Comparative evaluation of the blood mineral status of West African Dwarf Sheep and Goats managed under extensive and semi- intensive systems of management

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Abstract

A total of eighty (80) animals comprising of forty (40) each of West African Dwarf sheep and goats, averagely weighing 25.33 ± 2.50 kg and 15.13 ± 1.04 kg, respectively were used in an experiment at the Small Ruminant Unit of the Teaching and Research Farms of the University of Agriculture, Abeokuta and Olugbo village via Odeda in Odeda Local Government area of Ogun State. The forty animals from each species were divided into two groups of twenty (20) animals each and were randomly selected and managed under extensive system (ES) and semi intensive system (SIS). 10ml of blood sample from individual animal was drawn from each animal and analyzed for their mineral concentration of Ca, Mg, P, K, Na, Cu, Fe, Zn and Mn. The main effect of the systems of management significantly influenced the concentration of both major and trace minerals of sheep and goats except P and Cu. Sheep and goats under ES had higher ($P < 0.05$) concentration of Ca, Mg, Fe, Zn and Mn. The concentrations of K and Na were higher ($P < 0.05$) in sheep and goats under SIS. No significant ($P > 0.05$) interaction effect on Ca and P concentration was observed, although goats raised under both systems exhibited higher Ca and P concentrations than sheep. However, significant interactions ($P < 0.05$) of animal species and management systems was observed in the plasma concentrations of Mg, K, Na, Fe, Cu, Zn and Mn with no noticeable trend being followed. It was concluded that irrespective of the animal species (sheep or goats) and management systems, Ca and P supplementation is necessary to ensure optimum productivity of the animals.

Keywords: Sheep, Goat, Blood minerals, Management systems.

Introduction

Small ruminants are relatively easier to manage and produce than other species of livestock. The requirement for production depends largely on the scope and system of production. The bulk of sheep and goat production in Nigeria is of the traditional free-range type (Alawa, 2002). Management of sheep and goats in Nigeria is mostly under extensive and semi intensive systems of management (Adu and Ngere, 1979; Mack *et al.*, 1985) and only in few instances are they managed under a fully intensive system. Feeding of these animal species mostly depend

on the native grasses, some crop residues, and agro industrial by-products. Minerals are interactive ingredients in feeding programme, as they are dependent on plant, animal species and management factors (Puls, 1988). They are essential in the nutrition of sheep and goats because they play important metabolism role in animals' body processes. Thus, ruminants under different management systems may be exposed sometimes to the danger of deficiency and/or over intake of some minerals (Vijchulata, *et al.*, 1983; Kumagai, *et al.*, 1990; Fujihara *et al.*, 1992a, b). Therefore, economically important effects on

performance and health of animals can be affected by mineral deficiencies even before clinical signs are evident (Kincaid, 1999).

Blood has been noted to be a good indicator of mineral status of various animal species (McDowell, 1997) and could be used in assessing the nutritional state of a particular animal (Herdt, 1994). There is paucity of information on the blood mineral status of sheep and goats raised under intensive and semi intensive system of management particularly in Nigeria. The objective of this study was to compare the plasma calcium (Ca), phosphorus (P), magnesium (Mg), potassium (K), sodium (Na), iron (Fe), copper (Cu), zinc (Zn) and manganese (Mn) status of sheep and goats under extensive and semi intensive systems of management.

Materials and Methods

Experimental animals and management

The experiment was conducted at the Small Ruminant Unit of the Teaching and Research Farms of the University of Agriculture, Abeokuta and Olugbo village via Odeda in Odeda Local Government area of Ogun State. A total of eighty (80) animals comprising forty (40) each of West African Dwarf sheep and goats, averagely weighing 25.33 ± 2.50 kg and 15.13 ± 1.04 kg, respectively were used. Twenty (20) each of sheep and goats were randomly selected and managed under extensive system (ES). Another set of 20 sheep and goats were selected and managed under semi intensive system (SIS). The sheep and goats under the SIS were allowed eight hours of grazing in paddocks sown with *Stylosanthes hamata* and *Panicum maximum* after which concentrate supplement containing a mixture of wheat offal, brewer's dried grain, bone meal and common salt was provided. Animals on ES were allowed to graze on natural pasture consisting of different species of grasses, legumes and browse plants in addition to kitchen

wastes; cassava peels and other materials under the traditional village setting.

Blood collection and plasma separation

About 10mls of blood sample from individual animal was drawn via the jugular vein (Frandsen, 1986) with sterilized 19-gauge needle and syringe and then deposited in lithium-heparinized bottle. The samples bottles were placed in ice cube and immediately transferred to the laboratory for plasma separation. The blood was centrifuged at 3000 rpm using Melin 503 centrifuge to aspirate the plasma.

Chemical analysis

Plasma samples were analyzed for their mineral concentration using the procedure described by A.O.A.C. (1990). The concentration Ca, Mg, Cu, Fe, Zn and Mn were read at 422 nm, 285 nm, 248 nm, 327 nm and 279 nm, respectively using Buxx 2000 Atomic Absorption Spectrophotometer. The concentrations of Na and K were determined using Jenway Digital Flame Photometer while the P concentration was estimated by Vanadomolybdate method and read at 470 nm on the spectrophotometer.

Statistical analysis

All data accumulated from the chemical analysis were subjected to a two-way analysis of variance using a 2×2 factorial format (in which breed and management systems were factors) in a completely randomized design (SPSS, 1999). Weights of the animals were used as a covariate in the analysis.

Results and Discussion

The main effects of systems of management significantly influenced the concentration of both major and trace minerals of sheep and goats except phosphate and copper (Table 1). Sheep

Table 1: Effect of management systems on the plasma mineral concentrations of sheep and goats

Minerals	Management systems		R ²
	Extensive	Semi-intensive	
Major minerals (mmol/l)			
Ca ²⁺	1.05 ± 0.03 ^a	0.82 ± 0.03 ^b	0.64
PO ₄ ⁻⁻⁻	2.32 ± 0.49	2.80 ± 0.37	0.25
Mg ²⁺	1.79 ± 0.12 ^a	0.88 ± 0.14 ^b	0.84
K ⁺	5.93 ± 0.01 ^b	14.99± 0.45 ^a	0.93
Na ⁺	12.06± 0.78 ^b	15.53± 0.77 ^a	0.69
Trace elements (μmol/l)			
Fe ²⁺	46.18±0.92 ^a	31.43±0.91 ^b	0.75
Cu ⁺	35.33±0.77	33.89±0.76	0.59
Zn ²⁺	35.05±0.58 ^a	19.62±0.57 ^b	0.88
Mn ²⁺	33.95±0.58 ^a	13.44±0.59 ^b	0.87

a, b, values on the same row with identical superscripts are not significantly ($P > 0.05$) different

and goats under ES had higher ($P < 0.05$) concentration of Ca, Mg, Fe, Zn and Mn. The concentrations of K and Na were higher ($P < 0.05$) in sheep and goats under SIS. In both systems, except Ca and Na that were deficient, the concentrations of P, Mg, K, Fe, Cu, Zn, Mn were normal (NRC, 1985; Fraser and Mays 1986; Meyer and Harvey, 1998). The higher concentrations of Ca, Mg, Fe, Zn and Mn in sheep and goat under ES could be attributed to their access to different forage types of different botanical composition. This is in line with Gatenby (2002) who reported that small ruminants under ES rarely develop mineral deficiency, while mineral deficiency is usually noticeable in intensive system. The higher Na observed in the animals managed under SIS could be attributed to the inclusion of salt (NaCl) in concentrate diets.

The main effect of breed (animal species) showed that plasma concentration of the minerals determined were higher ($P < 0.05$) in West African

Dwarf goats than in sheep (Table 2). Species differences in blood plasma mineral concentration have been reported (Radostits *et al.*, 1997). Aside from Mg, higher plasma concentrations of Ca, P, K and Fe in goats than in sheep is contrary to the reports of Meyer and Harvey (1998) who reported higher concentrations of these minerals in sheep. However, this result is in line with Fraser and Mays (1986). This suggests higher metabolic activities in West African Dwarf goats than sheep. The plasma concentrations of P, Mg, Cu and Zn observed in goat in this study were higher than those reported by Orden *et al.* (2000) except a higher Ca concentration of 2.37 mmol/L reported by the same author. The concentrations of Ca and P in the blood of sheep are lower than the NRC (1985) standards, while plasma concentrations of Mg, Cu and Zn are in accordance with the reports of Fujihara *et al.* (1999) except the concentration of Fe which is higher.

Table 2: Effect of small ruminant species on the plasma mineral concentrations

Minerals	Animal species		R ²
	Sheep	Goats	
<u>Major minerals (mmol/l)</u>			
Ca ²⁺	0.70± 0.04 ^b	1.16 ± 0.04 ^a	0.62
PO ₄ ⁻⁻⁻	0.42 ± 0.04 ^b	2.14 ± 0.28 ^a	0.20
Mg ²⁺	1.08 ± 0.05 ^b	0.88 ± 0.05 ^a	0.83
K ⁺	5.18 ± 0.50 ^b	15.33± 0.54 ^a	0.92
Na ⁺	9.36± 0.86 ^b	18.21± 0.92 ^a	0.69
<u>Trace elements (µmol/l)</u>			
Fe ²⁺	38.62±1.01	39.00±0.18	0.75
Cu ⁺	36.00±0.85	34.17±0.91	0.57
Zn ²⁺	15.88±0.64 ^b	38.79±0.68 ^a	0.87
Mn ²⁺	14.89±0.65 ^b	32.49±0.70 ^a	0.86

b, values on the same row with identical superscripts are not significantly (P >0.05) different

Table 3: Interactive effect of animal species and management systems on the plasma mineral concentrations.

Minerals	Sheep		Goats	
	Extensive	Semi-intensive	Extensive	Semi-intensive
Major minerals (mmol/l)				
Ca ²⁺	0.86 ± 0.05	0.55± 0.05	1.24±0.05	1.09±0.05
PO ₄ ⁻⁻⁻	0.53 ± 0.06	0.32± 0.05	1.80±0.42	2.49±0.32
Mg ²⁺	1.29 ± 0.06 ^b	0.83 ± 0.07 ^c	2.24±0.06 ^a	0.90±0.07 ^c
K ⁺	7.16 ± 0.62 ^a	3.18± 0.75 ^c	4.67±0.69 ^b	2.69±0.72 ^d
Na ⁺	13.22 ± 1.16 ^b	5.50± 1.29 ^d	10.87±1.17 ^c	25.56±1.25
Trace elements (µmol/l)				
Fe ²⁺	30.64±0.02 ^c	46.59±0.18 ^b	61.71± 0.03 ^a	16.26±0.03 ^d
Cu ⁺	44.85±0.02 ^a	27.14±0.02 ^c	25.81± 0.02 ^c	40.64±0.02 ^b
Zn ²⁺	19.55±0.64 ^c	12.19±0.02 ^d	50.52± 0.01 ^a	27.05± 0.01 ^b
Mn ²⁺	16.16±0.02 ^b	13.64±0.02 ^c	51.82± 0.18 ^a	13.24±0.02 ^c

b, c, d values on the same row with identical superscripts are not significantly (P >0.05) different

Table 3 shows the interactive effect of the animal breed and management systems on the plasma mineral concentration of small ruminants. There was no significant ($P > 0.05$) interaction effect on Ca and P concentrations although goats raised under both systems exhibited higher Ca and P concentrations than sheep. However, significant interactions ($P < 0.05$) of animal species and management systems was observed in the plasma concentrations of Mg, K, Na, Fe, Cu, Zn and Mn with no noticeable trend being followed.

Conclusion

Small ruminants on extensive system of management exhibited higher plasma mineral concentrations than those on semi-intensive system while goats had higher plasma mineral concentrations than sheep. It is evident from the result of this study that irrespective of the animal species (sheep or goats) and management systems, Ca and P supplementation is necessary to ensure optimum productivity of the animals. Blood measures are frequently used in assessment because they are significantly correlated with the nutritional status of the animals. To offer a more reliable criterion for assessing the nutritional status of minerals in sheep and goats raised under the two management systems, it will be better to discuss the mineral contents of the main organs (kidney, liver etc.) together with the concentration of minerals in the blood plasma.

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