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Contents of Some Essential Minerals in Forages for Ruminants in Adama, Ethiopia. A Case Study

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ABSTRACT

The contents of phosphorous (P), calcium (Ca), sulphur (S), manganese (Mg), sodium (Na), potassium (K), iron (Fe), and copper (Cu), in graminaceae and legumes used for ruminant nutrition in the city of Adama, Ethiopia, were determined. The samples were taken at random, from grazing areas near the city, and in the food market for these animals. The Molibdovanate method was used to determine P; Ca, Mg and Cu were determined by the atomic adsorption spectroscopic method with flame; Na and K were determined by flame photometry; and S, by the turbidimetric method. The values were compared with the values reported for these animal requirements. Deficiencies of Cu, P and Na were found in all the samples analyzed. King Grass, wheat and *teff* stalks, important sources of nutrients during the dry season, were the scarcest. Statistics ($P < 0.05$) showed that, as a group, graminaceae were more mineral deficient than legumes. A study of certain mineral sources from the area is recommended for use as raw materials for salt production.

Key words: *mineral content, supplementation, grazing ruminants*

INTRODUCTION

Among the components of a balanced diet, minerals play an important role. The lack of some minerals in the diet is known to affect production and reproduction. The most widely occurring effects are related to dairy production and the reproduction cycle. The absence of some minerals that had initially been supplied in water and the soil (now depleted due to constant extraction without supplementation), brings about the need for an adequate supplementation to prevent negative outcomes, and the ensuing nutrient deficiency, which is progressively increased (McDowell *et al*., 1997).

Ethiopia has several ecological locations with a wide variety of natural resources, but grazing animals depend mainly on low-quality feeds, such as some types of graminaceae, very few legume species, and especially, stalks from less arid areas (Kabaija and Little, 2012). During the dry season (the longest season), when forage is scarce, both in quality and quantity, losses in life weight are a fact, disease resistance decreases and poor fertility occurs (Tilahun, *et al.*, 2007).

Some Ethiopian locations are known to have shortages of one or more minerals; one typical example is the absence of copper in the Rift Valley. There is evidence of shortages in sodium, phosphorous, copper, zinc, cobalt, and manganese in widespread areas of the territory. Copper, manganese and iron-toxic areas have been spotted as well (Alemu, 2008).

It is common practice worldwide to supplement animal feeds with mineral salts, especially to dairy animals. It also means higher expenses when the animals must be carried for long distances, or imported.

Moreover, in most territories (Adama is not the exception), there is a potential of raw materials that can be used as supplements. Therefore, it is important to know each region´s deficiencies in order to choose the supplement to use and how to use it.

Most animals are fed stalks almost the entire year, mainly wheat and tef, whose mineral compositions not only depend on the soil, but also on the application of fertilizers.

In addition to it, a company in the location has the mission to cultivate pastures, which are later sold as seed or forage. Some legume species, like alfalfa and clove, are also included.

To evaluate the contents of phosphorous (P), calcium (Ca), sulphur (S), magnesium (Mg), sodium (Na), potassium (K), iron (Fe) and copper (Cu), analyses of samples from graminaceae and

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legume species used in ruminant nutrition in the Adama city area, were performed.

MATERIALS AND METHODS

Three replicas were collected from each forage type as follows:

- Fresh samples of alfalfa (*Medicago sativa*), clove (*Trifolium repens*), ARVEJA COMUN (*Vicia sativa L*) and RODES (*Chloris gayana*), collected from several different spots chosen at random, at Assella Model Agricultural Enterprise, between the cities of Adama (8° 42' N; 39° 16' E) and Asela (7° 57' N; 39° 08' E), 1 800 m above sea level. A stainless steel sickle was used to cut the samples to total 5 kg, later dried in the sun for a week.
- Samples of *king grass* (*Pennisetum purpureum*), wheat stalk (*Triticum aestivum*), and *tef* (*Eragrostis tef),* a yearly herbaceous plant, originally from Ethiopia, from the Poaceae family, with edible seeds (the steeple food of the country´s population) collected on different days until 1 kg was gathered, at the hay market in Adama.

The samples were taken to the Adama Science and Technology University labs, and shredded with stainless steel scissors, previously washed in distilled water to eliminate possible contaminating materials or dust, then dried in circulating air stove (TIP-906 SHIVAKI, JAPSON, JAMBUPERSHAD & SONS, India) at 80 ± 1° C for 24 h. A crushing mill was used to crush 500 g (IKA-WERKE GMBH & Co.KG, D-7219 Staufen, Germany), then the material was sieved (0.5 mm). Crushing was made again, and 100 g were dried at 105 ± 1° C to achieve constant weight. It was stored in plastic jars with air-tight cap. 5 g from each replica were incinerated in china containers at 525 ± 5° C in muffle furnace with digital temperature control (DTC-201 Ambala, Japson Jamba Per shad & Sons, India).

The ashes were dissolved in 1+3 pure hydrochloric acid solutions, for analysis (Fisher Scientific UK, Bishop Meadow Raod, Loughbrough, Liecs, LE115RG, UK), through warm digestion up to humid salts. The salts were lixiviated in 100 ml Erlenmeyers using 125 mm diameter filter paper (Whatman quantitative filter paper, Grade 540, New Delhi, India).

The analytical variants used for the different elements in each case are below.

Phosphorous and iron were determined by calorimetric methods (molybdovanadate and phenanthroline, respectively), using a UV-Vis spectro photometer (PG INSTRUMENTS, Model T70/70+, Leicestershire, United Kingdom). The same instrument was used to determine barium sulfate turbidity, at 540 nm.

Sodium and potassium were determined by photometry (PG INSTRUMENTS, Model FP902, Leicestershire, United Kingdom), with an air/butane-propane flame.

Magnesium, calcium, and copper were analyzed by atomic absorption spectroscopy, using an air/acetylene flame (S series, Wagtech International, England), and hollow cathode lamp for excitation

In all the cases, borosilicate glassware was used, which was cleaned with a dilution of nitric acid for washing (AnalaR, BDH Laboratory Supplies, Poole, England), and then with deionized water. Conductivity was below 1 µS/cm .

Al the procedures were made following standard methodologies **(**AOAC, 1995; FAO, 2008).

Calculations and statistical analysis were performed using Microsoft® Excel®, 2007. Comparison between graminaceae and legumes was made by the T-Student test, for the paired samples.

RESULTS AND DISCUSSION

Fig. 1 shows the average contents of ashes in the three replicas for each forage type.

The highest value was observed for alfalfa (*M. sativa*), and the lowest, for wheat stalks (*T. aestivum*). A general difference ($P < 0.05$) between legumes and graminaceae was observed. The latter have a slight lower content. The difference between lower and higher was, however, relatively small. The ash content in green forages and tef stalks (*E. tef*) was similar to the one reported by Kabaija and Little, (2012); whereas it was slightly lower for wheat stalks.

The main deficiency problems occurred in most forages used by local farmers, especially in the dry season: *tef* stalks, wheat stalks and *king grass*.

As to the elements, the greatest deficiencies were observed for copper, phosphorous, and sodium, below the requirements in all the cases. This result is in agreement with reports made by

Yemi (2008) for Rift Valley, not far from the location studied.

With regards to phosphorous, essential for ruminant nutrition, the levels found (except for alfalfa) in this study are lower than the values reported by Suttle, (2010), and Tolera, (2008). According to Tolera (2008), it might mean a decrease in the mineral levels, due to the absence of supplementation and the continuous drawing out process.

The element´s mean comparison (Fig. 2) showed that their concentrations are inferior ($P < 0.05$) in graminaceae. This situation contradicts reports by Martínez *et al.* (2007) in a similar study made east of the city of Camagüey, Cuba. The discrepancy may be given by the fact that in this case the legumes used in the study come from cultivated pastures, whereas the graminaceae used are from harvest stalks or *king grass* plantations exploited for several years. In Cuba, both legume and graminaceae samples were collected from the same fields under exploitation.

CONCLUSIONS

There are deficiencies in the levels of phosphorous, copper and sodium in the location studied, both in graminaceae and legumes.

RECOMMENDATIONS

Shortage of important minerals, like phosphorous, at the main sources of feeds in the region suggests the need to start phosphorous supplementation right away. Relatively less costly copper sodium may be used to control consumption of feedstuffs.

It is useful to study possible mineral sources in the area, which allow for cost-effective supplementation by small low income farmers.

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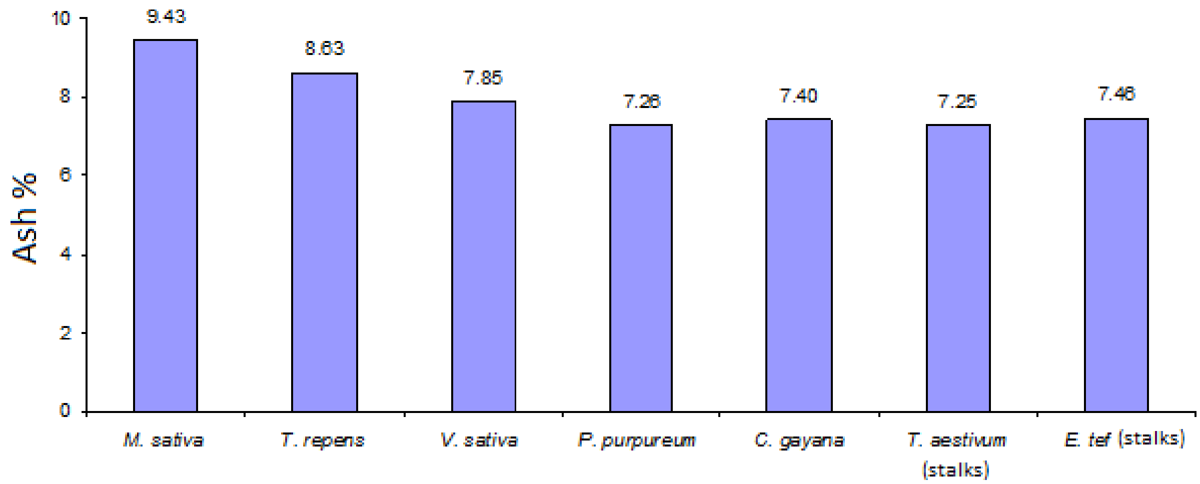

Fig. 1. Average ash contents (%) in the forage samples studied

Table 1. Mineral levels in the forages studied

Forage / Element	*M. sativa*	*T. repens*	*V. sativa*	*P. purpureum*	*C. gayana*	*T. aestivum*	*E. tef*
	Alfalfa	Clove	Peas	*king grass*	Rhodes grass	Wheat (stalks)	Tef (stalks)
P (g/kg)	1.93(*)	1.27(*)	1.18(*)	0.97(*)	1.43(*)	0.32(*)	0.35(*)
Ca (g/kg)	8.13	10.12	7.40	3.14	3.47	2.61	4.87
S (g/kg)	2.30	7.60	1.63	1.37(*)	2.63	1.60(*)	4.30
Mg (g/kg)	4.87	3.19	3.93	1.23	2.83	1.43	1.97
Na (g/kg)	1.13(*)	1.02(*)	0.94(*)	0.23(*)	0.77(*)	0.47(*)	0.81(*)
K (g/kg)	17.9	19.0	17.7	16.8	19.3	14.7	16.4
Fe (mg/kg)	264	269	37	14(*)	98	21(*)	17(*)
Cu (mg/kg)	6(*)	6(*)	5(*)	2(*)	4(*)	2(*)	4(*)

(*) Lower than requirements for grazing ruminants (McDowell *et al.*, 1997)

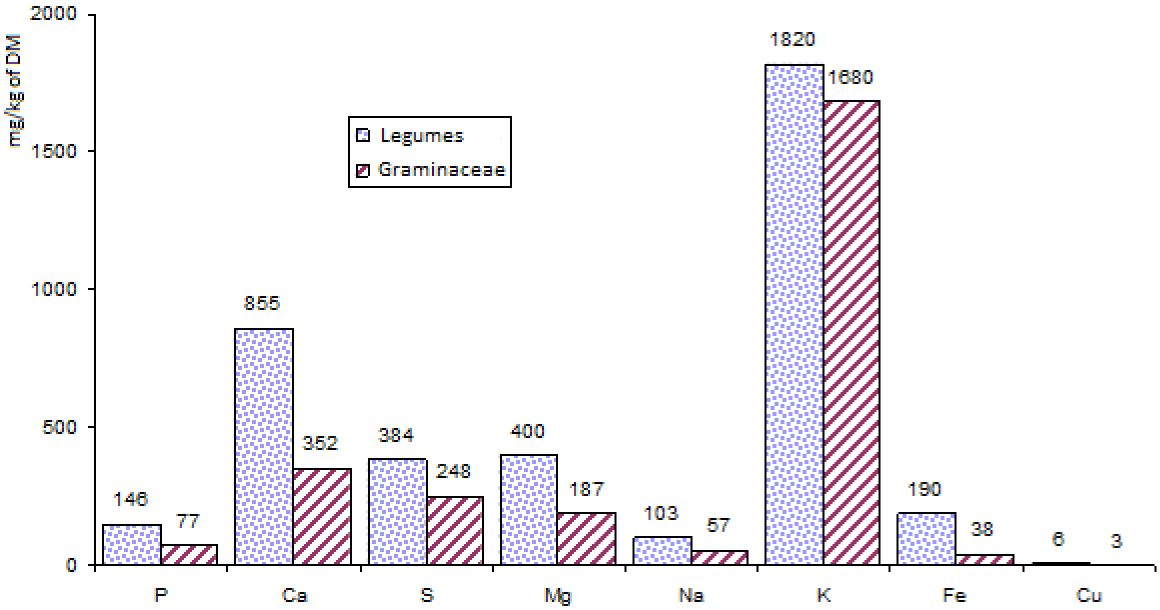

Fig. 2. Comparison between graminaceae and legumes as groups of mineral levels studied