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MINERAL CONTENTS OF EXTRACELLULAR FLUIDS IN CAMEL AND CATTLE IN THE NORTH EAST SAHEL REGION OF NIGERIA

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SUMMARY

The levels of some mineral elements in serum, urine, ruminal fluid and digesta of camels and cattle of the North East Sahel region of Nigeria were evaluated using apparently healthy animals presented for slaughter at the Maiduguri municipal abattoir during the months of November and December, 1993. Serum, urine, and rumen samples were obtained from the animals and analysed for calcium, phosphorus, magnesium, sodium, potassium, and copper. The results showed that the concentrations of all the minerals studied, except sodium, were higher in the ruminal fluid of camels compared to cattle. However, serum concentrations were comparable in both species, with the exception of phosphorus which was lower in cattle, and potassium which was higher in cattle. For urine samples, all the minerals measured were higher in camel than in cattle. Analysis of solid rumen digesta showed that the concentrations of phosphorus, magnesium, copper and calcium, sodium, potassium were respectively higher in camels than cattle digesta.

KEY WORDS: Cattle, Camel, Minerals, Sahel Region

INTRODUCTION

Livestock rearing is the main occupation of the people of the North-East Sahel region of Nigeria, and the region supplies the country with a substantial quantity of slaughter cattle (Alaku and Igene, 1983). However, the region has been subjected to cycles of drought periods, which have left the vegetative cover sparse and the available natural forage scarce. The ability of livestock raised in this area to obtain enough nutrients has, therefore come under question.

Minerals are inorganic substances required for the growth and normal life processes of animals. They are not synthesized in the body but obtained from feed. Herbivores under natural grazing obtain their minerals from forage plants. Inadequate mineral intake leads to reduced productivity (Minson *et al.*, 1976). The adequacy of the diet in the essential minerals can be determined by chemical analysis of body tissues, and comparing the levels of the various elements with published data (Minson *et al.,* 1976). Knowledge of mineral concentration in body fluids is also used as a diagnostic tool for assessing a variety of disorders (Tietz, 1982). Camels and cattle have different feeding habits. Camels prefer to browse rather than graze, while cattle prefer to graze rather than browse (Rutagwenda *et al.*, 1990). The difference in feeding habits has its nutritional implication. It has been observed that browse plants have higher mineral contents than grasses, and also that as forages mature and dry up, their mineral contents decline. The rate of decline is faster for grasses than for browse plants (Kapu, 1976, Kapu and Lawal, 1976).

The main objective of this study was to evaluate and compare the mineral content of the serum, urine and ruminal fluid of camels and cattle in the North-East Sahel region of Nigeria.

MATERIALS AND METHODS

Thirty-three apparently healthy adult male ruminants comprising of 17 camels (*Camelus dromedaries*) and 16 zebu cattle (*Wadara*), presented for slaughter at the Maiduguri Municipal abattoir during the months of November and December, 1993 were used for the study.

Blood samples were collected at the point of ex-sanguination from each animal into clean universal plastic sample bottles, allowed to clot and serum harvested after separation by centrifugation at 2500rpm. The sera samples were stored at the freezing temperature of -10°C.

Urine was collected from the urinary bladder by excising urinary bladder of the animals and the content emptied into plastic bottles with screw cap. The urine was preserved by adding formaldehyde (a drop per 25ml of urine).

The ruminal fluid was obtained by filtering contents of the rumen through four layers of cheese cloth, and the filtrate preserved by adding formaldehyde (a drop per 25ml of fluid). In the absence of harvested forage, solid rumen content which is actually the herbage consumed was analysed for mineral content. The solid digesta from the rumen was obtained and preserved by submerging it in 10% formalin. Later, the solid rumen digesta samples from each species were pooled, dried, ground and mixed. One gram of the dry sample was ashed and the ash was dissolved in 50ml of deionized water. The filtered supernatant of the ash suspension was used for analysis. The preserved urine samples, rumen fluid and solid digesta were frozen at -10°C.

The mineral contents of the sera, urine, ruminal fluid and digesta were estimated. Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K) and Copper (Cu) were determined by atomic absorption spectrophotometry (using Pye Unicam Model SP9 A Series 2 from Pye Company Ltd, Cambridge, England). Phosphorus concentrations were determined by the method of Gomori, (1942) which is a modification of the colorimetric phosphorous determination for use with photoelectric colorimeter.

Statistical Analysis

Species differences in the mineral contents of the ruminal fluid, serum and urine were determined by the Student's t-test (Steel and Torrie, 1960).

RESULTS

The mineral contents of the ruminal fluid sera, urine, and digesta are summarized in Tables I, II, III and IV.

The ruminal fluid from camels contained higher ($P<0.05$) levels of K, Cu, Mg, and lower ($P<0.05$) levels of Na than those from cattle (Table I).

TABLE I: Concentration of inorganic elements in ruminal fluid (mmol/l, mean ± SEM)

Elements	Camel (n=17)	Cattle (n=16)
Calcium	1.14 ± 0.099^a	0.11 ± 0.904^b
Phosphorous	7.78 ± 0.39^a	4.90 ± 0.19^b
Magnesium	0.45 ± 0.096^a	0.22 ± 0.37^b
Sodium	36.44 ± 3.28^a	46.70 ± 2.67^b
Potassium	10.73 ± 0.83^a	7.77 ± 0.19^b
Copper	0.0202 ± 0.0007^a	0.0168 ± 0.0004^b

a, b: Means with different superscript in the same row are statistically different ($P < 0.05$)

The differences in Calcium, Magnesium, Sodium and Copper concentrations in the sera between camels and cattle were not statistically significant ($P>0.05$). However, camel sera contained significantly higher ($P<0.05$) levels of P and lower ($P<0.05$) levels of (K) than cattle sera (Table II).

TABLE II: Concentration of inorganic elements in serum (mmol/l, mean ± SEM)

Elements	Camel (n=17)	Cattle (n=16)
Calcium	3.12 ± 0.19^a	3.37 ± 0.19^a
Phosphorous	1.70 ± 0.10^a	0.81 ± 0.06^b
Magnesium	0.72 ± 0.05^a	0.85 ± 0.10^a
Sodium	141.63 ± 6.88^a	153.48 ± 15.73^a
Potassium	4.65 ± 0.16^a	6.27 ± 0.33^b
Copper	0.045 ± 0.006^a	0.0151 ± 0.008^a

a, b: Means with different superscript in the same row are statistically different ($P < 0.05$)

The urine levels of P, Mg, Na, and K were significantly higher ($P<0.05$) in camels than in cattle. The urine levels of Cu and Ca in the two animals species were not significantly different (Table III).

TABLE III: Concentration of inorganic elements in urine (mmol/l, mean ± SEM)

Elements	Camel (n=17)	Cattle (n=16)
Calcium	3.37 ± 1.17^a	1.33 ± 0.36^a
Phosphorous	11.32 ± 0.75^a	6.39 ± 0.70^b
Magnesium	3.84 ± 0.39^a	1.67 ± 0.23^b
Sodium	57.04 ± 14.76^a	20.33 ± 4.95^b
Potassium	124.25 ± 10.78^a	30.75 ± 7.76^b
Copper	0.021 ± 0.01^a	0.019 ± 0.04^a

a, b: Means with different superscript in the same row are statistically different ($P < 0.05$)

Apparently P, Mg and Cu contents were higher and the Ca, Na and K contents were lower in the camel rumen digesta compared to that of the cattle (Table IV).

TABLE IV: Concentration of inorganic elements in the solid rumen digesta

Elements	Camel (n=17)	Cattle (n=16)
Calcium, %	0.15%	0.33%
Phosphorous, %	0.145%	0.066%
Magnesium, %	0.0295%	0.0096%
Sodium, %	0.026%	0.036%
Potassium, %	0.18%	1.17%
Copper, mg/kg DM	9.5%	0.19

DISCUSSION

Electrolytes are not synthesized in the body but they are supplied by the feed. Their concentrations in the body fluid will therefore depend on the mineral content of feed, the level of feed intake and the availability of the minerals (Gomide, 1978, Underwood, 1981). This is particularly true of rumen electrolyte concentrations. Salivary secretion also contributes to rumen fluid volume and inorganic composition (Annison, and Lewis, 1962). The concentrations in other body fluids will then depend on absorption from the gut, metabolic usage, homeostasis and excretion (Simesen. 1970, Littledike and Goff, 1987).

Plants (forages) make up the bulk of the feed eaten by grazing animals. According to Underwood (1981), the factors affecting mineral contents of plants include (1) the genus, species or strain (variety), (2) the type of soil on which the plant grows, (3) the climatic of seasonal condition during plant growth, (4) the stage of maturity of the plant and (5) fertilizer application. Since the species studied are inhabitants of the same environment, the most important factors of concern are the plant species and the stage of maturity.

The Sahel region is a semi-arid region characterized by extremely seasonal conditions, relatively low rainfall and very long dry seasons (Payne, 1990). It has an annual rainfall of less than 800mm (Pagot, 1992), and vegetation cover of grass interrupted by trees and shrubs (Johnson and Tothill, 1985). The woody trees are mainly *Acaca* and *Commiphora* species. The predominant grass is the *Cenchrus* species (Kowal and Kassam, 1978; Pagot, 1992). During the month of November and December when the present study was carried out, the grass had become brown and dry.

The data reported here indicate that most of the electrolytes studied are higher in the rumen fluid and urine of camels compared to cattle. Some differences were also found in the mineral content of the solid rumen digesta obtained from the two species, but there was not much differences observed in the electrolyte concentrations in the sera.

Although these two animal species are ruminants with the same type of digestive system, they have different adaptations and food habits. The camels are adapted to the more arid areas and prefer to browse, while cattle do best in grassland regions and prefer to graze (Rutagwenda *et al.*, 1990; Pagot, 1992). During the months of November and December when the present study was carried out, the grass in the Maidaguri area of Borno state had become brown and dry in contrast to the weedy plants which still had green leaves and fruit on them.

The mineral content of the solid rumen digesta for each species would be expected to be a reflection of the mineral content of the forage eaten, especially the less soluble fraction. The more soluble fraction would easily disappear into the rumen liquor. The distribution of Calcium, Phosphorus and Magnesium ions between the alimentary fluid and particles of digesta is greatly influenced by acidity. However, at the pH of the rumen, very little of these may be in solution (Hungate, 1966; Hays and Swenson, 1993). Therefore, the concentrations of Calcium, Phosphorus and Magnesium in the solid rumen digesta would be expected to parallel forage content which is affected by state of maturity. Stage of maturity adversely affects most minerals in forage especially, Phosphorus and Potassium but not Calcium (Uderwood, 1981). The lower concentration of Phosphorus in cattle rumen digesta may have been as a result of decreased level in grass forage due to advanced level of maturity. The higher concentrations of Phosphorus and Copper contained in the camels solid rumen digesta is in agreement with previous observations that browse plants are higher in the two minerals (NRC, 1981; Ifut, 1982). It has to be noted, however, that the rate at which large forage particles are reduced to smaller ones in the rumen as well as the quick passage of comminuted particles out of the rumen will affect the mineral content of the residual solid rumen digesta (Hungate, 1996). The overall effect will be a relatively lower mineral content of the solid rumen digesta when compared to the unharvested herbage.

With the exception of Sodium, the concentrations of all the minerals studied were higher in the camel ruminal fluid. Ruminal fluid mineral levels are reflections of dietary intake. Electrolytes are recycled into the rumen either from saliva or from blood. According to Hungate (1966), saliva is important in maintaining fluid volume and inorganic composition of rumen content. Ruminant saliva contains the same inorganic salts found in blood (Dukes, 1995). While Sodium is actively reabsorbed from the rumen, Potassium is actively secreted into rumen (Dziuk, 1984). Saliva is the chief source of Sodium in the rumen, while other constituents are derived directly from food to about the same extent as saliva. Sodium in saliva is about 18 times as abundant as Potassium (Hungate, 1966). Since salivary secretion rate and hence the quantities of element recycled is affected by dryness of pasture, more elements are expected to be recycled into the rumen by cattle which consumed dryer forage. This probably explains the higher level of Sodium in cattle ruminal fluid.

Calcium is less affected by stage of maturity, hence cattle has more Calcium (Uderwood, 1981). The higher concentration of Potassium in camel ruminal fluid may mean that the camel is more efficient in conserving Potassium so as to compensate for losses in sweat. It has been observed that the sweat of camel is more alkaline than that of cattle and has a high concentration of Potassium, containing about 3 to 10 times more Potassium than Sodium (Mcfarlane, 1986a).

With the exception of Phosphorus and Potassium levels, no significant differences were observed in the serum mineral concentrations of the two species. According to Baldwin (1970), the blood of different species are remarkably alike in ionic composition, the reason being that the conditions under which cell life is possible are very restricted. This probably explains the similarity observed in this study between the concentrations of most of the minerals in camel and cattle sera. The difference in serum Phosphorus probably reflects dietary intake. Both the solid rumen digesta and the ruminal fluid from camel had higher Phosphorus levels than similar samples from cattle. In the case of Potassium the lower values observed in the camel serum compared to cattle serum is probably caused by greater transport of potassium from blood to the rumen (Dziuk, 1984) and not a reflection of dietary content. This follows because although the cattle rumen digesta contained a higher level of Potassium than camel rumen digesta, camel ruminal fluid contained greater concentration of Potassium than cattle ruminal fluid.

Urinary concentrations of minerals usually reflect the quantity excreted after the body needs have been met. When intake is inadequate there is almost complete reabsorption in the kidney and very little in the urine (Tasker, 1971). In this study the concentration of the minerals were higher in camel urine than in cattle urine. This is probably due to a combination of two factors. Firstly, the amount available for absorption as indicated by rumen fluid content, which was higher in camels than in cattle, and secondly, the greater ability of camels to concentrate urine as a way of conserving water (Siebert and McFarlene, (1971).

CONCLUSION

It is concluded that both species were receiving adequate mineral nutrition, when we compare the results with normal ranges for ruminants as reported by Swenson (1993). However, cattle which had a serum P level of 0.8 ± 0.06 mmol/l was marginal for the element normal range being 0.7-2.3 mmol/l (Swenson, 1993).

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