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RENAL FUNCTION OVER THREE 8-HOUR PERIODS IN HEALTHY SUDANESE NUBIAN GOATS

(With 4 Tables)

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SUMMARY

Renal function was investigated in 10 adult Sudanese Nubian goats (>2years old) by estimating the urine volume and constituents of each animal at 8 h intervals for 96 h. Urine volume, urine flow rate, pH, specific gravity, endogenous creatinine and urea clearance, urine concentration of urea, uric acid, total protein, and total excretory rate of proteins and electrolytes, were measured using standard methods. Blood serum constituents of the pervious chemicals were also estimated. Only urine outflow rate, urine urea concentration and uric acid as well as urea clearance differed significantly with time. These findings were discussed in relation to the renal function of goats and other ruminants.

Key words: *Renal function, Sudanese Nubian Goats.*

INTRODUCTION

The mammalian kidney plays a key role in the maintenance of the body internal environment. The renal function did not show any significant variation when tested at different urine collection periods, in dairy cattle (Fleming, *et al*., 1991) and in sheep (Garry, *et al*., 1991). In the Sudan Nubian goats are considered important household dairy animals which contribute to the nutrition (milk in particular) and economy of many families. The average milk yield of a Nubian goat ranges between 1.5-2 Kg per day. Information concerning renal function in normal Nubian goats seems to be limited. So this work was designed to measure urinary indices of renal function over three eight hour periods in healthy Sudanese Nubian goats.

MATERIALS and METHODS

This study was conducted in November 2003.

Animals:

Ten apparently healthy non-pregnant and non-lactating Nubian goats were used. The animals were over 2years of age with an average body weight of 22.5 kg. They were dosed against both internal and external parasites, and kept in well ventilated pens at the Farm of the College of Veterinary Medicine and Animal Production Khartoum North. They were maintained on alfalfa hay *adlibitum* with free access to water. The goats were allowed an adaptation period of three weeks before the start of the experimental protocol.

Sample collection: Urine and blood samples were collected from each goat at 8h intervals over a 96 hours period. A modified catheter with a plastic urine collection bag was used for urine collection. The urine catheter was introduced aseptically, after the vulva and the perennial region had been cleaned. The bladder was emptied and then rinsed with sterile distilled water. The urine collection bag was kept secure in a clean cloth bag. Each animal had been subjected to the urine collection procedure 3 times before the actual collection started. The daily collection periods were named: first (7 am – 3 pm), second (3 pm – 11 pm) and third collection periods (11 pm – 7 am).

Blood was collected with the aid of a fixed jugular vein catheter at mid time of each urine collection period. Serum was harvested and stored at -20 ^{o}C until used.

Physical properties of urine:

Urine volume for each animal at each period was determined by a glass measuring cylinder. The urine pH and specific gravity were determined by a pH meter (Jenco Electronics USA) and a refractometer (Cambridge Instruments inc, USA) respectively.

Chemical analysis of blood serum and urine were performed as follows:

Na and K were measured by flame photometry (Wooton, 1974). Ca, P,Cl, and Mg using standard procedure (Trinder (1960), Varley (1967), Vogel (1982), and Norbert (1982)) respectively. Colorimetric method was adopted for the determination of Total protein, creatinine, urea and uric acid was determined by colorimetric method, using commercial test-kits (Linear Chemicals Ltd.Spain).

Calculations:

Endogenous creatinine and urea clearance:

Endogenous creatinine clearance was calculated using the following equation (Guyton and Hall, 2000):

$CL_{CR} = (U_{CR} \times U_{vol} / S_{CR})$/ kg of BW/T.

Where CL_{CR} = Endogenous creatinine clearance

U_{CR} and S_{CR} = urine and serum concentration of creatinine respectively.

U_{vol} = urine volume in milliliters.

Kg of BW = body weight in kilograms.

T = time (hour).

The same procedure was followed for determination of urea clearance.

Electrolytes excretion rates were calculated, for a substance Y, as follows:

$TE_Y = (U_Y \times U_{vol})$/ kg of BW.

U_Y =Electrolyte level in urine.

TE_Y = the total urinary excretion rate of Y, which was expressed as millimol or milligrams, depending on the initial unit of measurement for the electrolyte (Bonsen and Toussky, 1945).

Urine flow rate:

Flow rate = urine volume/time in hours/ body weight (Guyton and Hall, 2000).

Statistical Analysis:

The main effect was the time of collection. Statistical analysis of the obtained data among the different periods was performed by analysis of variance as described by Gomez and Gomez (1984). The results are given as the means ± standard deviation.

RESULTS

No abnormal clinical signs were observed during the course of the study. The animals did not show any signs of pain, restless or discomfort during or after catheterization. All the animals were well adapted to the experimental protocol and remained in good condition to the end of the study.

The specific gravity, and pH did not varied among the periods. Significant variations ($P<0.01$) were observed with time for urine volume and flow rate (Table 1). Although a variation in the urine Na concentration was observed among the periods, its total excretory rate did not changed (Tables 2 and 3). Creatinine clearance, urine protein concentration and the total protein excretory rate remained stable with time, while urea clearance, urine urea and uric acid concentrations varied significantly (Table 4).

Table 1: Effect of the time on some urine physical properties.

Parameters / Periods	pH	SPG	Vol(ml)	Flow rate ml/ kg/h
1st	8.48±0.29 [a]	1.031±0.004 [a]	278.75±61.06 [b]	1.55±0.34 [b]
2nd	8.51±0.27 [a]	1.031±0.007 [a]	249.9±55.82 [b]	1.64±0.31 [b]
3rd	8.65±0.22 [a]	1.032±0.007 [a]	397.1±53.97 [a]	2.21±0.30 [a]

a.b = mean values in the same column followed by different superscripts are significantly different at (p<o.o1)
No. of measurement = 120
Measurement are expressed as mean ± SD
SPG = specific gravity
Vol = volume of urine.
1st = 7 am – 3 pm.
2nd = 3 pm – 11 pm.
3rd = 11 pm – 7 am.

Table 2: Effect of time on Nubian goats urine electrolytes concentration.

parameters / Periods	Na m.mol/L	K m.mol/L	Ca/ mg/L	Mg/mg/L	Po4/mg/L	Cl/ m.mol/L
1st	173.70±5.79 [a]	6.05±0.14 [a]	8.43±0.32 [a]	152.38±13.41 [a]	4.58±0.19 [a]	102.85±4.53 [a]
2nd	171.83±5.14 [a]	6.01±0.13 [a]	8.29±0.32 [a]	148.73±12.10 [a]	4.55±0.19 [a]	102.30±3.20 [a]
3rd	163.50±14.74 [b]	6.04±0.16 [a]	8.25±0.31 [a]	148.30±13.69 [a]	4.53±0.15 [a]	104.20±3.31 [a]

a.b=mean values in the same column followed by different superscripts are significantly different at (P<0.05).
No. of measurement = 120
Measurement are expressed as Mean ± S.D.
1st = 7 am – 3 pm. 2nd = 3 pm – 11 pm. 3rd= 11 pm – 7 am.

Table 3: Effect of time on Nubian goats urine electrolytes total excretory rate.

parameters / Periods	TE Na m.mol/ kg /h	TE k m.mol/ kg /h	TE Cl/ m.mol./kg /h	TE Mg mg/kg /h	TE Po4 mg/ kg /h	TE Ca/ mg / kg /h
1st	0.263±0.03	0.009±0.003	0.011±0.02	0.221±0.022	0.007±0.001	0.011 ±0.003
2nd	0.251±0.03	0.009±0.002	0.010±0.02	0.217±0.025	0.007±0.002	0.010 ±0.003
3rd	0.256±0.03	0.009±0.003	0.011±0.02	0.217±0.023	0.007±.002	0.011 ±0.002
Significance level	NS	NS	NS	NS	NS	NS

NS = not significant
No. of measurement = 120
Measurement are expressed as Mean ± S.D.
TE = total excretory rate
1st = 7 am – 3 pm. 2nd = 3 pm – 11 pm. 3rd= 11 pm – 7 am.

Table 4: Effect of collection time on protein and non protein nitrogenous compounds indices of Nubian goats renal function.

Parameters / Periods	CR –Cl ml/min/kg	Urea –Cl ml/min/kg	Urea mg/ ml	Uric acid (conc.) mg/L	Total Protein concentration mg/L	TE Pr mg/kg/h
1st	3.74±0.6[a]	1.85±0.40[b]	18.33±0.09[a]	200.75±36.9[b]	9.15±0.33[a]	0.014±0.000[a]
2nd	3.745±0.7[a]	1.93±0.37[b]	18.35±0.09[a]	199.43±35.4[b]	9.07±0.31[a]	0.014±0.000[a]
3rd	3.80±0.5[a]	2.21±0.39[a]	18.06±0.08[b]	210.15±33.7[a]	9.02±0.27[a]	0.019±0.000[a]

ab = means value in the same column followed by different superscripts are significantly different at ($P<0.05$).
No. of measurement = 120.
Measurements are expressed as Mean ± S.D.
Urea –Cl = urea clearance.
CR-Cl = creatinine clearance.
TE.Pr. = protein total excretory rate.
1st = 7 am – 3 pm. 2nd = 3 pm – 11 pm. 3rd = 11 pm – 7 am.

DISCUSSION

A stable urine specific gravity was observed over the time, this finding is similar to the values previously reported by Barakat and El-Guindi (1968); Altman (1961); and Mathews (1999). The mean daily urine output and the urine out flow rate reported in the present work are within the normal range reported by other workers (Altman, 1961; Mathews, 1999) for goats.

The urine volume of the third collection period was significantly higher than that of the preceding periods. We suspect that at the 3rd period the environmental temperature drops and the animals tend to rest, which most probably resulted in more urine formation.

The urine pH reported in this work was in accord with the values obtained by Altman (1961), Barakat and El-Guindi (1968), and Mathews (1999).

There were no significant differences in the urine concentration, or total excretory rate of total proteins, Ca,K, Mg, Po_4 and Cl among the collection periods. Similar findings were reported by Fleming *et al.* (1991) in dairy cattle and Garry *et al.* (1991) in sheep. Although urine concentrations of Na varied significantly with time, their total excretory rate remained stable over time. So this finding supports the opinion of Oken (1981) that the total excretory rate is the best measure which reflects the tubular handling of the solutes and also provides a clear picture for assessment of renal function in health and disease.

The values of urine concentration of Na in this study agreed well with the values obtained by Salwa *et al.* (2004) for Sudanese goats and were much lower than those obtained by Garry *et al.* (1991) in sheep. Higher values for TE-Na were reported by Garry *et al.* (1991) in sheep. This variation in urine Na concentration and TE-Na may be due to the variation in the Na proportion in the feed, as the goats in the present work were kept on a high diet Na proportion (0.5%) compared with the (0.2%) of the sheep of Garry *et al.* (1991).

The urine K concentration value in this work was similar to that recorded by Salwa *et al.* (2004) for Sudanese goats. However, higher values for urine K were obtained by Garry, *et al.* (1991) in sheep fed high dietary K. However, (TE) K for goats was much lower than that for sheep (Garry *et al.*, 1991 and Rabinowitz *et al.*, 1984). This discrepancy in urine K concentration and (TE) K can be attributed to K being unique among other substances in that it can be either reabsorbed or secreted,

and consequently with a low in take of K there is no re-absorption and minimal secretion.

In this study the urine concentration of Ca agrees well with the values obtained by Salwa (2004) but is much lower than that reported by Barakat and El-Guindi (1968) for Egyptian goats. Moreover, the total (TE) Ca is lower than that reported by Altman (1963) for goats.

In the present study the urine Mg concentration was found to be comparable to the value of Salwa *et al.* (2004), and disagrees with that reported by Barakat and El-Guindi (1968).

Barakat and El-Guindi (1968) obtained higher urine P concentration than in the present work. The TE PO_4 of this study is on line with the finding of Garry *et al.* (1991) in sheep. This low P excretion consolidates the finding of Osbaldiston and Moore (1971) that most Po_4 excretion in ruminants occur in the gastrointestinal tract and the relationship of renal excretion to dietary intake and serum concentration is not clearly defined.

Although the urine Cl concentration in this study is lower than that obtained by Garry *et al.* (1991) for sheep the TE Cl agreed well with their finding.

Comparing the present results with those of previously reports showed a great variation in the excretion of the different electrolytes. Such a variation is probably acceptable because of variation in the environmental conditions, sex, species, activities of the animal, diet and many other factors which are known to affect the renal handling of the electrolytes.

The urine urea and uric acid concentrations of the third collection period differed from that of the other periods, although they were within the range reported by Altman (1961). Urea clearance varied over time indicating that urea clearance is not a reliable method for characterization of renal function (Bickhard and Dungelhoef, 1994).

The endogenous creatinine clearance reported in this work remained stable over time indicating a stable renal function resulting from the stable experimental conditions. It is similar to the value found by Bove and Joya (1979) in dogs for endogenous creatinine, and to inulin clearance in sheep (Valtonen *et al.*, 1982). However, lower values were obtained by other researchers for inulin clearance in sheep (Garry *et al.*, 1990; Bickhard and Dugelhof, 1994), and in goats (Brown *et al.*, 1990). This variation may be attributed to many factors including dietary protein level, age, body weight, muscle mass and physical activity (Valtonen *et al.*, 1982). Also variation in the analytical methods for

creatinine measurement in serum and urine may preclude proper interlaboratory comparison as stated by Brown *et al.* (1990).

It is concluded that in healthy goats, under stable condition, their kidney excretory function does not vary significantly over time, similar results were reported by Kokkonen *et al.* (2001). The latter authors found that there was no circadian variation of plasma atrial natriuretic peptide in the goat plasma to which these results could be attributed. So eight hours urine collection period seems to be valid for studying goats renal indices under the Sudan conditions.

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