-Kawardha, Bilaspur, Kanker,Durg, Raipur, Mahasamund, Dhamtari, Raigarh, Korba,Janjgit-Champa, Rajnandgaon,

Plateau- Jagdalpur, Dantewada

The study was carried out on randomly selected rural and urban areas. Samples of soil, forage, concentrate, blood were collected towards the end of the rainy and dry season. The available feeds were pasture, hay, different types of straws and grains of maize, jowar, oats and small millets from small farms of local non-descript goats.

Sample collection

Samples of soil and pasture grass were collected from each district of Chhattisgarh where animals were grazing, and pooled. The samples were taken during the dry as well as rainy season. During rainy season pasture is the main source of feed. A soil sampling drill was used to sample the top 20 cm of soil. Representative samples of pasture were collected from grazing land and were dried in a forced draught oven at 90-10^{o}C. Samples of rice straws, local grass, berseem and as well as the grains of maize, jowar and other small millets were collected during the dry season from the targeted areas.

The blood samples were collected randomly from local non-descript goats from different rural and urban areas. These samples were collected by jugular puncture in vacutainers (10 ml) containing heparin as an anticoagulant and prepared for analysis. Faecal samples were also collected for the analysis of minerals. Faecal samples were dried in a hot air oven at 90-100^{o}C. Fresh liver samples of local breed were collected from local slaughter house and prepared for analysis.

Chemical analysis

Soil samples were analysed for Fe, Mn, Cu and Zn. These elements were extracted with 1 N ammonium acetate (DTPA-extractant) by the method of Lindsay and Norvell (1969) and the solutions were analysed by atomic absorption spectroscopy (ECIL – ElementAS AAS 4141).

Samples of forage, faeces and liver were dried in a forced draught oven at 60^{O}C. Dried liver samples were ground in a mortar before analysis. The samples were prepared for analyses of Fe, Mn, Cu and Zn according to the method described by Khalili et al. (1991). Blood plasma was analysed for Fe after diluting 1:2 with 20% trichloroacetic acid (TCA) solution and heated at 90^{o}C for 15 min. After centrifugation the supernatant was used for analysis. Blood plasma was diluted with distilled water 1:1 for determination of Cu. Zinc was determined by diluting the plasma samples with distilled water 1:4 (Fick et al. 1979).

Results and Discussion

Soil: Data for trace element contents are presented in Table 1. The mean values for soil Mn, Cu and Zn were significantly ($P<0.01$) lower in samples (61.03, 2.91 and 1.33 ppm, respectively). There were wide variations in the trace element concentrations of soil samples. There was no significant correlation above 0.50 among soil trace elements.

Feeds: The mean contents of trace elements in pasture and other available feeds are shown in Table 2. Mean Fe contents in pasture sample were found to be 1222.48 ppm, while Mn and Cu 221.59 and 9.51 ppm respectively. Pasture Zn was found to 48.27 ppm. The Zn content of hay was 28.45 ppm. There were wide variations in the trace element contents of forage samples. There was no correlations above 0.50 between pasture and soil trace elements

Blood: The mean concentrations of trace elements in blood plasma of graded Jammunapari goats and local desi non-descript goats as well as the overall means are presented in Table 3. The effect of season was statistically significant ($P<0.01$) for all the trace elements. Only Zn ($P<0.01$) differed between breeds. More than half of the animals were deficient in Cu and Zn during the rainy seasons. There was no significant correlation between plasma trace elements or plasma and soil minerals on the one hand and plasma and pasture on the other.

Faeces: Mean trace element contents of faeces from all animals and data for graded Jammunapari goats and local goats are presented in Table 4. Season significantly ($P<0.01$) affected content of Fe, Mn, Cu and Zn in faeces. Age was not related to the contents of Fe, Mn or Cu, but Zn content was found to be significantly higher in the faeces of kids than in that of does. Fe and Zn were higher ($P<0.01$) in local than in graded goats.

Liver: Mean liver trace element values were not significantly different between the seasons. It has been presented in Table 5 .Mean liver Fe in the rainy season was higher than the samples of animals slaughtered during the dry season. 91 and 54 % of the animals had Cu values lower than 25 ppm during the rainy and dry seasons, respectively. The remainder being lower than the critical level of 75 ppm as suggested by McDowell (1985).

Table 1: Micro-mineral content of soil sample collected during rainy season

Particulars	Mean	Standard Deviation
Fe (ppm)	202.97	105.21
Mn (ppm)	61.03	31.92
Cu (ppm)	2.91	1.89
Zn(ppm)	1.33	0.45

Table 2: Micro-mineral content of pasture,hay, different types of straws and grains (On DM basis)

Particulars	Pasture		Hay		Rice straw		Oat straw		Berseem straw		Grains	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Fe (ppm)	1222.48	1348	649.81	628	229.27	146	157.08	141	223.49	87.52	347.34	374
Mn (ppm)	221.59	109	313.09	209	25.20	11.87	95.04	50.25	79.12	53.74	62.31	42.03
Cu (ppm)	9.51	5.32	10.60	4.28	8.45	5.58	9.86	4.29	7.21	3.25	8.32	4.75
Zn(ppm)	48.27	22.40	28.45	6.63	40.82	13.36	19.39	6.61	23.60	4.75	33.12	5.55

Table 3: Micro-mineral concentration (ppm) of blood plasma collected from goats during rainy and dry season

Particulars	Season	Graded Jamunapari				Nondescript				Overall	
		Doe		Kid		Doe		Kid			
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Fe(ppm)	Rainy	2.02	0.53	1.83	0.17	1.62	0.14	1.74	0.06	1.80	0..23
	Dry	1.83	0.16	1.92	0.41	1.81	0.13	1.87	0.22	1.86	0.26
Cu(ppm)	Rainy	0.84	0.26	0.74	0.06	0.58	0.07	0.72	0.06	0.71	0.11
	Dry	0.78	0.07	0.81	0.15	0.76	0.05	0.91	0.25	0.81	0.16
Zn (ppm)	Rainy	0.57	0.07	0.56	0.11	0.59	0.07	0.67	0.17	0.60	0.13
	Dry	0.70	0.08	0.71	0.07	0.84	0.23	0.82	0.13	0.77	0.11

Table 4: Micro-mineral content of faeces collected during rainy and dry season

Particulars	Season	Graded Jamunapari				Nondescript				Overall	
		Doe		Kid		Doe		Kid			
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Fe (ppm)	Rainy	3379	908.56	3912	1417	3988	1134	3768	888.49	3761	1174
	Dry	-	-	5576	1504	5076	1338	7044	1433	5898	1438
Mn(ppm)	Rainy	479.49	121.55	523.30	129.98	676.10	101.75	629.43	192.37	577.08	163.71
	Dry	-	-	568.10	148,78	459.48	121.33	498.12	124.14	508.56	127.08
Cu(ppm)	Rainy	20.06	6.45	24.04	6.63	22.08	6.76	24.26	6.64	22.61	6.52
	Dry	-	-	17.28	6.81	17.46	7.05	22.30	6.34	19.01	6.73
Zn (ppm)	Rainy	63.32	10.42	76.12	15.78	76.09	15.85	78.26	14.64	73.42	13.78
	Dry	-	-	69.04	10.70	68.19	9.95	79.49	13.54	72.24	11.36

Table 5: Trace mineral content of liver collected from goat during rainy and dry season

Particulars	Season	Mean	Standard Deviation
Fe (ppm)	Rainy	1124	406.38
	Dry	840	287.52
Mn(ppm)	Rainy	15.10	6.23
	Dry	13.80	5.87
Cu(ppm)	Rainy	16.70	6.38
	Dry	25.10	6.06
Zn (ppm)	Rainy	168.10	9.95
	Dry	137.50	11.01

The mean contents of Fe and Mn in the soil samples from the plains, plateau and hills were about the same as those reported for several other parts. However it was comparative more in Bastar plateau. The mean Fe and Mn contents of the feeds were much higher than the respective dietary recommended levels of 50 and 40 ppm for goats (NRC, 1981). However, as in the soil samples there were wide variations of these elements in the forage. The Fe content of many pasture grass samples was very high, which is in agreement with the results of Wankhede et al. (1997). This could partly be related to the high Fe levels in the soils and a higher uptake of Fe by plant and partly to soil contamination of pastures grass samples (Mc Dowell, 1985). Pasture samples contained much more Fe than the samples of straws.

The overall mean Fe concentrations in the blood plasma was slightly higher than the level reported by Yadav et al. (1998).

About 95-98% of dietary Mn is excreted in the faeces (Thomas, 1970). The pasture samples seemed to contain sufficient Mn but liver samples showed that 19% of animals were deficient in Mn as judged by the critical level of 6 ppm (Mc Dowell, 1985). The Mn requirement is higher for reproduction than for growth (Spears, 2014).

The mean Cu content of the soils was higher than the critical level of 0.2 ppm (Lindsay and Norvell, 1969), but there was a high degree of variation among the samples. Samples contained slightly higher Cu. Mean Cu contents of pasture, hay and straws in the state were found to be low. When considering the dietary recommended level of 10 ppm Cu for goat (NRC, 1989) more than 60% of pasture samples were below this value during the rainy season. Copper deficiency is due to high levels of Mo there is good evidence that reproduction can be adversely affected (Spears, 2014). A concentration of 0.65 ppm Cu has been suggested as a critical level for blood plasma in goat, while for liver the critical levels lies between 25 and 75 ppm (Mc Dowell, 1985). In the present investigation a number of both graded and local goats had plasma Cu below the critical level while all collected liver samples contained Cu below 75 ppm. Findings were corroborate with Faye et al. (1986). Higher mean plasma Cu concentration of the graded goats compared with the local goats may be related to the provision of some minerals supplements. Farmers have been encouraged to feed mineral supplements to the goats, but these were not fed regularly to the animals. The Cu status of grazing goat is mainly related to the dietary intake of high dietary Fe or the Fe from ingested soil in the form of oxide, which inhibits the absorption of Cu (Prabow et al., 1989). Higher mean plasma Cu concentration of the graded goats as compared with the local goats may be related to the provision of some mineral supplements. Farmers have been encouraged to feed mineral supplements to the graded animals, but these were not fed regularly to the animals.

The recommended level of Zn is 40 ppm for does (NRC, 1981). Pasture samples collected contained lower level of Zn. The present study showed low concentrations of plasma Cu and Zn among the majority of goats and kids of both graded and local non descript during the rainy season. Lack of correlations between soil, pasture and blood plasma trace elements in the present study is in agreement with previous results (Das et al., 2002).

Conclusion

The result of survey of micro element lacked any definite correlation between soil, pasture and blood plasma, therefore it is suggested that analysis of soils and pastures are not reliable for assessing the Fe, Cu and Zn status of grazing goats in the plains, plateau or hills of Chhattisgarh region. Analysis of liver and blood appear to provide better indications.

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