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Critical Mineral Concentration of Mineral Soil Commonly Consumed By Livestock's In Ethiopia

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Abstract

The study was carried out in the Humboworeda, Wolaita zone, southern Ethiopia to assess physic-chemical properties of soil mineral commonly consumed by livestock's. Bole and makaduwa are mineral soils are commonly used as a livestock feed around Humbo Woreda. The mineral soils samples were collected from the study site from the depth of 30 cm to analyze for both mineral content and physical property analysis. The result revealed that the mean content of macro(%) and trace(ppm) elements in bole and makaduwa were Ca (0.41, 0.51); Mg (0.20, 0.16); K (0.31, 0.40); Na (3.01, 4.86); P (0.02, 0.04); Fe (92.24, 87.09); Mn (165, 120); Zn (12.16, 17.56) and Cu (4.52, 5.06), respectively. High content of Na ($P<0.01$) and Mn ($P<0.001$) was observed in makaduwa mineral soil. The pH of bole and makaduwa is 10.9 and is 11.1, respectively. The texture of bole is silt loam while makaduwa is clay. The concentration of Ca and Na in makaduwa was at the level to meet the Ca and Mg requirement of ruminants. The Na, Fe and Mn contents in both bole and makaduwa are above the requirement level, whereas Zn, P and Cu contents are below the requirement. It is recommended that strategic mineral survey which should include analysis of soil, water, grass and animal tissue must be undertaken in the different areas of the region in order to detect mineral imbalances for proper mineral supplementation.

Keywords: Bole, Makaduwa, Mineral Requirements, Ruminant

Introduction

In Ethiopia livestock sector has been contributing considerable share to the national economy of the country, for instance through export commodities of live animals, hides and skin to earn foreign exchange to the country. However, livestock productivity is very low and lags behind the growth of human population leading to a net decline in per capita consumption of livestock products [1].

The major feed resources for ruminants in Ethiopia are green forages from natural pasture, crop residues and feed grain/ other concentrates [2]. Among these feed resources, the expansion of cropping area as result of human population pressure makes crop residues to be very important, especially during the dry season [3]. Residues of cereal and pulses accounts for about 26% of total feed utilized and ranked second to grazing in mixed crop-livestock production system of Ethiopia [4].

Large numbers of livestock in many parts of the world consume diets that do not meet exacting requirements [5]. Deficiency of minerals in under grazing and grazing plus concentrate supplementation has been reported [6]. During the dry season when the available forage is low in quantity, quality and in mineral contents, what usually occurs is loss of live weight, low birth weights, lowered resistance to disease and reduced animal performance [7] reported that overgrazed pastures in Ethiopia are deficient in Calcium (Ca), Phosphorus (P), Sodium (Na), Zinc (Zn), Copper (Cu), cobalt (Co), sulfur (S) and selenium (Se), but their Iron (Fe) and Magnesium (Mn) levels are too high.

Mineral deficiencies are considered to be one of the nutritional constraints to animal productivity. Local mineral deficiencies and imbalances are likely to become more apparent and more critical [8]. Mineral imbalances (deficiencies or excesses) in soils and forages have long been held responsible for low production and reproductive problems among grazing ruminants in the tropics. Poor body conditions, slow live weight gain, low fertility and high mortality are normally observed in mineral-deficient animals [5,8].

Feeds, mineral soils and water are the major mineral sources for sheep in Ethiopia [7]. Bole (an Ethiopian name for soil lick) is one of widely spread resource, cheap and well licked by animals once they accustomed to it. Makaduwa is also a type of lick soil used in Wolayta Zone, Southern part of Ethiopia. The feeding strategies are either by trekking animals to natural mineral soil area or by bringing the mineral soil to animals holding pen. In some areas where farmers located far away from natural mineral soil area are purchasing it from local markets. According to [9] in some parts of Ethiopia, supplementation with multi-nutrient mineral blocks and local mineral soils may provide an adequate or even excess amount of essential minerals.

Mineral supplementation play vital role in increasing the nutritive value of low-quality roughages and crop-products in developing countries [8]. Supplementary need of minerals and concentrate mixture to sheep of various ages under grazing has also been advocated [6]. The animals must be supplied with a diet that is palatable and non-toxic and which contain the required minerals, as well as other nutrients, in adequate amounts, proper proportion and available forms [10]. Thus, it is necessary to provide supplementary minerals to promote efficient and profitable livestock production in warm climate regions.

The supplementation of mineral soil may have some positive contribution and may be valuable if explored as mineral supplements, but there is little information available on the techniques of supplementation and marketing system of minerals soils and effect of mineral soil supplementation on growth performance, digestibility of nutrient and economic efficiency indicators on sheep.The present study is, therefore, planned to undertake the following specific objectives:

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Methodology

The Study Area

The study was conducted at Humbo district of Wolayta zone. Humbo district is located at 350 km south of Addis Ababa, Ethiopia. The district is located at an altitude of 1100 to 2300 meter above sea level and 6°40'N latitude and 37°50'E longitude.The Mean annual rainfall and temperature of the study area is 1123.15 mm and 22.0°C, respectively. The district has total area of 86,646 hectare (ha) which is 70% of the lowland and 30% of midland.

Sample Collection and Preparation

The mineral soil samples from Abaya were taken directly from the depressions where the animals actually lick/eat the soil. Before sampling, the top ten centimeter layer was scraped and discarded in case of contamination. An individual mineral soil sample was collected in plastic collection bag using auger to the depth of 20 cm from 12 different depressions which fall approximately in the radius of 40 m. The samples from closer depressions were mixed together and a total of two composite soil samples were collected from Abaya for the analysis of both physical properties and critical mineral concentration in wet seasons. After collection, mineral soil samples were allowed to dry in air. Then the samples were pounded with clean mortar and pestle. The ground samples were sieved to pass through two mm sieve screen and stored in plastic bags until analysis [11].

Analytical Procedures

The soil samples were analyzed for both physical properties and mineral concentration. Soil texture was determined by hydrometer method after destroying OM and disposing the soil with a dispersing agent known as sodium hexametaphosphate that oxidizes the OM present as cementing agent to separate the soil mass into its primary particles.Soil pH was measured by using a pH meter in a 1:2.5 soil: water ratio. Soil organic carbon was determined following the wet digestion by Walkly and Black oxidation method. The percent soil OM was calculated by multiplying the percent organic carbon by a factor of 1.724, following the standard procedure that OM is composed of 58% carbon. Ca, Mg, Fe, Mn, Zn, and Cu were determined by atomic absorption spectrometer. Sodium and Potassium were analyzed by using flame photometrically. Available phosphorus was determined following the standard Olsen extraction method [11].

Statistical Analysis

The data obtained on mineral concentration was subjected to analysis of variance based on the model for completely randomized design in factorial arrangement with using the General linear Model (GLM) procedures of the Statistical Analysis System.The statistical differences between means were estimated by LSD test.

Results and Discussions

Physical Properties

The analyzed data of physical properties of mineral soil in current study are presented in (Table 1). The analyzed data showed that pH of bole is 10.9 and makaduwa is 11.1. The pH value in the present study is comparable with those reported by [12,13] from Southern lowland of Ethiopia however it is lower than the value reported by [14,15] from different sites of Somali region. The difference could be due to the variation in sites and some mineral concentration. In the present study, the texture of bole is silt loam and makaduw is clay. The colors of the soils varied from dark brown to light brown. This is in line with [15,14].

Macro Mineral Concentration of Soil

According to critical level established for sheep, Ca content of bole (0.41%) and makaduwa (0.51%) in present study can meet the requirement from 1.4 to 7 g Kg -1 set by AFRC (2007), from 0.20 to 0.82% set by NRC and 0.37% set by AFRC. The Ca content of soil lick is comparable with soil lick from Zeway (0.35%) and Medacho(0.5%) [16], however it is lower than soil lick from lakeShala (1.7%), Did Harra (1.7%), Negele(1.52%) and Nile valley (2.21%) [16]. Dissimilarity observed in values of some mineral element is normal as soil vary from site to site depending on the parent material soil licks were derived and also on the soil formation process.

Concentration of Mg in bole (0.2%) and makaduwa (0.16%) (Table 1). According to stipulated critical level of Mg for Sheep from 0.12 to 0.18% NRC, bole and makaduwa analyzed in this study can satisfy the recommended level of Mg for sheep. This result comparable with Mg concentration of soil lick from Lake Zeway (0.2%) [16] and report of [15] 0.18% for soil lick from Jijiga in wet season. However lower than Lake Shala (1.5%), Nile Valley (0.99%) [16].

The Na concentration of bole (3.01%) and makaduwa (4.86%) are above the upper limit of the requirement recommended level from 0.07 to 0.1% set by AFRC and from 0.09 to 0.18% set by NRC. In agreement with Na value of current study, mineral soils can serve as universal role of supplementing diets with Na [17-20]. In similar way, [18,16] reported that mineral lick soil can adequately fulfill Na need of cattle and sheep.

The concentration of K in bole (0.31%) and makaduwa (0.40%) are below the recommended level of requirement by [5], meaning that, dietary K levels should not fall below the critical levels of 0.5-0.8%. Based on the suggested requirement for K for ruminants, the analyzed mineral soils cannot supplement K for the licking sheep in the study areas. In similar study, [16,18] also reported that mineral soil licks are not capable of satisfying K requirement of cattle and sheep, respectively. [13] reported that mineral soil lick contained adequate level of potassium for ruminants. This could be due to variations in the parent materials where the mineral soil licks are derived and also on the soil formation process [19].

The mineral soil bole(0.02%) and makaduwa (0.04%) used in this experiment could not be used as source of P in order to meet P requirements for a sheep according to recommend level from 0.26 to 0.28% set by AFRC, and from 0.2 to 0.29 set by NRC. The current finding is similar with the report of [16] lick soil from Lake Shala (0.02%), Lake Zeway (0.02%) and Medacho (0.01%). The same author similarly suggested that, P concentration of maqaduwa from Lake Abaya is 0.05%. This is also in agreement with the works of [12-15,18] they reported that P content of lick soil is lower than the recommended level.

Mineral soil	pH	Sand (%)	Silt (%)	Clay (%)	Texture	Color
Bole	10.9	12	70	18	Silt loam	dark brown
Makaduwa	11.1	6	10	84	Clay	light brown

Table 1: Physical properties of mineral soil.

Macro mineral	Bole (%)	Makaduwa (%)	Micro mineral	Bole (ppm)	Makaduwa (ppm)
Ca	0.41	0.51	Cu	4.52	5.06
Mg	0.2	0.16	Fe	92.24	87.09
P	0.02	0.04	Mn	165	120
K	0.31	0.04	Zn	12.16	17.56
Na	3.01	4.86			

Table 2: Macro and micro mineral concentration of soil.

Micro Mineral Concentration of Soil

The micro mineral compositions of treatment feeds are summarized in (Table 2). In this study, the Cu concentration obtained for bole (4.52 ppm) and makaduwa (5.06 ppm) are in close with the value reported by [15] who found 0.82 to 4.42 ppm Cu in mineral soil from different location of Jijigaworeda. From the present result, Cu in mineral soil was deficient to supply the critical level of 7 to 11 ppm suggested by [5] and NARC. Deficiency of Cu was also reported by [12]. However, the Cu content reported in the present study is higher than the value of reported by [14] where Cu content ranged from 0.28 to 2.22 ppm.

Concentration of Fe in bole and Makaduwa was 92.24 ppm and 87.09 ppm, respectively. Compared to stipulated level of AFRC and from 30 to 50 ppm of NARC, Fe was found to be adequate to supplement sheep in the study area. The current finding is comparable with the Fe value reported by [13,15, 16,18,21] in which they reported that mineral soil lick contained Fe from acceptable level to too excess than ruminant requirement.

The Mn value in bole and makaduwa were 165 ppm and 120 ppm, respectively. According to NARC, Mn for sheep requirement ranges from 20 to 40 ppm. A study on the Mn requirement of growing sheep by [5] showed that 13 ppm was adequate for live weight gain. In agreement with the current study, [13,15,18] reported that mineral soils contained above acceptable level of Mn for ruminants. In contrast, [14,16] reported Mn deficiency in mineral lick soil.

The concentration of Zn in bole (12.16 ppm) and makaduwa (17.56ppm) could not meet stipulated requirement of sheep from 20 to 30 ppm NARC. This finding is similar with the report of [14,15,16] who reported that lick soils are deficient in Zn concentration to supplement sheep.

Summery and Conclusion

The study was conducted in Humbo Woreda, Wolayta Zone of Southern Ethiopia with objectives to study physical properties and critical mineral concentration of mineral soil bole and makaduwa commonly consumed by livestock in study area. The study hypotheses mineral soil can meet the recommended level of mineral requirement to small ruminants. Mineral soil sample were collected from Abaya where animals lick soil. The samples were analyzed for physical properties and critical mineral concentration. The data analyzed by SAS 9.3, for descriptive statistics analysis.

The analyzed data showed that pH of bole is 10.9 and makaduwa is 11.1. In the present study, the texture of bole is silt loam and makaduw is clay. The colors of the soils varied from dark brown to light brown. The result revealed that the mean content of macro(%) and trace(ppm) elements in bole and makaduwa were Ca (0.41, 0.51); Mg (0.20, 0.16); K (0.31, 0.40); Na (3.01, 4.86); P (0.02, 0.04); Fe (92.24, 87.09); Mn (165, 120); Zn (12.16, 17.56) and Cu (4.52, 5.06), respectively. High content of Na ($P<0.01$) and Mn ($P<0.001$) was observed in makaduwa mineral soil.

The concentration of Ca and Na in makaduwa was at the level to meet the Ca and Mg requirement of ruminants. The Na, Fe and Mn contents in both bole and makaduwa are above the requirement level, whereas Zn, P and Cu contents are below the requirement. It is recommended that strategic mineral survey which should include analysis of soil, water, grass and animal tissue must be undertaken in the different areas of the region in order to detect mineral imbalances for proper mineral supplementation.

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