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Mineral Profile of Sheep and Goats Grazed Natural Pasture in Nyala Locality, Western Sudan

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Abstract

The study was conducted in the cold dry season (November 2009-February 2010) to determine Calcium (Ca), Phosphorus (P), Sodium (Na), Potassium (K), Copper (Cu), Manganese (Mn) and Zinc (Zn) concentrations in soil, forage and plasma samples of sheep and goats grazed naturally around Nyala, South Darfur State. Seven soil, 11 forage and 250 blood samples from sheep and goats were collected randomly at the three areas around Nyala town. Calcium and phosphorus were determined by spectrophotometer, Na and K with flame photometer and Cu, Zn and Mn with atomic absorption. Analysis, showed that, soil Ca, K, Cu and Mn concentrations were below the critical limits. While, only Na and Mn in forage were below the critical level. The effect of location on both soil and forage mineral element concentrations were not significant. The study reported higher mineral concentrations in plasma of goats than in sheep, particularly Cu and Zn levels. The plasma mineral profile of sheep and goats fluctuated in relation to sex and age. The results indicated that the mineral supplementation of the livestock at this region is almost at the marginal. This concentration may change abruptly to severe deficient levels at any time and may result in decreasing effective minerals particularly at dry season. It is concluded that mineral supplement is recommended to the grazing animals to enhance the mineral status for maximizing the production potential of goats and sheep and to overcome the marginal deficient level in some essential minerals in dry forages which are considered as the main reason for poor animal performance.

Keywords: Mineral status, small ruminants, forage and blood plasma, Nyala.

Introduction

Minerals are divided into two groups, macro-minerals, those required at 0.1% or more in the diet, and micro-minerals, those required at very small amounts (part per million (ppm)) levels. Macro minerals include calcium, phosphorus, sodium, potassium, chlorine, sulphur, and magnesium. Micro minerals include iron, copper, cobalt, manganese, zinc, iodine, selenium, molybdenum, and others. Mineral deficiencies can lead to decreased growth and reproduction.

Soil is the source of all minerals found in plants. The bioavailability of minerals in

grasses depends on their effective concentrations in the soil (Reid and Horvath, 1980).

Minerals in forage are dependent upon the interaction of a number of factors including soil, plant species, stage of maturity, yield, pasture management and climate (McDowell, 1985). In the absence of mineral supplements, forages should then contain sufficient macro- and micro-elements to cover the requirements of animals (Poland *et al*., 2001).

Small ruminants (sheep and goats) are economically important livestock to the common people in Darfur state. The animals scattered around in small flocks in arid and semi arid condition, feeding of these animals mostly depends largely on available forage and grasses. Selection and intake of forage depends not only on the available plant resources but also on the feeding behaviour of animals.

Sheep and goats differ in their feeding habits. Goats prefer to consume a wide variety of feedstuffs and browse more than sheep, especially under extensive conditions (Roger and Subandriyo, 1997). Much attention had been focused to sheep, goats, and their mineral concentrations in the serum as this is reflected on their health and productive status.

There is limited information on the mineral nutrition of sheep and goats in the pastoral production systems in South Darfur. The objective of the study was to determine the level of some macro and micro-minerals in soil and natural forage as well as the mineral concentration in the serum of sheep and goats.

Materials and Methods

Study area:

The study was conducted at Nyala, South Darfur State, Western Sudan, during the period November 2009-February 2010 (cold dry season). The survey covered three areas: *Domaia* and *Alseraif* (West), *Moasaih* (South) *and Belail* (East) of Nyala.

The area is characterized by semi desert climate in the northern part to rich woodland savannah in the southern. The climate is generally dry and hot during summer (March-June), worm/hot during rainy season (July – October) and moderately cool during the winter (November - February). The temperature varies from 10°C- 40.7°C and the annual rainfall range between 400-1000mm. The natural grazing land was colonized predominantly by *Arista pulmosa, Cenchus biflorus, Cynodon dactylon, Cenchrus spp., Tribulus pentrandus, Adansomia digitata and Cassia itilica.*

Soil samples collection:

Seven soil samples were collected from the three sites at the same season. These soil samples were first dried under shade and then dried in an oven. Concentrations of Ca, Zn, Cu and Mn were determined according to method described by Unicam LTD manual (1990) using an atomic absorption spectrometer (Phoenix 686). The concentration of Na and K were determined by Jenway Digital flame photometer using the deflection of the flame photometer as a measure of their concentration. P concentration was determined by vanadomolybdate method and the concentration of P was read thereafter on the UV/VIS spectrophotometer (AOAC, 1990).

Forage samples collection:

Eleven forage samples were collected from the same sites where soil sampling was done. After removing the non-edible plant species, forage samples were dried at 60º C to a constant weight in a forced air-dried oven. Ashing of forage samples in a Gallenkamp muffle furnace at 600°C was done overnight. Concentrations of Ca P, Na, K, Zn, Cu and Mn were determined as mentioned above in soil samples.

Animals:

Two hundred and fifty animals each of goats and sheep were used. All animals were

grouped according to species, sex and age as less than and greater than 2 years. Animals were allowed to graze the pasture during the day whereas in the night they were sheltered in a barn built on stilts. The animals were not provided with any form of supplementation.

Blood samples collection:

Blood samples were collected by jugular vein puncture in heparinized trace mineral free vacutainer tubes; plasma separation was done using a MERLIN 503 centrifuge at 3000 rpm for 10 minutes; plasma was collected and frozen at -20^{o}C for further analysis.

All plasma samples were analyzed for Ca and P by spectrophotometer (Unicam, England) using a method described by Smith and Beuger (1979) and Varley (1975) respectively, Na and K were determined according to Wootton (1974) by Jenway Digital flame photometer (Jenway, 110) and Zn, Cu and Mn were estimated according to method described by Unicam LTD manual (1990) using an atomic absorption spectrometer (Phoenix 686).

Statistical Analyses:

The effect of species, sex, age and location on the soil, forage, and blood mineral content was computed using t-test and ANOVA analysis format (SPSS version 16).

Results and Discussion

Soil:

Results of the effect of location on the level of Ca, P, Na, K, Zn, Cu and Mn in soil were shown in Table (1).

The location has no significant (P>0.05) effect on the elements studied. The level of soil Ca, Na, Cu and Mn were almost similar in different locations, K level was lower in the Eastern area compared with the North and South areas. Zn, level was lower in the Western area compared with the South and East areas. Zn and Cu level were found within normal range reported by McDowell (1997). Moreover Ca, K, and Mn, level in all regions were lower than the critical level determined by McDowell (1997) and Rhue and Kidder (1983), this is not in agreement with McDowell *et al.*, (1983), who reported that Sudan soils were generally deficient in copper.

Table 1: Effect of location on the level of Ca, P, Na, K, Zn, Cu, and Mn in the soil

Element	Concentration of element in soil(mg/kg)			Critical levels*
	South	East	West	
Ca ppm	0.290±0.05	0.265±0.05	0.285±0.02	0.7
Na meq	0.395±0.05	0.360±0.02	0.38±0.03	-
K meq	0.135±0.01	0.115±0.01	0.136±0,01	0.58
Zn ppm	0.685±0.01	0.62±0.01	0.46±0.1	0.60
Cu ppm	0.20±0.01	0.22±0.01	0.22±0.01	0.20
Mn ppm	0.06. ±002	0.63±0.004	0.68±0.62	5.00

*Critical level adopted from McDowell (1997) and Rhue and Kidder (1983).

Forage:

The mean concentrations of Ca, Na, K, Zn, Cu and Mn in forage consumed by goats and sheep in different locations are shown in Table (2).

In this study, the location have no significant effect on all minerals level in forage samples studied (P>0.05). Moreover, Ca, K and Cu concentrations in the forages are within the normal range reported in the literature (McDowell, 1997).). Poor levels of minerals were reported for Mn and Na in South, East and West regions and Zn in the South region. This may be due to decrease Na and Mn level in Soil as mentioned above. Also they seem to be a general agreement that Na is deficient in

most tropical grasses McDowell (1997). Moreover, Howard *et al.* (1963) reported low Na content in pasture in Muguga region of Kenya. Shamat *et al.* (2009) reported that, in Western region, more than 87% of all forage samples analyzed were deficient in Zn. Also Mohamoud *et al.* (1983) recorded Zn deficiency among sheep as a result of Zn deficiency in forages in Sudan.

Our result is not in agreement with that reported previously by Shamat *et al.* (2009) who indicated high forage concentration of Mn in dry season in western region attributed to low rates of Mn translocation and accumulation of Mn in older tissue. Variations in the concentrations of minerals among browse and forage in this study agreed with Conrad (1978) who stated that trace minerals in plants may increase decease or show no consistent change with stage of growth, plant species, soil or seasonal conditions. Variations in the concentrations also could be accounted for by genotypic differences, efficiency of mineral uptake and retention and stage of foliage maturity coupled with proportion of leaf samples (i.e. leaf vs. twigs) harvested for mineral analysis. Younger leaves and leaflets contain higher levels of minerals than older mature leaves, twigs and stem parts (Minson, 1990).

Table 2: The effect of location on level of Ca, Na, K, Zn, Cu and Mn in Forage

Element	Concentration of element in grass			Critical levels* (ppm)	Dietry** requirement (ppm)
	South	East	West		
Ca ppm	0.64±0.04	0.67±0.06	0.68±0.03	<0.3	0.52-2.39
P ppm	0.42±0.01	0.38±0.01	0.71±0.18	<0.24	0.06-0.40
Na meq/100g	0.107±0.01	0.140±0.09	0.171±0.07	<0.6	0.01-0.12
K meq/100g	10.24±2.6	14.0±1.0	9.71±1.92	<0.8	0.28-3.03
Zn ppm	25.05±11.70	52.15±18.5	50.15±9.13	30	6.35-38.14
Cu ppm	44.72±10.49	24.59±13.11	33.95±8.19	10	5.77-11.14
Mn ppm	6.13±0.98	17.08±2.03	16.37±9.31	<20	24.93-199.97

*****Critical level adopted from McDowell and Conrad (1977).
**Recommended by McDowell (1997).

Plasma:

Minerals in the blood in well-fed healthy animals are controlled by homeostatic mechanisms, which keep contents within the limits. Any variation within reasonable limit can be influenced by dietary changes, environments, gestation, lactation and other management factors (Akinsoyinu, 1982).

The effect of animal species in the mean concentrations of Ca, P, Na, K, Cu, Mn and Zn in goats and sheep are presented in Table (3).

In the present study, the mineral contents in plasma of sheep and goats are at the marginal deficient level. This may be due to the deficiency in soil and forage as mentioned above.

The present study indicates the higher minerals concentrations in the plasma of goats than that in sheep as the mean concentration of Ca, Na and K are higher in goats than sheep without significant differences ($P<0.05$). Copper and Zn are significantly ($P<0.05$) higher in goats than sheep. This in agreement with Khan *et al*. (2007) who reported lower Cu and Zn concentrations in sheep plasma compared to goats. Mean plasma mineral concentrations were found more often lower in sheep as compared to those in goats. This is probably due to their slightly different adaptations and feeding habits, although these two animal species have a same type of digestive system. Goats prefer more browsing, while sheep are grazing lower forage. It has been observed that browsed forages have higher mineral contents

than lower forage and grasses. Also as forages mature and dry up, their mineral concentration declines. The rate of this decline is higher in grasses than that of browsed forage plants as earlier reported by Kapu (1976) and Khan *et al.*, (2007).

Table 3: The effect of animal species on level of Ca, Na, K, Cu, Mn and Zn in plasma of goats and sheep

Minerals	Goat	Sheep	Critical level*
Ca ppm	7.65±0.29	7.16±0.16	8mg/100 ml
P ppm	4.13±0.12	4.17±0.08	4.5 mg/100ml
Na meq	115.14±2.89	115.85±2.26	-
K meq	3.32±0.10	2.99±0.06	-
Cu ppm	0.88±0.05*	0.84±0.03**	0.7 ppm
Mn ppm	0.155±0.01	0.15±0.01	0.65ppm
Zn ppm	1.25±0.16*	1.16±0.05**	0.6ppm

The effect of animal sex on the mean concentration of Ca, P, Na, K, Cu, Mn and Zn in goats and sheep are shown in Table (4).

In the present study, Ca, K, and Cu levels showed different trends in the two species, Ca content decreased significantly($P<0.05$) in female goats while, increased significantly($P<0.05$) in female sheep. Potassium level was significantly ($P<0.05$) decreased in female goats and almost similar in male and female sheep. Copper content is significantly decreased ($P<0.05$) in female sheep, while increased in female goats. Zn level significantly ($P<0.05$) decreased in female in the two species. Manganese level is significantly ($P<0.05$) higher in female than male in the two species.

Moreover P and Na concentrations are similar in male and female in the two species, although Na level tend to decrease in the female. This is not in agreement with Sowande *et al.* (2008) who reported that Ca, P, Na and K concentrations in plasma of sheep and goats were not influenced by sex. The variation in results may be due to different in animal breeds (Table, 4).

Table 4: The effect of animal sex on level of Ca, Na, K, Cu, Mn and Zn in goats and sheep

Minerals	Goats		Sheep	
	Male	Female	Male	Female
Ca ppm	9.17±0.45*	6.88±0.31**	7.50±0.12*	7.68±0.35**
P ppm	3.99±0.17	4.33±0.13	4.30±0.07	4.14±0.13
Na meq	120.61±5.15	110.81±2.62	123.14±1.50	117.91±4.90
K meq	3.64±0.14*	2.98±0.10	3.19±0.05	3.13±0.10
Cu ppm	0.85±0.11*	0.97±0.05	0.94±0.03*	0.67±0.06**
Mn ppm	0.13±0.01*	0.16±0.01**	0.14±0.00*	0.146±0.04**
Zn ppm	1.79±0.23*	1.19±0.18**	1.29±0.07*	1.13±0.06**

The effect of animal age in the mean concentration of Ca, P, Na, K, Cu, Mn and Zn in goats and sheep are presented in table (5).

Calcium and Na levels were significantly ($P<0.05$) increased with the increase in age in the two species, this is not in agreement with that reported by Ishraga (2000) in goat, the difference might be due to difference in nutrition and breed. Phosphorus and Cu appear to be similar in the two age groups in

the two species. Potassium, Zn and Mn showed different trend in the two species, while, the level appear to be similar in goats, the K and Zn significantly increased (P<0.05) and Mn significantly (P<0.05) decreased with increase in age in sheep. Samdija *et al*. (2011) reported normal physiological ranges in K and Na concentrations in Boer goats and in crossbreeds without significant differences according to parity and the litter size and significantly higher phosphorous level in primiparous in comparison to pluriparous goats. Also younger flocks were reported to have higher Zn profile than elder one. Moreover, phosphorus concentrations were significantly affected by age with higher levels in the young compared to the adult goats as reported by Gwaze *et al.* (2012).

Table 5: The effect of animal age on level of Ca, Na, K, Zn, Cu and Mn in goats and sheep

Minerals	Goat		Sheep	
	<2	>2	<2	<2
Ca ppm	6.64±0.46*	8.35±0.21**	7.18±0.15*	8.19±0.18**
P ppm	4.22±0.11	4.23±0.16	4.24±0.07	4.32±0.14
Na meq	106.00±3.66*	119.84±3.11**	119.77±1.98*	126.86±2.18**
K meq	3.05±0.14±	3.31±0.12	3.10±0.06*	3.32±0.06**
Cu ppm	0.97±0.07	0.90±0.06	0.94±0.04	0.82±0.05
Mn ppm	0.16±0.01	0.16±0.01	0.16±0.01*	0.13±0.01**
Zn ppm	1.27±0.21	1.01±0.20	1.13±0.07*	1.51±0.10**

Conclusion

It was concluded that the mineral nutrition of the livestock at these regions are at the marginal deficient level in some essential minerals. This concentration may change abruptly to severe deficient levels at any time and may result in decreasing effective minerals particularly at dry season due to decrease in the levels of essential minerals in winter forages which are considered as the main reason for poor animal performance.

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صورة المعادن للماعز و الضأن التي ترعى طبيعيا في محلية نيالا جنوب دارفور، السودان

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المستخلص

تم اجراء هذه الدراسة في فترة الجفاف الباردة (نوفمبر 2009– فبراير 2010) لتحديد تراكيز الكالسيوم ، الفسفور، الصوديوم، البوتاسيوم، النحاس، الزنك، المنجنيز في 7 عينات من التربه، 11 عينة من الحشائش و 250 عينة من دم الماعز والأغنام التي ترعى في ثلاث إتجاهات مختلفة حول مدينة نيالا، ولاية جنوب دارفور، السودان. تم قياس الكالسيوم والفسفور باستعمال جهاز المطياف الضوئي ، الصوديوم والبوتاسيوم بواسطة جهاز اللهب الضوئي، النحاس، المنجنيز والزنك بواسطة جهاز الامتصاص الذري. اثبتت التحاليل أن محتوى الكالسيوم ، البوتاسيوم، النحاس والمنجنيز في التربه والصوديوم والمنجنيز في الحشائش أقل من المستوى الحرج. أوضحت الدراسة أن تأثير المناطق على تركيز المعادن موضوع الدراسة في التربة والحشائش غير معنوي. بينت الدراسة تأرجح دون وجود فروق ذات دلالة معنوية في محتوى المعادن بإختلاف الأعمار والجنس في الماعز والأغنام. أظهرت الدراسة أن مستوى الإملاح المتوفره لتغذية الحيوانات في المنطقة في حد حرج وقد يتحول الي نقص حاد في فترات الجفاف. و خلصت الدراسة الى إحتياج الحيوانات في المنطقة للتغذية الإضافية للتغلب على النقص الطبيعي في التربه والحشائش في فترة الجفاف وذلك للمساعدة في رفع الكفاءة الإنتاجية للماعز والأغنام.