



Macro and micro-mineral status of feeds and fodders in West Kameng district of Arunachal Pradesh

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Farm animals derive their mineral requirements mainly from the feed stuffs offered to them. Livestock in India, do not receive regular mineral supplementation and depend mainly on feeds and fodder for their mineral requirements (Garg *et al.* 2002). Mineral profile of a particular feed stuff is largely dependent on the mineral profile in soil of that particular region and may vary from place to place. Their contents in soil, plants or feed stuffs tend to change due to introduction of high-yielding crop varieties, intensive cropping, fertilization and leaching loss. A number of researchers in the world have reported a high incidence of forage samples below critical levels for different elements (Miles and McDowell 1983, Underwood and Suttle 1999, Garg *et al.* 2010).

The West Kameng district as well as almost the whole of Arunachal Pradesh state fall under the eastern Himalayan region (Agro-eco-region 17) as classified by NBSSLUP (1990), which is characterized by warm pre humid eco-region with brown and red laterite hill soil. Animal husbandry is an indispensable part of the life, economy and culture of tribal high altitude people of this region (Buragohain *et al.* 2004). Livestock feeds mainly comprise of dry or green roughages, pasture grass along with locally available tree leaves and homegrown grains like maize, millets etc. Some reports are available on the nutritional quality of pasture lands of this region (Basu and Chatterjee 2002, Basu *et al.* 2005) and tree fodders (Chatterjee *et al.* 2003). However, the literatures on mineral status in feeds and fodder of this region are scanty. In the present study an attempt has been made to assess the macro and micro-mineral status of feeds and fodder commonly fed to the livestock in West Kameng district of Arunachal Pradesh.

Nine representative sites of varying altitude (5000 to 10000 ft asl) from the district were selected so that it represent

the whole district. The sites were Dirang, Namshu, Nykmadoung, Tomhill, Senge, Manalaphudung, Debrabu, Sangti and Yewang. From each sites samples of green and dry fodder, tree fodder and concentrate ingredients were collected. The number of samples collected for each fodder/feed have been mentioned in the tables. The samples were dried in oven at 80° C for 24 h, ground (1 mm) and stored in airtight containers until analyzed. The samples were processed to make its acid-extract as per the method described by Heckman (1967) and AOAC (1990). Two gram of dried ground fodder sample was placed in a porcelain crucible and ashed in muffle furnace at 550°C. The sample was cooled and 10 ml of 3 N HCl was added, covered with a watch glass and boiled gently for 10 min. After cooling, the sample was filtered and diluted with deionized water to 100 ml in volumetric flask.

Calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), copper (Cu), zinc (Zn), manganese (Mn), iron (Fe) and cobalt (Co) were analysed following standard procedure through atomic-absorption-spectrophotometer. The standard for each element was prepared using the separate stock standards. For the determination of calcium, 1% lanthanum was added to standards and samples. A blank reagent was also made. Phosphorus (P) was estimated by alkali metric ammonium-molybdophosphate method (AOAC 1990). The statistical analysis of the data was done as per Snedecor and Cochran (1994).

Concentration of various macro and micro-minerals in roughages, tree leaves and concentrate feed ingredients commonly fed to livestock in West Kameng district are presented in Tables 1, 2.

Mineral profile in dry roughages: Paddy straw, millet straw and dry grasses harvested from the jungle form the bulk of the roughage feeding. Amongst the dry fodder, paddy straw is more common in this region. It was found to contain higher levels of phosphorus, but deficient in calcium, magnesium, sodium and potassium. Millet straw was found to be deficient in all the macro-minerals studied. Dry grasses,

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Table 1. Macro-mineral status in locally available feed resources

Name	Calcium %	Phosphorous %	Magnesium %	Sodium %	Potassium %
<i>Dry roughages</i>					
Paddy straw (n=8)	0.142±0.01	0.50±0.03	0.098±0.02	0.008±0.001	0.116±0.04
Millet straw (n=7)	0.026±0.02	0.199±0.01	0.050±0.008	0.005±0.001	0.094±0.012
Dry grass (n=5)	0.383±0.10	0.289±0.04	0.053±0.009	0.030±0.005	0.134±0.01
Mean ±SE	0.184±0.04	0.329±0.04	0.067±0.006	0.014±0.002	0.115±0.014
<i>Green roughages</i>					
Maize (n=5)	0.047±0.007	0.160±0.01	0.061±0.006	0.021±0.004	0.114±0.01
Pasture grass (n=9)	0.192±0.033	0.385±0.03	0.060±0.005	0.058±0.007	0.153±0.02
Mean ±SE	0.120±0.012	0.273±0.02	0.061±0.002	0.040±0.003	0.134±0.01
<i>Tree fodders (n=5 for each tree fodder)</i>					
<i>Blemkar (Buddlija asitica)</i>	1.265±0.11	0.428±0.02	0.089±0.013	0.002±0.0003	0.119±0.01
<i>Khaksuma (Araliaceae family)</i>	0.002±0.0004	0.181±0.017	0.152±0.011	0.002±0.0003	0.130±0.012
<i>Baggar (Berberis sp)</i>	0.010±0.0034	0.359±0.041	0.160±0.017	0.002±0.0003	0.129±0.016
<i>Salix (Salix humboldtiana)</i>	0.011±0.0009	0.195±0.014	0.135±0.014	0.001±0.0002	0.109±0.016
Bamboo leaves	0.229±0.021	0.725±0.032	0.091±0.005	0.006±0.0008	0.127±0.024
<i>Phrengpa (Quercus walliasehiana)</i>	0.081±0.007	0.249±0.021	0.134±0.011	0.004±0.0007	0.115±0.003
<i>Silulii (Acer campbelli)</i>	0.599±0.04	0.206±0.024	0.127±0.011	0.002±0.0003	0.116±0.006
<i>Domkar (Symplocos racemosa)</i>	0.009±0.001	0.124±0.011	0.142±0.003	0.004±0.0006	0.133±0.008
<i>Maar (Costanpis sp)</i>	2.386±0.03	0.097±0.007	0.106±0.014	0.002±0.0002	0.118±0.012
<i>Bamlakpa (Embelia sp)</i>	0.144±0.0021	0.089±0.014	0.046±0.007	0.019±0.002	0.151±0.021
<i>Matekpa (Quercus fenestrata)</i>	0.423±0.042	0.334±0.026	0.072±0.004	0.023±0.002	0.108±0.011
<i>Ngeksing (Symplocos crataegoides)</i>	0.006±0.001	0.270±0.019	0.154±0.003	0.002±0.0003	0.110±0.007
Mean ±SE	0.430±0.047	0.271±0.012	0.117±0.012	0.006±0.0003	0.122±0.008
<i>Concentrate ingredients</i>					
Wheat grain (n=4)	0.017±0.002	0.896±0.16	0.052±0.006	0.012±0.002	0.152±0.020
Maize grain (n=8)	0.007±0.001	0.342±0.01	0.050±0.002	0.006±0.001	0.127±0.040
Kodo (n=4)	0.096±0.011	0.431±0.03	0.055±0.015	0.011±0.002	0.135±0.011
Millet grain (n=4)	0.021±0.002	0.392±0.05	0.059±0.004	0.020±0.002	0.152±0.021
Soybean (n=3)	0.051±0.007	1.02±0.13	0.063±0.006	0.007±0.001	0.114±0.013
Mean ±SE	0.038±0.003	0.616±0.052	0.056±0.005	0.011±0.001	0.136±0.011
Critical level*	<0.30	<0.25	<0.20	<0.06	<0.80

n, Number of samples; critical level*, Concentrations below which are considered deficient (McDowell *et al.* 1993) based on requirements for cattle (NRC 2001).

comprising of various jungle grasses of hilly track, contained optimum level of calcium and phosphorus, but were deficient in magnesium, sodium and potassium. Das *et al.* (2003) reported comparatively lower level of phosphorous (0.11%) than calcium (0.29%) in paddy straw in hilly zones of West Bengal. Cobalt and manganese content of paddy straw were above the critical level, but deficient in copper, iron, and zinc. Dry grasses contained optimal level of all the micro-minerals, whereas, millet straw was deficient in copper and zinc. Low zinc and copper content in straw may be due to interference in their availability by higher iron content (Maan *et al.* 2003).

Mineral profile in green roughages and tree leaves: Due to lack of enough aerable land in this forest covered hilly tract, cultivation of fodder crops is not a common practice. Pasture grasses and tree leaves comprise the major portion of the green resources fed to the livestock. The pasture grasses were found to be adequate in P and Na but deficient in Ca, Mg and K. The mean content of cobalt (3.20±0.03 mg/kg

DM), copper (41.50±0.03 mg/kg DM), iron (1543.00±0.21 mg/kg DM), zinc (54.20±0.01 mg/kg DM) and manganese (561.00±0.06 mg/kg DM) were adequate in pasture grasses. Higher level of iron (1543.00±0.21 mg/kg DM) and manganese (561.00±0.76 mg/kg DM) in pasture grass probably arisen from soil contamination (Underwood and Suttle 1999) and high acidity of soil in this region (Mitchell *et al.* 1957). Cobalt, copper, iron, zinc, and manganese content of maize leaves were well above the critical level.

The tree leaves are important for livestock feeding during scarcity period when availability of other green roughages becomes low. Calcium, phosphorous, magnesium, sodium and potassium content of different tree leaves varied from 0.002 to 2.386%; 0.089 to 0.725%, 0.046 to 0.160%; 0.001 to 0.023% and 0.108 to 0.151% (on DM basis), respectively. Calcium content in about 34% of the tree leaves was above critical level with the highest amount found in Maar (2.386%) followed by Blemkar (1.265%) leaves. Six out of 12 tree fodders (50%) analyzed in this study were found to be

Table 2. Micro-mineral status (mg/kg DM) in locally available feed resources

Name	Cobalt	Copper	Iron	Zinc	Manganese
<i>Dry roughages</i>					
Paddy straw (n=8)	1.95±0.02	0.70±0.01	34.8±0.12	24.1±0.14	338.5±7.01
Millet straw (n=7)	1.05±0.03	4.25±0.05	345.8±4.04	9.80±0.42	369.5±3.05
Dry grass (n=5)	2.90±0.11	23.3±0.13	818.5±8.09	79.3±2.08	421.6±8.06
Mean ±SE	1.97±0.05	12.00±0.08	399.70±5.69	37.70±0.88	376.53±6.23
<i>Green roughages</i>					
Maize (n=5)	1.25±0.01	28.9±0.64	361.0±6.03	34.5±1.03	56.0±1.07
Pasture grass(n=9)	3.20±0.03	41.5±0.83	1543.0±9.21	54.2±0.89	561.0±9.06
Mean ±SE	2.23±0.03	35.20±71	952.00±7.89	44.38±0.79	308.50±12.3
<i>Tree fodders (n=5 for each tree fodder)</i>					
<i>Blemkar (Buddlija asitica)</i>	0.60±0.02	13.70±0.22	204.25±3.04	6.75±0.11	226.25±0.17
<i>Khaksuma (Araliaceae family)</i>	0.90±0.03	ND	28.20±0.22	27.50±0.21	267.85±1.04
<i>Baggar (Berberis sp)</i>	2.10±0.12	ND	44.35±0.04	43.00±0.07	16.25±0.28
<i>Salix (Salix humboldtiana)</i>	3.30±0.07	7.55±0.22	98.35±0.03	18.90±0.03	32.00±1.10
<i>Bamboo leaves</i>	1.05±0.08	4.25±0.12	345.8±7.05	9.80±0.03	369.5±4.09
<i>Phrengpa (Quercus walliasehiana)</i>	1.45±0.21	6.25±0.11	172.90±1.23	25.35±0.25	182.90±0.01
<i>Silulii (Acer campbelli)</i>	0.50±0.01	8.15±0.07	132.70±2.01	10.10±0.08	15.45±0.22
<i>Domkar (Symplocos racemosa)</i>	3.80±0.03	18.25±0.33	647.0±9.06	9.50±0.09	269.75±2.10
<i>Maar (Costanpis sp)</i>	3.90±0.06	2.30±0.01	138.15±0.24	6.95±0.21	301.95±1.30
<i>Bamlakpa (Embelia sp)</i>	0.95±0.04	2.95±0.08	165.80±0.35	9.00±0.25	40.35±0.04
<i>Matekpa (Quercus fenestrata)</i>	1.25±0.05	10.7±0.23	551.0±8.10	27.6±0.03	496.2±0.27
<i>Ngeksing (Symplocos crataegoides)</i>	2.65±0.01	9.7±0.12	185.9±1.11	34.4±0.11	252.9±1.54
Mean ±SE	1.87±0.05	8.38±0.17	226.20±2.03	19.07±0.13	205.95±2.12
<i>Concentrate ingredients</i>					
Wheat grain (n=4)	1.45±0.22	3.0±0.03	476.2±1.08	20.7±0.03	20.3±0.15
Maize grain (n=8)	2.80±0.25	8.10±0.08	313.9±1.09	15.55±0.15	11.25±0.28
Kodo (n=4)	2.05±0.04	36.9±0.21	538.5±7.06	24.1±0.25	212.2±4.57
Millet grain (n=4)	1.20±0.08	9.65±0.08	547.0±7.02	16.35±0.06	40.25±0.09
Soybean (n=3)	0.20±0.016	39.8±0.29	251.2±6.05	52.85±1.07	24.45±1.01
Mean ±SE	1.54±0.08	19.49±0.12	425.36±	25.91±1.08	61.69±3.29
Critical level*	<0.10	<8.00	<50.00	<30.00	<40.00

ND, Non detectable; n, number of samples; Critical level,* Concentrations below which are considered deficient (McDowell *et al.* 1993) based on requirements for cattle (NRC 2001).

deficient in phosphorus. Bamboo and Blemker leaves were found to be comparatively richer source of phosphorus. All the tree fodders were found to be deficient in Mg, Na and K.

Micro-mineral contents (mg/kg DM) were found to be variable among the tree leaves ranging from 15.45 to 496.2 for Mn, 28.20 to 647.00 for Fe, 0.50 to 3.90 for Co, 2.30 to 18.25 for Cu and 6.95 to 43.00 for Zn. Cobalt content of all the tree leaves was above critical levels. Blemkar, silulii, domkar, metekpa and ngeksing leaves were optimal in copper content. Iron content was optimal in all the tree leaves except khaksuma and baggar. All the leaves except baggar, salyx and silulii were adequate in manganese content. The overall values for mean content (mg/kg DM) of Co, Cu, Fe, Zn and Mn in tree fodder were 1.87±0.05, 8.38±0.17, 226.2±2.03, 19.07±0.13 and 205.95±2.12, respectively indicating that the tree fodders in this region were rich source of Fe, Mn and Co, adequate in Cu and deficient in Zn.

Mineral profile in concentrate feed ingredients: Feeding of commercial concentrate mixture to the animals is not at

all a common practice in this region. However, animal owners use to offer different homegrown or locally procured concentrate ingredients to their animals. The most common concentrate ingredient is maize-grain followed by millet-grain and kodo-grain. Only a very few farmers offer wheat grain, soybean or other oil cakes to their animals. All the concentrate ingredients were found to be deficient in calcium, magnesium, sodium, and potassium. The content ranged from 0.007 to 0.096%, 0.050 to 0.063%, 0.006 to 0.020%, and 0.114 to 0.152% respectively, for Ca, Mg, Na and K. However, phosphorous content (0.342 to 1.02%) was adequate in all the concentrate ingredients.

All the concentrate feed ingredients contained adequate to high level of cobalt (0.20 to 2.80 mg/kg DM) and iron (251.2 to 547.0 mg/kg DM). Wheat grain was found to be deficient in copper (3.0 mg/kg DM) whereas, the other ingredients were adequate. Zinc content of soybean (52.85 mg/kg DM) was adequate, whereas other ingredients were deficient. The manganese content was very high in Kodo

(212.2 mg/kg DM), just adequate in millet (40.25 mg/kg DM) and the other concentrate ingredients were deficient. Copper, Zinc and Manganese deficiency of some concentrate ingredients may be due to higher iron content in soil inhibiting their absorption.

It is evident from the present study that dry roughages were deficient in macro-minerals except phosphorus in paddy straw and calcium and phosphorus in dry grasses. Micro-minerals content in dry grasses were adequate but both paddy straw and millet straw were deficient in copper and zinc. The pasture grasses were found to be deficient in Ca, Mg and K. The overall values for the macro and micro minerals in tree fodder indicated deficiency of Mg, Na, K and Zn. Most of the concentrate feed ingredients were adequate in P, Fe, Co and Cu but deficient in Ca, Mg, Na and K, Zn and Mn. Therefore, it may be concluded that with the existing feeding system of dry roughages, pasture grass, tree leaves and minimal concentrates with little or no mineral supplementation may not support optimal production potentialities of livestock in this region. The knowledge of mineral status in concentrates, roughages and the locally available tree leaves may help in formulating better feeding strategies for improving the productivity of livestock by the farmers.

SUMMARY

In the present study an attempt was made to assess the mineral status of feeds and fodder commonly fed to the livestock of West Kameng district of Arunachal Pradesh. Samples of feeds and fodder were collected from nine representative sites of varying altitude (5000 to 10000 ft asl) and analyzed for some important minerals. The dry roughages were deficient in most of the macro-minerals except phosphorus in paddy straw and calcium and phosphorus in dry grasses. Micro-mineral content in dry grasses were optimum. Paddy straw contained adequate level of cobalt and manganese whereas, millet straw contained adequate level of cobalt, iron and manganese. The pasture grasses were deficient in Ca, Mg and K. The tree fodders in this region were rich source of Fe, Mn and Co, adequate in Cu and deficient in Zn. Most of the concentrate feed ingredients were adequate in P, Fe, Co and Cu but deficient in Ca, Mg, Na and K, Zn and Mn. This account of the macro and micro-mineral content of feeds/fodder resources should help in strategic supplementation intended to alleviate local deficiencies for

improving the productivity of livestock of this region.

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