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Macro- and micro-mineral profile of feeds, fodders and animals in east and south eastern coastal plain zone of Odisha

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Deficiency / imbalance / toxicity of minerals severely inhibit production and reproduction in animals (McDowell 1984). Minerals act as electrolytes and catalysts in enzyme and hormone system (Underwood 1981). Mineral imbalances in soil and forages have long been responsible for low production and reproduction among ruminants. The extent and pattern of mineral deficiencies and excesses in plants vary in different agro-climatic conditions (Gowda *et aI.* 2001, Das *et al.* 2003a) as available mineral content in green vegetation depends on physical and chemical properties of soil, soil erosion, cropping pattern, fertilizers and chemical application, species and genetic differences among plants, stage of growth, presence of other minerals etc. (McDowell 1985). It is necessary to generate zone-wise information on mineral status so as to identify the deficiencies or toxicities (Garg *et al.* 1999a). So the present study was undertaken to assess mineral status of feeds and fodders and further assessment of mineral and biochemical status of the animals available in the east and south eastern coastal plain zone (ESECPZ) of Odisha.

The survey was carried out in the ESECPZ of Odisha. The ESECPZ comprises Nayagarh, Khurdha districts, Cuttack, Kendrapara, Puri, Jagatsinghpur and Ganjam. To undertake the survey work Puri and Jagatsinghpur districts of ESECPZ were selected. Then 2 blocks were randomly selected from each of the selected districts and 2 villages were selected from each of the block. Representative samples of pastures grass, agricultural by-products, feed ingredients, straws and compounded feed were collected either from the grazing land of the village or from the farmers. About 250 g of samples of these collected and all the samples were first air-dried in shed and thereafter, in hot air oven at 80°C for 24 h, then ground to 1 mm particle size, and stored in acid washed glass container for further analysis of major and trace elements. Twenty animals of each surveyed villages were randomly selected for collection of blood samples and serum was harvested. The Ca and P content of feeds and fodders were estimated as per AOAC (1995). The micro minerals content of plant and serum samples were estimated by using atomic absorption spectrophotometer. The concentration of serum Ca, glucose, cholesterol, protein and albumin were estimated by using kit. The concentration of P was estimated by using also a kit. The data were analysed statistically (Snedecor and Cochran 1973).

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Mineral content in feeds and fodders

The mineral content in the feeds and fodders of ESECPZ is presented in Table 1. Among all the feeds and fodders analysed, lower Ca content was observed in straws of black gram and horse gram and highest in compound feed. The mean Ca content of the paddy straw was marginally higher in Ca than that of critical level (0.3%) (Prabowo *et al*. 1990). The *dub* grass and the mixed local grass contained higher Ca content than that of the critical level. Verma and Gupta (1984) reported Ca content of pasture grasses in the range of 0.340–0.507% which was closer to the present findings. Mishra (2006) observed marginally higher Ca content in *dub* grass, pasture grass, hybrid napier grass, *mutha* grass and sugarcane tops than the critical level. All the ingredients of concentrates available in surveyed area like groundnut oilcake, rice bran, *mung chuni* and compound feed contained higher Ca than that of critical level. Das *et al.* (2003[b]) reported higher levels of Ca in concentrate mixture.

The P content of the paddy straw of ESECPZ was lower than that of critical level. The lower P content in the roughages might be attributed to the lower concentration of soil P (Singh 2010) and acidic pH of the soil. Among different concentrates available in surveyed area, wheat bran and maize had marginally higher P than that of critical level. Groundnut

Table 1. Mineral status of the feeds and fodders in east and south eastern coastal plain zone of Odisha

Feeds and fodders	Ca (%)	P (%)	Mn (ppm)	Cu (ppm)	Zn (ppm)	Fe (ppm)
Paddy straw	0.32±0.01	0.08±0.006	24.70±0.40	7.42±0.24	33.82±0.86	149.89±2.52
Rice bran	0.27±0.01	0.91±0.02	29.83±0.95	21.12±0.64	43.60±0.93	164.23±2.07
Maize	0.31±0.01	0.43±0.01	17.44±0.56	7.13±0.23	30.82±0.89	140.93±0.84
Dub grass	0.70±0.20	0.25±0.01	39.79±0.87	40.79±1.17	37.24±1.12	201.97±6.45
Mixed grass	0.68±0.01	0.30±0.01	32.54±0.74	29.24±0.79	30.50±0.79	218.46±0.72
Compound feed	0.84±0.02	0.53±0.02	54.29±0.86	18.87±0.61	34.02±1.05	219.95±0.85
GNOC	0.53±0.02	0.81±0.03	48.16±0.91	34.67±0.91	49.40±0.94	217.97±0.95
Wheat bran	0.24±0.01	0.33±0.02	45.91±1.22	4.76±0.42	44.87±1.03	144.36±1.19
Blackgram straw	0.21±0.01	0.18±0.01	22.34±1.06	31.89±1.24	39.04±1.65	135.69±1.57
Horse gram straw	0.23±0.02	0.18±0.01	42.91± 1.42	11.66± 0.64	17.68± 0.86	148.02± 1.67
Critical level	0.3	0.25	40	8	30	50

oilcake, rice bran and compound feed contained higher P than that of critical level. Garg *et al.* (2008b) reported similar range of P in rice bran and wheat bran as observed by us.

Except horse gram straw, the Zn concentration of all the feeds and fodders was higher than the critical level (Prabowo *et al*. 1989). It is generally observed that the plant protein concentrates are invariably high in Zn content than cereal grains (Underwood 1981). Except paddy straw, the Cu concentrations of other roughages were higher than critical level (8ppm). Garg *et al.* (2004, 2008a) reported low Cu content in straw (5.4 ppm). The Cu concentrations of groundnut oilcake, rice bran, and compound feed were higher than critical level (8ppm) while maize grain and wheat bran were deficient. These results corroborated with Desai *et al.* (1984) who reported higher Cu level in oilcakes. The paddy straw and black gram straw contained lower levels of Mn than critical level (40 ppm). The green gasses contained lower level or marginally lower level of Mn than critical level (40 ppm). The variation observed in Mn concentration of some roughage samples might be due to the effect of the climate, forage management, stage of maturity and yield, which might have influenced plant mineral composition (Mc Dowell and Conrad 1990). Except the maize grain and rice bran, the Mn concentrations of all other cattle feeds like groundnut oilcake, rice bran, wheat bran and compound feed were higher than critical level. Underwood (1981) observed that maize, sorghum and barley were generally lower in Mn content than wheat and oat. The Fe concentrations in all the roughages were higher than the critical level (50ppm) and this is obviously due to both higher uptake of Fe from the soil (Singh *et al.* 1980). The observed range of Fe content in present study was in agreement with Desai *et al.* (1984).

Serum mineral profile of animals

The mineral content in the serum of animals in ESECPZ is presented in Table 2. The average serum Ca concentration of ESECPZ was below critical level (8.0 mg/dl). Considering the higher percentage (60%) of animals deficient in Ca, the principal reason might be attributed to the fact that the majority of animals were dependent upon paddy straw as a staple source of fodder, which was deficient in Ca. Mandal *et al.* (2004) and Mishra (2006) reported deficient serum Ca

Table 2. Serum mineral concentrations of the animals of east and south-eastern coastal plain zone of Odisha

Minerals	Puri			Jagatsinghpur			East and south-eastern coastal plain zone	Critical level
	Satyabadi	Delanga	Average	Tirtol	Kujanga	Average		
Ca (mg/dl)	7.89±0.42 (56.6)	6.73±0.37 (80.0)	7.313±0.41 (68.3)	8.05±0.19 (53.3)	8.03±0.19 (50.0)	8.04±0.19 (51.6)	7.68±0.16 (60.0)	8.0
P (mg/dl)	4.30±0.29 (63.3)	4.15±0.21 (63.3)	4.2±0.25 (63.3)	5.92±0.23 (20.0)	4.80±0.16 (43.3)	5.36±0.22 (31.6)	4.79±0.13 (47.5)	4.5
Zn (ppm)	0.83±0.02 (20.0)	0.61±0.02 (63.3)	0.72±0.04 (41.6)	1.23±0.02 (0.0)	1.44±0.02 (0.0)	1.33±0.03 (0.0)	1.03±0.03 (20.8)	0.6
Cu (ppm)	0.56±0.02 (83.3)	0.61±0.04 (70)	0.58±0.02 (76.6)	0.60±0.01 (63.3)	0.64±0.01 (56.6)	0.62±0.01 (60.0)	0.60±0.01 (68.3)	0.65
Mn (ppm)	0.21±0.04 (16.6)	0.23±0.05 (23.3)	0.22±0.01 (20.0)	0.17±0.10 (66.6)	0.25±0.01 (33.3)	0.21±0.006 (50.0)	0.22±0.003 (35.0)	0.2
Fe (ppm)	2.31±0.03 (0.0)	1.97±0.049 (0.0)	2.14±0.05 (0.0)	2.30±0.04 (0.0)	2.34±0.07 (0.0)	2.32±0.06 (0.0)	2.23±0.03 (0.0)	1.0

Figure in the parenthesis indicates the percentage of animal deficient.

Table 3. Metabolic status of the animals in east and south eastern coastal plain zone of Odisha

Parameters	Puri			Jagatsinghpur			East and south eastern coastal plain zone	Normal range
	Satyabadi	Delanga	Average	Tirtol	Kujanga	Average		
Protein (g/dl)	4.43±0.15	4.28±0.13	4.35±0.08	5.71±0.31	5.82±0.27	5.77±0.14	5.06±0.13	6.7–7.5
Albumin (g/dl)	2.55±0.11	1.85±0.09	2.48±0.06	3.67±0.23	3.91±0.22	3.79±0.11	3.14±0.10	3–3.5
Globulin (g/dl)	1.87±0.08	1.85±0.09	1.86±0.04	2.04±0.11	1.90±0.13	1.97±0.06	1.92±0.05	3.6–4.0
Cholesterol (mg/dl)	58.02±4.12	49.86±2.11	53.94±1.66	44.0±2.72	43.99±2.65	44.00±1.33	48.97±1.57	58–88
Glucose (mg/dl)	51.60±3.11	48.60±2.83	50.10±1.48	36.69±1.67	42.48±6.43	39.59±2.34	44.84±2.01	45–75

levels in anoestrus cows. It was observed that 47.5% of the surveyed animals showed the deficiency of serum. Mishra (2006) observed that serum P concentration in all the anoestrus heifers, 98% of anoestrus cows and 72% of cyclic cows were below the critical level in Dhenkanal district of Odisha. The P concentration in the soil of ESECPZ was deficient in P (Jena 2010) and this might be the reason of low level of P in feed ingredients and roughages. Higher Fe concentration was observed in the feeds and fodders of all the surveyed samples. Higher Fe concentration in the soil, feeds and fodders causes precipitation of inorganic P, making it unavailable to plants and subsequently to animals (Prabowo *et al*. 1989). The average serum P level of this zone was higher than critical level which might be due to presence of high yielding animals and in those animals supplementation of mineral is practiced. The average serum Zn concentration of cows in ESECPZ was above the critical level (0.6 ppm). This may be due to higher availability of Zn from the feed and fodder as evident from the Zn content in the available feeds and fodder of the zone. In spite of higher Zn content in the feeds and fodders, nearly one-fifth population of the surveyed animals showed the deficiency of low serum Zn content. Mishra (2006) also observed low serum Zn content in 46% of anaoestrus cows of Dhenkanal district of Odisha. Similar observations were reported by Sarkar *et al*. (1994) and Kawitkar (2004). The average serum Cu concentration of cows in ESECPZ was marginally lower than the critical level (0.65 ppm). Although the Cu content in the feeds and fodders was marginally higher than critical level, 68.3% of the surveyed animals in ESECPZ showed lower level than that of the critical level. This might be due to poor biological availability of Cu, caused by increased lignifications in the fodders of tropical countries and the susceptibility of Cu to form biologically unavailable complexes (Cu-Fe, Cu-Zn, and Cu-phytase). Singh *et al.* (2004) and Tiwary *et al.* (2007) reported deficiency of serum Cu up to some extent in the animals similar to the present findings. The average Mn concentration in the serum of cows in ESECPZ was higher than the critical level. The higher concentration of Mn in feed ingredients and roughages might have been reflected in the serum of animals under investigation. Similar higher levels of serum Mn were reported by Mandal *et al*. (2004) and Tiwary *et al*. (2007). Serum Fe concentration in all the animals of ESECPZ was above the critical level even with or without any additional mineral supplementation. This might be due to the abundance of element Fe in feeds and fodders grown on naturally Fe rich soil. Similar observations were reported by Tiwary *et al.* (2007) and Sukla *et al.* (2010). Majority of the tropical soils are acidic, resulting in forage level of Fe in excess of requirement. In addition to this, grazing animals may receive substantial amount of Fe by soil ingestion, which could negatively affect absorption of Cu and other elements (Probowo *et al*. 1989). Thus the serum mineral status of the animals of ESECPZ indicated deficiency of Ca, P and Cu.

Serum biochemical profile of animals

The metabolic status of animals in east and south eastern coastal plain zone of Odisha is presented in Table 3. The average serum glucose content of animals of ESECPZ was marginally lower than the normal range (Kaneko *et al*. 1997). Mishra (2006) also observed low serum glucose level in the anoestrus cows of Dhenkanal district of Odisha. The average cholesterol level of animals in ESECPZ was 48.97±1.57 mg/dl. The serum cholesterol content of the animals of ESECPZ varied greatly. The probable reason for this might be due to the type of animals from which blood was collected and with the available feeds and fodders. The average serum protein level of the animals in ESECPZ was found below the normal range (Kaneko *et al*. 1997) with wide range of variation. The low level of serum protein might have been induced by the low level of protein fed to these animals (Singh *et al*. 2004).

SUMMARY

The feeds and fodders were good sources of macro-and micro-minerals with exception of paddy straw, mixed grass and other straws. But higher percentage of animals was found deficient in Ca, P and Cu. Though the mean serum level of Zn and Mn in cattle was observed to be higher than the critical level, still deficiency of these minerals was noticed in the serum of some of the cattle. Low level of serum protein and glucose was the indicative of the poor plane of nutrition.

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