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Mineral profile of feeds, fodders and biochemical profile of animals in west- central table land zone of Odisha

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ABSTRACT

Sample of feeds and fodders and serum samples of cows in 8 villages, 2 from each block and 2 blocks from each of the 2 districts namely Bargarh and Jharsuguda of West-central table land zone (WCTLZ) of Odisha were collected and analysed for macro and micro mineral content. Among the fodders, paddy straw was deficient in calcium (Ca), phosphorus (P), copper (Cu) and manganese (Mn). Deficiency of P was observed in most of the fodders. Most of the concentrate contained higher level of the analysed minerals. The average serum Ca, P, zinc (Zn), Cu, Mn and iron (Fe) content of cows in WCTLZ were found to be 6.81±0.14 mg/dl, 3.67±0.09 mg/dl, 0.90±0.02 pmm, 0.68±0.01 pmm, 0.26±0.004 pmm and 2.38±0.07 pmm, respectively. The percentage of animals deficient in serum Ca, P, Zn, Cu and Mn were observed to be 75.8, 72.5, 13.3, 29.1, 9.1 and 5.8 %, respectively. The serum mineral content of the animals of WCTLZ was highly deficient in Ca and P. Deficiency of Zn, Cu, Mn and Fe was also noticed in some animals. The serum glucose, cholesterol, protein, albumin and globulin content of the animals in WCTLZ were 45.87±1.56 mg/dl, 63.99±2.84 mg/dl, 4.49±0.09g/dl, 2.16±0.05g/dl and 2.32±0.08g/dl, respectively. Based on the study, supplementation of deficient minerals, viz. Ca, P, Zn and Cu and protein and energy in the diet of cattle under existing feeding practices in WCTLZ of Odisha is imperative for better health and productivity.

Key words: Animals, Feeds and fodders, Mineral, West-central table land zone

It is necessary to generate zone-wise information on mineral status so as to identify the deficiencies or toxicities (Garg *et al.* 1999). So the present study is undertaken with the objectives of assessment of mineral status of the feeds and fodders available in the WCTLZ of Odisha and further assessment of mineral and biochemical status of the animals of the WCTLZ of Odisha.

MATERIALS AND METHODS

The survey was carried out in the WCTLZ of Odisha. The WCTLZ comprises districts namely Bargarh, Sambalpur, Jharsuguda, Sonepur and Bolangir districts. This is located between 20°9’ N latitude and 82°39’- 85°15’ E longitude. To undertake the survey work, 2 districts of WCTLZ were selected namely Bargarh and Jharsuguda. 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 blood samples and serum. The Ca and P content of feeds and fodders were estimated as per the standard procedure (AOAC 1995). The micro minerals content of plant and serum samples were estimated by atomic absorption spectrophotometer method. The concentration of serum Ca, glucose, cholesterol, protein and albumin were estimated by using the kit. The concentration of P was estimated by using a kit. The data were analysed statistically (Snedecor and Cochran 1973).

RESULTS AND DISCUSSION

Mineral content in feeds and fodders

The mineral contents in the feeds and fodders of WCTLZ are presented in Table 1. Among all the feeds and fodders

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analysed, except the green grasses and groundnut oil cake (GNOC), all other feeds and fodder samples contained lower levels of Ca. The Ca content of the paddy straw of all the surveyed areas was low in Ca than that of critical level (0.3%) (Prabowo *et al*. 1990). The straws were deficient in Ca as they contain excess of silica, oxalates and tannins, which may interfere in the utilization of Ca and also due to accumulation of minerals in seed due to translocation. This result was in accordance with Das *et al.* (2002[a]) who reported lower Ca level in paddy straw (0.07–0.17%). The Ca content was higher in legume straw than the cereal straws. This can be attributed to high uptake of Ca from soil by the legumes than the grasses. These observations corroborate with Ramana *et al.* (2001) who reported 2.0 to 2.6% of Ca content in black gram and green gram fodder (2–2.6%). Mishra (2006) also reported the higher Ca content in legume straw than that of the critical level in Dhenkanal district of Odisha. 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 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. Among different concentrates available in surveyed area, wheat bran and maize were found to contain lower Ca than that of critical level. Other feed ingredients like rice bran, maize and wheat bran contained lower Ca than that of critical level. The low Ca content of wheat bran observed in the present study was in agreement with Singhal and Mudgal (1984) who reported low Ca in cereals and bran. The P content of the paddy straw of WCTLZ was lower than that of critical level. The lower P content in the roughages might be attributed to the lower concentration of soil P and acidic pH of the soil. The paddy straw was extremely low in P probably because as plants mature, mineral contents decline due to natural dilution process and translocation of nutrients to the root system (Underwood 1981). The marginally higher level of P content in leguminous straws might be attributed to decline in P with advancing maturity of plant reflecting increase proportion of stem to leaf and old to new leaves, since the stem and old leaves have lower mineral concentrations than young leaves. Similar findings were reported by Kawitkar (2004). Concentrate feed ingredients like groundnut oil cake, rice bran, maize and wheat bran contained higher P than that of critical level. The reason for higher Zn content in all the feed ingredients that this might be due to transfer of Zn from plant segment to seeds was quite substantial (Garg *et al*. 2002). It is generally observed that the plant protein concentrates are invariably high in Zn content than cereal grains (Underwood 1981). Paddy straw and black gram straw of all the surveyed areas of the zone were observed to be having marginally higher content of Zn than that of critical level. Also all the green grasses like dub grass, mixed grass and hybrid napier grass contained marginally higher level of Zn than the critical level (30ppm) (Prabowo *et al*. 1990). This might be attributed to the higher Zn content of the soil of the WCTLZ (Singh 2010). The Cu concentrations of dub grass, pasture grass (mixed grass), hybrid napier grass, sugarcane tops, paddy straw and black gram straw contained higher levels of Cu than critical level (8 ppm). The Cu content of cereal straw was on borderline while legume straws contained above the critical level. The Cu concentrations of groundnut oil cake and rice bran contained higher levels of Cu than critical level (8ppm) while maize grain and wheat bran contained low levels of Cu than that of the critical level. These results corroborate with Desai *et al.* (1984) who reported higher Cu level in oil cakes. Paddy straw and black gram straw contained lower levels of Mn than critical level (40 ppm). All the green gasses studied in the surveyed zone contained marginally lower levels of Mn than critical level (40 ppm). Though the soil contained higher level of Mn (Singh 2010) than that of critical level, the straws and green grasses contained lower level of Mn. This 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, the Mn concentration of all other cattle feeds like groundnut oil cake, rice bran,

Table 1. Mineral status of the feeds and fodders in west central table land zone of Odisha

Minerals/ ingredients	Ca (%)	P (%)	Mn (ppm)	Cu (ppm)	Zn (ppm)	Fe (ppm)
Paddy straw	0.28±0.01	0.08±0.005	25.56±1.10	7.54±0.42	38.08±1.19	164.28±1.41
Rice bran	0.24±0.01	0.54±0.04	57.04±1.87	19.83±0.60	41.25±1.07	154.21±1.48
Maize	0.28±0.01	0.43±0.01	17.37±0.70	7.82±0.45	38.63±0.92	173.77±1.22
Dub grass	0.67±0.01	0.23±0.01	36.88±0.77	15.17±0.77	40.30±0.76	162.98±1.10
Mixed grass	0.65±0.01	0.27±0.01	30.01±1.02	11.39±0.60	34.34±0.88	174.85±1.58
Hybrid Napier grass	0.49±0.01	0.18±0.01	30.14±0.88	17.15±0.77	31.59±0.75	178.68±1.39
Sugarcane top	0.26±0.01	0.94±0.04	33.88±1.30	16.02±0.71	27.39±1.23	174.38±1.42
GNOC	0.50±0.01	0.76±0.01	56.71±1.90	28.23±1.17	51.47±1.65	193.25±1.93
Wheat bran	0.28±0.01	0.28±0.01	60.32±1.91	7.08±0.26	41.66±0.90	127.87±1.32
Blackgram straw	0.35±0.02	0.30±0.02	30.71±0.41	16.79±0.34	31.60±0.39	139.82±3.40
Critical level	0.30	0.25	40	8	30	50

and wheat bran was higher than critical level. It was observed that maize, sorghum and barley were generally lower in Mn content than wheat and oat (Underwood 1981). The Fe concentrations of all the roughages were observed to be at much higher level than the critical level (50 ppm) and this is obviously due to both higher uptake of Fe from the soil and higher Fe content of soil as well. The observed range of Fe content in present study was in agreement with Desai *et al*. (1984) who observed Fe content in seeds and grain (95.4–427.6 ppm), bran and husk (318.8 ppm), chuni and bharda (187.3–516.3 ppm). Moreover, maize and wheat crops were hardly grown in those areas of study. So the mineral composition of these ingredients as reported might not be the true reflection due to the soil status of the studied zone.

Serum mineral profile of the animals

The mineral content in the feeds and fodders of WCTLZ is presented in Table 2. The average serum Ca concentration (6.81±0.14 mg/dl) of WCTLZ was observed to be below critical level (8.0 mg/dl). Considering the higher percentage (75.8%) 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 and paddy straw is found to be deficient in Ca content as evident from the earlier discussion in this article. Ramana *et al.* (2001) and Mishra (2006) reported deficient serum Ca levels in animals. In Bargarh district, the average serum Ca concentration of the animals was 7.36±0.19 mg/dl and in Jharsuguda district 6.16±0.20 mg/dl. Such variations in reported values may be due to various factors such as feed source and its Ca content. Also other factors that influence serum Ca level is season as observed by Rowland *et al*. (1979) and Kawitkar (2004) who reported higher serum Ca in wet season than dry season. The wide variation in Ca level of animals in this zone might be due to the fact that the blood was collected randomly from animals of different farmers of villages having stall fed and/or grazing method of feeding. The animals, either stall-fed or on straw based diet, in the present investigation were probably maintained without mineral supplementation and this explained the Ca deficiency in most animals in the area of study. The average serum P concentration (3.67±0.09 mg/dl) of cows in WCTLZ was below critical level (4.5 mg/dl). It was observed that 91.6% of the surveyed animals showed the deficiency of serum phosphorus. Samantha and Samantha (2002) also reported inadequate blood P concentration in cattle. Mishra (2006) observed that all the anoestrus heifers, 98% of anoestrus cows and 72% of cyclic cows were below the reported critical level (4.5 mg/dl) in Dhenkanal district of Odisha. The soil of WCTLZ was observed to be deficient in P (Singh 2010) and this might be the reason of low level of P in feed ingredients and roughages. Also higher Fe concentration was observed in the feeds and fodders of all the surveyed areas. 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). One of the reasons of P deficiency was that the basal feed available for the animals was mainly paddy straw which was found almost deficient in the P content. The average serum Zn concentration of cows in WCTLZ was above the critical level (0.65 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-sixth numbers of the surveyed animals showed low serum Zn content. Such deficiency has also been reported by Ramana *et al.* (2000) up to 50%. Similarly, Kawitkar (2004) also reported deficiency in percentage of serum Zn in the animals similar to present findings. Mishra (2006) also observed low serum

Table 2. Serum mineral concentrations of the animals of west central table land zone of Odisha

Minerals	Bargarh			Jharsuguda			West Central Table Land Zone	Critical level
	Bargarh	Attabira	Average	Laikera	Kulabera	Average		
Ca (mg/dl)	7.55±0.25 (5.34-10.22)	7.36±0.19 (5.56-9.73)	7.45±0.15 (5.34-10.22)	6.07±0.32 (3.05-11.04)	6.25±0.25 (3.98-8.56)	6.16±0.20 (3.05-11.04)	6.81±0.14 (3.05-11.04)	8.0
P (mg/dl)	4.31±0.14 (2.24-5.51)	4.54±0.10 (3.54-6.17)	4.42±0.09 (2.24- 6.17)	2.88±0.12 (2.02-4.82)	2.96±0.15 (2.06-4.65)	2.92±0.09 (2.02-4.82)	3.67±0.09 (2.02-6.17)	4.5
Zn (ppm)	1.03±0.06 (0.56-1.83)	0.87±0.05 (0.46-1.56)	0.95±0.04 (0.46-1.83)	0.81±0.03 (0.52-1.38)	0.91±0.04 (0.48-1.42)	0.86±0.03 (0.48-1.42)	0.90±0.02 (0.46-1.83)	0.6
Cu (ppm)	0.69±0.03 (0.43-0.96)	0.64±0.02 (0.42-0.84)	0.66±0.01 (0.42-0.96)	0.67±0.01 (0.46-0.89)	0.74±0.01 (0.56-0.89)	0.71±0.01 (0.46-0.89)	0.68±0.01 (0.42-0.96)	0.65
Mn (ppm)	0.31±0.01 (0.20-0.45)	0.25±0.007 (0.18-0.35)	0.28±0.01 (0.18-0.45)	0.23±0.008 (0.15-0.30)	0.26±0.004 (0.23-0.31)	0.24±0.004 (0.15-0.31)	0.26±0.004 (0.15-0.45)	0.2
Fe (ppm)	3.08±0.08 (2.15-3.47)	2.87±0.07 (1.96-3.52)	2.98±0.05 (1.96-3.52)	2.06±0.13 (0.70-3.03)	1.53±0.06 (0.73-1.93)	1.78±0.08 (0.70-3.03)	2.38±0.07 (0.70-3.52)	1.0

Figures in the parenthesis indicates the range of the mineral profile of the animals.

Table 3. Metabolic status of the animals in west central table land zone of Odisha

Minerals	Bargarh			Jharsuguda			West Central Table Land Zone	Critical level
	Bargarh	Attabira	Average	Laikera	Kulabera	Average		
Protein (g/dl)	4.85±0.17	4.78±0.20	4.81±0.09	3.81±0.092	4.52±0.16	4.17±0.07	4.49±0.09	6.7-7.5
Albumin (g/dl)	2.28±0.08	2.30±0.11	2.29±0.04	1.82±0.11	2.31±0.09	2.07±0.05	2.16±0.05	3-3.5
Globulin (g/dl)	2.56±0.18	2.48±0.24	2.52±0.10	1.98±0.11	2.21±0.14	2.10±0.06	2.32±0.08	3.6-4.0
Cholesterol (mg/dl)	71.80±4.81	71.53±4.60	71.67±2.33	67.15±6.90	45.48±4.95	56.31±3.14	63.99±2.84	58-88
Glucose (mg/dl)	44.89±2.53	68.83±2.62	56.86±1.68	35.11±0.34	34.64±0.47	34.88±0.20	45.87±1.56	45-75

Zn content in 46% of anaoestrus cows of Dhenkanal district of Odisha. The reason might be the effect of season, physiological state of the animals and availability of feeds and fodders. Kawitkar (2004) also reported lower serum Zn values in lactating animals than pregnant and heifers (Radostits *et al*. 1994, Kawitkar 2004). The average serum Cu concentration of cows in WCTLZ was above the critical level (0.60 ppm). Though the average concentration of serum Cu was above the critical level, still 26.6% of the surveyed animals in WCTLZ showed lower level than that of the critical level. Although the Cu content in the feeds and fodders of all the zones was at marginally higher level than critical level, deficiency of Cu was observed in the serum of some cows. This might be due to poor biological availability of Cu, which was mostly due to 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), which is also responsible for high incidence of Cu deficiency syndrome, particularly in grazing ruminants. 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 (Prabowo *et al*. 1989). Although there is no deficiency of micro nutrient in the soil, still the plants and animals have shown deficiency of some minerals as the soil-plant animal chain is a complex one (Anetzhofer *et al*. 1977). However, deficiency that observed in present study was reported by various workers in different locations of India. Ramana *et al.* (2000) reported deficient serum Cu content in the blood plasma of animals in southern transition zone of Karnataka. Gowda *et al.* (2001) reported deficiency of serum Cu up to some extent in the animals similar to the present findings. However, Das *et al.* (2003) reported normal level of serum Cu in blood plasma of animals. The average Mn concentration in the serum of cows in WCTLZ was higher than the critical level. The animals of WCTLZ were mainly maintained on paddy straw, rice bran and wheat bran. Mn is highly concentrated in outer layer of grains, so brans have high content of Mn (Underwood 1981). Similar higher levels of serum Mn were reported by Das *et al*. (2003) and Kawitkar (2004). Mn deficiency is not wide spread in tropical regions due to sufficient amount of Mn in the plants. Mn deficiency may be partly due to interference from other minerals. In addition to this, a considerable excess of P and Ca can interfere with the utilization of Mn (Roja 1965). Also a competition exists between Fe and Mn absorption in plants. A symptom of Fe toxicity corresponds to symptoms of Mn deficiency and vice-versa (Thompson and Troeh 1985). This might be the explanation for some the deficiency of serum Mn in some animals of the surveyed zone. Serum Fe concentration in all the animals of WCTLZ 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 and it is in agreement with earlier findings of Rupde *et al*. (1993). Similar observations were reported by Das *et al*. (2003), Kawitkar (2004) and Sukla *et al.* (2010). They reported higher serum Fe concentration of the animals well above the critical level at different locations in India. The higher serum Fe content of the animal is attributed to the reason that temperature (high) and pH (acidic) are among the primary factors affecting Fe availability and uptake by plants. The absence of primary Fe deficiency is a reflection of high Fe content of posture and forages (Underwood 1981). Majority of the tropical soils are acidic, resulting in forage level of Fe in excess of requirement. Fe supplementation is warranted when forage contains less than 100 ppm Fe (McDowell and Conrad 1990). 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 (Prabowo 1989). Thus the serum mineral status of the animals of WCTLZ was found deficient in P, Ca, Zn and Cu.

Serum biochemical profile of the animals

The average serum glucose level of animals in WCTLZ was observed to be 45.87±1.56 mg/dl (Table 3.). The average serum glucose content of animals of WCTLZ was within the normal range (Kaneko *et al*. 1997). The average serum glucose level of animals in Deogarh district was lower than that of the normal range. Mishra (2006) observed low serum glucose level in the anoestrus cows of Dhenkanal district of Odisha. Glucose, being the chief metabolic fuel regulates the whole functional processes of the body by acting as the immediate source of energy. The positive energy balance facilitates the normal maintenance and reproductive performances in time. Although ruminants mainly depend on volatile fatty acids for energy metabolism but 40–60 mg% of glucose is essential for smooth functioning of RBC, retina of eye, kidney and brain. The alterations in blood glucose level serve as the marker clinical findings in a variety of metabolic disorders. The blood glucose concentration is affected by energy status and reproductive efficiency of animals (Arosh *et al*. 1998). The average cholesterol level of animals in WCTLZ was 63.99±2.84 mg/dl. The average serum cholesterol content of animals of Jharsuguda district was lower than the normal range but it was higher in Bargarh district. The probable reason for this might be the type of animals from which blood was collected in Bargarh districts, they might be better nourished with the available feeds and fodders. Cholesterol is one of the precursors for synthesis of androstenidione, progesterone and oestrogen (Arosh *et al*. 1998). Pereek and Deen (1985) have suggested that subnormal energy status induces hypocholestemia which might be the cause of low cholesterol level in the surveyed area as the serum glucose level was found to be low in those animals. The high level of cholesterol in cows was indicative of more secretion of steroids during oestrus due to increased ovarian activity. The declined level of cholesterol in the cows suggested the reduced steroidgenesis in the ovaries. Mishra (2006) also observed low serum cholesterol level in the anoestrus cows of Dhenkanal district of Odisha. The average protein level of animals in WCTLZ was 4.49±0.09g/dl. The average serum protein levels of the animals in WCTLZ was below the normal range (Kaneko *et al*. 1997) with wide range of variation. The low level of serum protein was greatly influenced by the amount of protein intake; therefore, the low level of serum protein in cows might have been induced by the low level of protein fed to these animals. Serum protein being the crucial factor for normal growth and reproduction is considered as the central organic bio-molecule in living beings. The serum total protein comprises albumin and globulin. The major fraction albumin is synthesized in liver and maintains the osmotic pressure and acts as a carrier for transportation of other macro/ micro molecules in body. The steroid hormones of reproductive importance function through regulation of protein synthesis. Low intake of protein therefore will put the animal in negative nitrogen balance and continued status of such nitrogen deficiency obviously will affect the phenomenon. The average albumin level of animals in WCTLZ was 2.16±0.05g/dl. The average serum albumin and globulin levels of the animals in all the zones were below the normal range with wide range of variation. Serum albumin levels of the animals are normally influenced by the physiological status of the animal as evident from the report of Dhami *et al*. (2004). Low protein level in the ration of cows might be one of the reasons of low serum albumin and globulin level of the surveyed animals.

The feeds and fodders were good sources of macro- and micro-minerals with exception of maize, paddy straw and other straws. But higher percentage of animals was deficient in Ca and P. Deficiency of Zn, Cu and Mn was also noticed in the serum of these animals. Low level of serum protein, glucose and cholesterol was the indicative of the poor plane of nutrition. Based on the study, supplementation of deficient minerals, viz. Ca, P, Zn and Cu and protein and energy in the diet of cattle under existing feeding practices in WCTLZ of Odisha is imperative for better health and productivity.

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