Journal of Environmental Chemistry and Ecotoxicology Vol. 4(13), pp. 229-233, November 2012
Available online at http://www.academicjournals.org/JECE
DOI: 10.5897/JECE12.002
ISSN-2141-226X ©2012 Academic Journals

Full Length Research Paper

Minerals deficiency diagnosis in grazing cattle of Uasin Gishu District, Kenya

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Accepted 28 August, 2012

Grazing cattle in the tropics and especially in Uasin Gishu district depend on a variety of plant species for their mineral supply. One area of concern is that the grazing cattle may be experiencing mineral imbalances due to lack of proper mineral mapping of the region to ascertain the levels of imbalance. A study conducted in the Uasin Gishu region revealed severe deficiencies of mainly Cu (3.30 ± 0.90) and Zn (6.70 ± 0.40) in soils, the elements Na (1.00 ± 0.39), K (11.80 ± 5.00), Ca (0.57 ± 0.19), Mg (1.35 ± 0.72), P (6.34 ± 3.22), Fe (56.00 ± 0.53), Cu (5.32 ± 2.84), Zn (19.50 ± 8.20) in pasture species and the elements Fe (2.43 ± 1.53), Mn (0.26 ± 0.14), Cu (0.60 ± 0.17), Mg (0.02 ± 0.01) in animal blood. The study recommends immediate mineral supplementation schemes to grazing cattle in the region and encouragement of certain pasture species in the region.

Key words: Grazing cattle, mineral imbalances, supplementation schemes, severe deficiencies.

INTRODUCTION

Grazing cattle derive their mineral supply from a variety of plant species. Plants in turn derive their mineral elements from soil in which they grow which is related to underlying rock type (Jumba et al., 1995b). Any insufficient supply of minerals by the forages results in mineral imbalance, which limits animal production. The effects of these mineral imbalances in the tropics are manifestation in such cases as low fertility, bone abnormalities, nutritional muscular dystrophy, retarded growth and maturity, hair disorders and low milk and meat production (National development Plan (NDP), 2000; Faria et al., 1981). Studies in grazing areas of Mount Elgon region of western Kenya have shown wide variations in soils and forage mineral composition (Oduor, 2002).

Soil-plant mineral interactions have been used to predict mineral levels in animals (Jumba et al., 1995b; Siva, 1996). However, other studies have revealed that status, age and breed of the animal influence mineral status in animals. Uasin Gishu is one region that used to produce high quantities of meat and milk, a trend that is declining (Ministry of Finance and planning (MFP), 2001). It comprises six divisions with Northern part comprising of Soy and Moiben, the central part having Turbo and Kapsaret which borders Eldoret town and Southern region having kesses and Ainabkoi divisions (Ministry of Agriculture and Livestock Development (MALD), 2003). It is anticipated that Uasin Gishu district could be experiencing same nutritional disorders in the neighbouring Trans Nzoia district.

The main objective of the study was to assess mineral deficiencies in Uasin Gishu district and recommend possible measures to alleviate the situation. The study focused on macro elements Na, K, Ca, Mg, P and trace elements Fe, Mn, Cu and Zn in soils, pastures and animal blood. 28 soil and forage samples and 28 blood serum from lactating cows were collected from six major farms numbered 1 to 6 situated in three different regions of the district that is, farms 1,3 and 5 in Central; farms 4 and 6 in Northern and farm 2 in Southern (Figure 1). Extractable trace elements and macro elements were determined using the method as described by Lakanen

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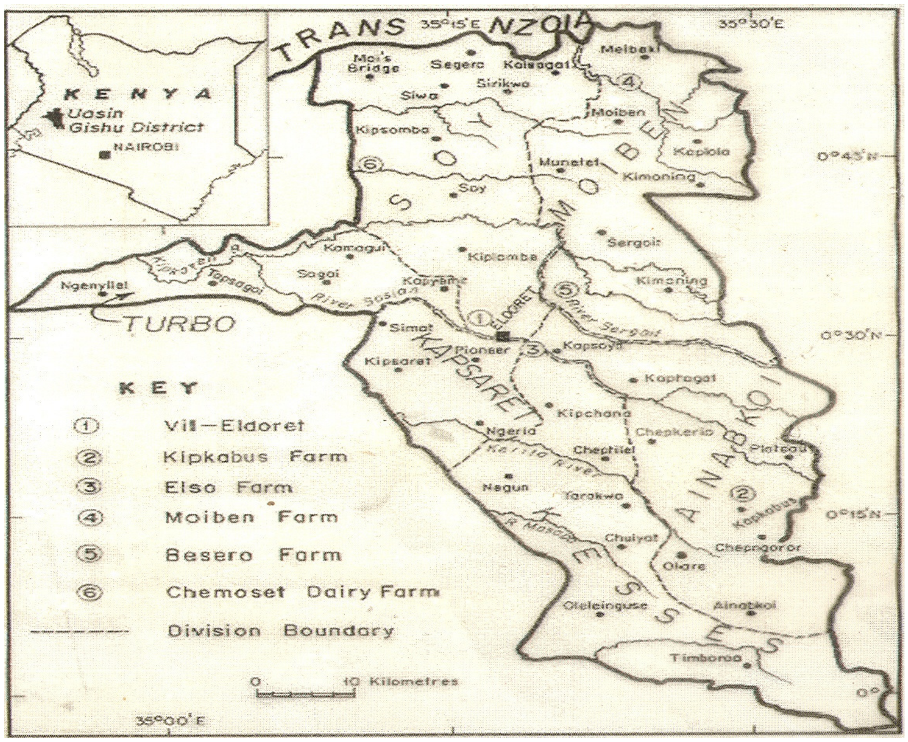

Figure 1. Sampling sites in Uasin Gishu district.

Table 1. Soil macro and trace elements concentrations (mg/kg DM).

Parameter	Mean ±SD n=28	Range n=28	Central ± SD n=16	Northern ± SD n=8	Southern ± SD n=4
Na	101.00±32.00	58.13-155.00	88.00±22.30	109.00 ±36.52	135.00± 27.39
K	709.00±24.40	189.10-1135.00	709.00±20.77	756.00 ± 38.68	614.00± 181.04
Ca	720.00±33.30	280.00-1840.00	667.00± 40.83	805.00± 105.07	765.00± 148.85
Mg	330.00±11.90	161.30-627.70	317.00± 90.84	332.00± 94.11	381.00± 104.26
Fe	551.00±22.80	228.30-1198.30	598.00± 115.46	526.00± 103.80	412.00± 107.29
Mn	630.00±34.50	703.00-1583.50	703.00± 180.37	536.00 ±139.27	525.00± 109.65
Cu	3.30±0.90	1.60-5.13	3.00 ±0.89	3.80± 0.67	3.50± 1.50
Zn	6.70 ±0.40	1.97-22.06	8.00± 3.52	5.50 ±2.43	4.10 ±1.90

and Ervio (1971) while those in forages were determined by wet digestion and in blood serum by Frick method (Frick et al., 1979), and molybdenum was determined by a modification method as described by Bingley (1963). Forage species Rhodes (*Chloris gayana*), kikuyu (*Pennistum clandestinum*) and grass mixtures were sampled while animal blood was sampled based on age and breed. Statistical analyses were done using generalized linear model (GLM) of statistical analysis system in which ANOVA, spearman's rank correlation and regression coefficients for stipulated variables were used to estimate relationships between parameter values observed in soils, forages and blood serum.

RESULTS AND DISCUSSION

The Northern region was superior in macro elements K (756.00 ± 38.68), Ca (805.00 ± 105.07), while the central region had high levels of Fe (598.00 ± 115.46), Mn (703.00 ± 180.37), and Zn (8.00 ± 3.52). The three regions revealed high concentrations of macro and trace elements which were above the recommended levels (Rhue and Kidder, 1983; McDowell et al., 1983). Only 14 and 4% of samples were deficient in Cu and Zn (Critical Level=2), respectively (Tables 1, 2 and 3). All the three areas recorded minimal deficiencies in all the elements concentrations except for Ca and Mg which revealed 86

Table 2. Forage macro and trace elements concentrations (mg/kg DM).

Parameter	Mean ± SD n=28	Range n=28	Central ± SD n=16	Northern ± SD n=8	Southern ± SD n=4
Na	1.00± 0.39	0.55-2.12	0.92 ±0.17	0.94 ±0.22	1.47 ±0.60
K	11.80± 5.00	3.73-20.53	11.08± 5.50	14.00± 4.34	10.50 ±3.60
Ca	0.57 ±0.19	0.15-1.17	0.56 ±0.19	0.54 ±0.08	0.72± 0.29
Mg	1.35± 0.72	0.10-3.13	1.36± 0.50	1.42± 0.81	1.18± 0.90
P	6.34± 3.22	1.83-14.41	6.69± 3.02	6.69± 2.07	4.23 ±1.51
Fe	56.00 ±0.53	10.25-231.00	50.00± 10.36	57.16± 26.60	80.56 ±20.59
Mn	105.00± 0.58	38.25-246.50	119.00± 30.65	85.59± 21.06	89.63± 30.80
Cu	5.32 ±2.84	2.00-15.50	4.95± 1.09	5.56 ±2.06	6.31± 2.15
Zn	19.50± 8.20	8.30-39.78	20.12± 7.59	17.20± 6.70	21.65± 10.01

Table 3. Serum macro and trace elements concentrations (g/l for macro and µg/ml for trace elements).

Parameter	Mean ± SD n=28	Range n=28	Central ± SD n=16	Northern ± SD n=8	Southern ± SD n=4
Na	2.38± 0.61	1.13-4.04	2.56± 0.62	1.99 ±0.54	2.44± 0.21
K	0.39± 0.06	0.28-0.58	0.36± 0.07	0.38± 0.03	0.44± 0.04
Ca	0.81 ±0.32	0.49-2.16	0.84± 0.41	0.75± 0.11	0.78± 0.06
Mg	0.02 ±0.01	0.003-0.04	0.02± 0.01	0.02 ±0.01	0.03± 0.01
P	0.15± 0.05	0.07-0.22	0.15± 0.05	0.13 ±0.05	0.13± 0.04
Fe	2.43± 1.53	0.40-6.10	1.86 ±1.20	3.13 ±1.92	3.43± 0.08
Mn	0.26 ±0.14	0.10-0.70	0.28± 0.15	0.27± 0.12	0.17± 0.05
Cu	0.60± 0.17	0.20-1.00	0.56± 0.17	0.61± 0.08	0.77± 0.20
Mo	0.36± 0.35	0.07-1.31	0.33± 0.03	0.56± 0.13	0.07± 0.01
Zn	3.71± 1.63	0.65-6.84	4.04± 0.43	2.84± 1.87	4.23± 1.43

Table 4. Soil pH and soil minerals.

Parameter	Mean ± SD	Range	Critical level	% Samples deficient
pH	5.80± 0.44	5.10-7.20	>5.00	0
Na	101.00 ±32.00	58.13-155.00	55.00	0
K	709.00± 24.40	189.10-1135.00	60.00	0
Ca	720.00 ±33.30	280.00-1840.00	71.00[a]	0
Mg	330.00 ±11.90	161.30-627.70	30.00	0
Fe	551.00± 22.80	228.30-1198.30	30.00[b]	0
Mn	630.00± 34.50	703.00-1583.50	10.00[c]	0
Cu	3.30 ±0.90	1.60-5.13	2.00[d]	14
Zn	6.70± 0.40	1.97-22.06	2.00[d]	4

CL source: Rhue and Kidder, 1983; McDowell et al., 1983.

and 89% of samples deficient and for Cu and Zn deficiencies in 93 and 39% of samples (National Research Council (NRC), 2001). Mineral levels for lactating cows was above critical levels except for Mg (21% samples were deficient) while Mn and Cu recorded deficiencies in 100 and 42% of samples.

The study also investigated the factors that could be contributing to mineral deficiencies in the region as shown in Tables 4, 5, 6, 7 and 8. The soils pH values ranged from 5.10 to 7.20 which were above critical levels of 5.00 (Table 4). This range enables maximum absorption of ionic species by plants to occur (Reid and Horvath, 1980). A soil-plant study revealed a positive trend in all minerals except Ca (r=-0.002) and Cu

Table 5. Correlation between soil and forage minerals.

Parameter	Soil (mg/Kg) n=28	Forage (mg/kg) n=28	Correlation (r)
Na	101.00 ±32.00	1000.00± 33.00	0.094
K	709.00± 24.40	11800±50.00	0.201
Ca	720.00± 33.30	570 ±19.00	-0.002
Mg	330.00± 11.90	1350.00± 71.00	0.005
Fe	551.00± 22.80	56.00 ±0.53	0.205
Mn	630.00± 34.50	105.00± 0.58	0.281
Cu	3.3±0 0.90	5.32 ±2.84	-0.257
Zn	6.70± 0.40	19.50± 8.20	0.078

Table 6. Mean macro - element concentrations (g/kg DM) of forage species.

Parameter	Concentrations (g/kg DM)							
	Pasture species				Supplement species			
	Rhodes	Kikuyu	Mixed natural	Rhodes/Kikuyu	Maize	Oats	wheat	silage
Na	1.03	1.01	0.93	1.25	0.83	0.80	0.81	1.90
K	14.93	5.29	21.65	13.07	10.58	14.93	13.07	5.60
Ca	0.61	0.49	0.66	0.54	0.42	0.78	0.47	0.56
Mg	1.51	1.93	1.32	1.64	1.13	0.93	1.15	0.10
P	7.29	9.38	5.87	7.93	4.50	4.04	4.50	3.20

Table 7. Mean trace element concentrations (mg/kg DM) of forage species.

Parameter	Concentrations (g/kg DM)							
	Pasture species				Supplement species			
	Rhodes	Kikuyu	Mixed natural	Rhodes/Kikuyu	Maize	Oats	wheat	silage
Fe	43.84	51.75	72.42	164.80	47.08	19.67	25.75	66.00
Mn	101.30	129.10	179.40	109.60	58.00	110.30	61.42	56.00
Cu	6.06	6.50	5.67	9.42	3.00	3.83	3.30	2.50
Zn	21.64	23.64	21.15	27.00	14.93	18.59	12.75	9.05

Table 8. Macro and trace elements concentrations in various cattle breeds (g/l).

Parameter	Lactating cows		
	Friesian	Ayrshire	Fresian/Ayrshire
Na	2.35 ±0.45	2.58 ±0.78	2.13 ±0.59
K	0.41± 0.06	0.38 ±0.07	0.37 ±0.02
Ca	0.70 ±0.10	0.99 ±0.50	0.77 ±0.12
Mg	0.03 ±0.01	0.02 ±0.01	0.02 ±0.01
P	0.15 ±0.05	0.16± 0.05	0.15 ±0.05
Fe	2.90 ±1.12	2.20 ±1.97	2.14 ±1.55
Mn	0.24± 0.12	0.30± 0.17	0.26± 0.13
Cu	0.59± 0.20	0.66± 0.12	0.52± 0.17
Mo	0.34± 0.05	0.37± 0.40	0.36± 0.19
Zn	4.59± 0.99	3.24 ±1.03	2.78± 0.79

Table 9. Mineral composition in young calves and lactating cows (g/l).

Parameter	Young calves	Lactating cows
Na	2.45 ± 0.42	2.38 ± 0.61
K	0.37 ± 0.08	0.39 ± 0.06
Ca	0.68 ± 0.21	0.81 ± 0.32
Mg	0.02 ± 0.01	0.02 ± 0.01
Fe	2.28 ± 1.13	2.43 ± 1.53
Mn	0.27 ± 0.15	0.26 ± 0.14
Cu	0.60 ± 0.19	0.60 ± 0.17
Zn	3.11 ± 1.23	3.71 ± 1.63

(r=0.257) (Table 5). This implies that an increase of these minerals in soil leads to their decrease in plants. This may be due to varying stages at which forages were sampled (Minson, 1990).

Forage species revealed that kikuyu was superior in most minerals which agrees to other studies (Oduor, 2002). The supplements were also rich in most minerals except Mg, Zn and Cu. This is due to physiological differences between the plant species (McDowell et al., 1993),

All the three breeds revealed no significant differences in concentrations of macro elements although, low levels in Mn were observed in cows. This could be due to efficiency of absorption of minerals from the diet (McDowell and Conrad, 1989). When minerals composition were investigated based on age (Table 9), lactating cows (2 to 14 years old) were found to contain higher levels of K (0.39 ± 0.06) and Ca (0.81 ± 0.32) than young calves (2 to 14 months old) $P<0.05$. The differences could be due to the type of feed given to the animal. Lactating cows depend wholly on forages, which may have high mineral levels while calves depend mostly on the available mother's milk and little on forages (McDowell and Conrad, 1989).

Conclusion

This study revealed that deficiencies of Cu and Zn in soils existed and forages showed deficiencies in all elements except Mn while animal serum had Mg, Fe, Mn and Cu deficiencies. This could be due to inadequate dietary supply since the proportion of forage that could not meet required levels for cows were 89 and 93% for Mg and Cu. Lower levels of Cu in samples could be due to antagonistic relationship with molybdenum which suppresses any available copper in samples.

The study therefore recommends:1) direct and indirect mineral supplementation schemes to grazing cattle; 2) encouragement of specific pasture species and 3) encouragement of certain animal breeds to be reared in the region. This, if carefully done, could help increase production of meat and milk in the region.

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