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STUDIES ON THE CORRELATION BETWEEN PROTEINS AND ELECTROLYTES IN DESERT GOATS SUFFERING FROM INTERNAL PARASITES

(With 4 Tables and One Figure)

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دراسة عن الارتباط بين البروتينات والأملاح في الماعز الصحراوية التي تعاني من الطفيليات الداخلية

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تهدف هذه الدراسة إلى تقييم الارتباط بين تركيز البروتينات والشوارد في بلازما دم الماعز الصحراوية التي تعاني من الطفيليات الداخلية تحت البيئة الحارة الجافة في الواحات المصرية. طبقا للفحوص الطفيلية تم اختيار عدد ٦٠ من ذكور الماعز (٨-١٠ شهور) أثناء الاعتدال الحراري (شهر مارس) واختيار عدد مماثل من ذكور الماعز في نفس عمر المجموعة السابقة أثناء الطقس الجاف الحار (شهر يوليو) عام ٢٠٠٦. وبناء علي ذلك كل مجموعة من هذه الحيوانات تم تقسيمها إلى ثلاث مجموعات متساوية (كل منها ٢٠ حيوان). المجموعة الأولى كانت تعاني من الديدان الخيطية بالقناة الهضمية والمجموعة الثانية كانت تعانى من الديدان الكبدية أما المجموعة الثالثة فكانت سليمة واستخدمت كمجموعة ضابطة. هذا وقد تم أخذ عينات دم من كل الماعز لتقدير مستوى البروتين و الشوارد في البلازما. وقد أظهرت النتائج أن تركيز كل من البروتين الكلي والألبومين ونسبة الألبومين إلى الجلوبيولين في بلازما الماعز المصابة بالديدان الداخلية كانت أقل من تركيزاتها في الماعز السليمة. وقد كان هذا الانخفاض أكثر حدة في الماعز المصابة بالديدان الكبدية عن الماعز المصابة بالديدان الخيطية. كما أوضحت الدراسة أنه خلال الطقس الحار الجاف كانت الماعز التي تعاني من الطفيليات الداخلية تحتوي على مستوى صوديوم في البلازما أعلى من المجموعة الضابطة في نفس الطقس وأيضا عن المجموعة المصابة بالطفيليات الداخلية أثناء الاعتدال الحراري. وقد أوضح معامل بيرسون للإرتباط (r) ومعادلة انحدار الخط المستقيم ومعامل الانحدار (R^2) أن هناك ارتباط سلبي بين تركيز الألبيومين والصوديوم في بلازما الماعز المصابة بالطفيليات الداخلية أثناء الطقس الحار الجاف (r= - 0.56, R^2 =0.32 P=0.002). هذا يؤدي إلى التكهن بأن الماعز المصابة بالطفيليات الداخلية أثناء الطقس الحار الجاف تحاول الأقلمة لهذا الطقس من خلال الإحتفاظ بمياه الجسم وأن تلك الآلية تتميز بحالة من الاحتفاظ الاختياري للصوديوم بالجسم مقابل الاستنزاف الإجباري للألبومين نتيجة للإصابة بالطفيليات الداخلية.

SUMMARY

This study aimed to evaluate the correlations of plasma protein and electrolytes in the desert goats suffering from internal parasites under the effect of hot dry environment in the Egyptian oasis. According to parasitological examination, 60 male goats (8-10 months) were selected during the temperate climate (March) and a similar number of age-matched male goats were selected during the hot-dry climate (July) 2006. Each group of the selected goats was divided equally into 3 sub-groups (20 each). The first harboured gastrointestinal nematodes (GIN), the second was suffering from fascioliasis and the third was clinically healthy, which served as control. Blood samples were drained from all goats for estimation of plasma proteins and electrolytes concentration. All goats with GIT parasites had a significant reduction in concentrations of plasma total protein, albumin and A/G ratio compared with control ones. The reduction was more severe in goats suffering from fascioliasis. During hot-dry climate, goats with internal parasitism had higher plasma sodium than in control group during the same climate and than in the corresponding parasitized groups in the temperate climate. Pearson's correlation coefficient (r), linear regression equation and the regression factor (R^2) revealed a significant negative correlation (r= - 0.56, R^2 =0.32 P=0.002) between plasma sodium and albumin concentrations in goats reared under hot-dry conditions, suggesting that the desert goats infected with GIT parasites try to adapt to the hot-dry weather throughout retaining body water. This mechanism is characterised by a state of selective sodium retention against the obligatory depletion of albumin due to internal parasitic infection.

Key words: *Goats, internal parasites, plasma protein, electrolytes.*

INTRODUCTION

Gastrointestinal parasites have deleterious effects and collectively they lead to chronic illthrift (Radostits, *et al.* 2000). They are a major constraint to animal health, productivity, and profitability in grazing livestock production systems (Urquhart *et al.*, 1996). Economic evaluations consistently show that the major losses due to parasites are on animal production, rather than on mortality (Perry *et al.,* 2002). Gastrointestinal (GIT) parasites impair animal productivity through reductions in voluntary food intake and/or reductions in the efficiency of food use, particularly inefficient use of absorbed nutrients (Waller, 2006). Disturbances in protein metabolism and reduced absorption and/or retention of minerals are particularly significant during GIT parasitic infection in animals (Coop and Kyriazakis, 2001). The magnitude of these effects is influenced by the species of worms present in the GIT (Waller, 2006).

Livestock populate with their natural habitat (arid or semi-arid zones) are stressed by complex interactions between the environment and animal health (Burgos *et al.,* 2001). In this respect, Fox (1997) declared that the term homeostasis is a reaction of the internal environment for the nutrient partitions and metabolism regulation in a coordinated and orchestrated mechanism for the priorities and to support the body against the stress stimulus.

Plasma proteins and electrolytes can provide an efficient way on the internal homeostasis and help in the maintenance of blood viscosity and osmotic pressure (Kaneko, 1997; Feldman *et al.,* 2000 and Gholap & Dixit, 2004). The concentration of plasma proteins reflects the health status because they are nutritive, carrier for the transport of component for most of the plasma constituents (Jain, 1993). In addition they have an important function in body defences (Kaneko, 1997). These proteins can react in response to disturbances in animal's homeostasis caused by infection or tissue injury (Thomas, 2000) and their variations may indicate that tissue damage has occurred at the time when there are no clinical signs of the process in question (Feldman *et al.,* 2000). Disturbances in protein metabolism and water balance were reported in sheep infested with gastrointestinal nematodes (Xiao and Gibbs, 1992a, b).

The present work aimed to evaluate the correlations of protein and electrolytes in the desert goats suffering from internal parasites under the effect hot-dry environment in the Egyptian oasis.

MATERIALS and METHODS

Animals:

The climate in the Egyptian oasis is temperate in winter and very hot and dry in summer. This study was carried out in March (representing the temperate climate) and July (representing the hot-dry climate) 2006. Two groups of male goats (each consisted of 60 male Balady goats), their age 8-10 months, were selected from the grazing animals in the peri-urban areas in the Egyptian oasis. One group was selected during temperate climate and the other was selected during the hot-dry climate. The selection was based on faecal analysis for detection of gastrointestinal nematode and liver fluke eggs by floatation sedimentation techniques after Coles (1986). According to the parasitological examinations, each group of the selected goats were divided equally into 3 sub-groups (20 each). The first sub-group was harbouring gastrointestinal nematodes (including Osteatgia spp., Haemonchus spp. and or Trichostrongylus spp.). The second sub-group was infested with fasciola spp. The third sub-group was clinically healthy and was used as controls. Goats with mixed infection with nematodes and trematodes were avoided.

Blood sampling and analysis:

Blood was sampled by jugular vein puncture in centrifuge tubes contain Na-EDTA as an anticoagulant. Plasma was separated by centrifugation and stored at -20°C until analysis. The total protein and albumin were estimated by using commercially available test kits (Boehringer Mannheim, Germany) according to Henry *et al.* (1974). Plasma globulin concentration and albumin/globulin (A/G) ratio were calculated mathematically (Feldman *et al.*, 2000). The concentrations of plasma sodium and potassium were carried out using flame photometer (Corning 400) using calibrated standers for Na and K. The chloride concentrations in the plasma were measured using a chloride meter (Corning chloride meter 925).

Statistical analysis:

The obtained data were expressed as means ± standard error (SE). Differences between groups were determined using an analysis of variance followed by the Student t-test. The obtained individual data (paired) of the infested groups were subjected to Pearson's correlation coefficient (r), linear regression equation and the regression factor (R^2). The packaged SPSS program for windows version 11.0.5 was used for statistical analysis according to SPSS (2002). The significance difference was set at $P<0.05$.

RESULTS

The means and SE of plasma proteins and electrolytes concentrations in control and parasite infested sheep are shown in Tables 1 and 2. It is clear that goats infested with gastrointestinal nematodes and those with fascioliasis had a significant reduction in the in the mean concentrations of plasma total protein, albumin and A/G ratio without change in plasma globulin concentrations than the values recorded in the control group. During hot-dry environment the mean concentrations of plasma sodium concentration were significantly elevated in goats with internal parasites than controls. The mean values of plasma concentrations of potassium and chloride did not differ between infested and control groups. The reduction of the mean values of plasma total protein, albumin and A/G ratio was more severe in goats suffering from fascioliasis than in GIN infested goats. There were no differences between the two infected groups in the variations of the mean values of plasma globulin and electrolytes concentrations.

The effect of climate is shown in Table 3. It is clearly evident that albumin was significantly lower in control goats during hot-dry climate than in temperate climate. Goats infested with internal parasites (GIN and fascioliasis) showed a significant elevation in plasma sodium concentration during hot-dry climate than in thermo-neutral climate.

Pearson's correlation coefficient (r), linear regression equation and the regression factor (R^2) between the individual biochemical data of the internal parasite infested goats (Table 4) revealed that there were a significant negative correlation (r= -0.056, R^2 =0.32, P=0.002) between plasma sodium and albumin concentrations (Figure 1) during the hot-dry climate. The other estimated parameters during temperate and hot-dry climates were not correlated.

Table 1: Mean (±SE) of plasma proteins and electrolytes concentrations in control and parasite infested sheep during hot environment.

	Control	Infested		GIN x Fasc
		GIN	Fascioliasis	
Total protein (g/L)	69.3±0.57	64.1±0.49*	53.2±0.43**	*
Albumin (g/L)	36.1±0.21	27.1±0.19*	21.0±0.24***	**
Globulin (g/L)	33.2±0.17	37.0±0.21 ns	32.2±0.22 ns	Ns
A/G ratio	1.09±0.02	0.73±0.01**	0.66±0.01***	**
Sodium (mmol/L)	138.3±7.4	151.6±8.7 **	149.1±6.9*	Ns
Potassium (mmol/L)	4.22±0.46	3.89±0.39 ns	4.04±0.41 ns	Ns
Chloride (mmol/L)	96.1±4.5	103.5±3.9 ns	98.4±4.4 ns	Ns

ns: non significant; *, **, *** significant at P< 0.05, 0.01 and 0.001 respectively.

Table 2: Mean (±SE) of plasma proteins and electrolytes concentrations in control and parasite infested sheep during temperate environment.

	Control	Infested		GIN x Fas
		GIN	Fascioliasis	
Total protein (g/L)	71.5±0.62	61.5±0.55*	54.6±0.49**	*
Albumin (g/L)	38.2±0.33	26.6±0.26*	22.3±0.19**	**
Globulin (g/L)	33.3±0.16	34.9±0.18 ns	32.3±0.25 ns	Ns
A/G ratio	1.15±0.02	0.76±0.01**	0.69±0.01**	**
Sodium (mmol/L)	135.8±6.1	142.1±5.8 ns	139.6±5.4 ns	Ns
Potassium (mmol/L)	4.56±0.51	4.11±0.42 ns	4.32±0.38 ns	Ns
Chloride (mmol/L)	98.2±5.4	100.6±5.6 ns	101.9±0.44 ns	Ns

ns: non significant; *, **, *** significant at P< 0.05, 0.01 and 0.001 respectively.

Table 3: The effect of environment (thermo-neutral vs. hot-dry) on plasma proteins and electrolytes concentrations in control and parasite infested sheep

	Control	Infested	
		GIN	Fascioliasis
Total protein	ns	ns	ns
Albumin	*	ns	ns
Globulin	ns	ns	ns
A/G ratio	ns	ns	ns
Sodium	ns	**	**
Potassium	ns	ns	ns
Chloride	ns	ns	ns

ns: non significant effect of the environment; *, ** the environment has significant effect at P< 0.05 and 0.01 respectively.

Table 4: Pearson's correlation coefficient between the individual biochemical data of the internal parasite infested goats during temperate (TN) and hot-dry climate (HD).

	Total protein		Albumin		Globulin	
	TN	HD	TN	HD	TN	HD
Sodium	-0.23 ns	-0.21 ns	-0.29 ns	-0.56**	0.19 ns	0.23 ns
Potassium	-0.15 ns	-0.13 ns	-0.21 ns	-0.19 ns	0.21 ns	0.22 ns
Chloride	-0.21 ns	-0.18 ns	-0.19 ns	-0.21 ns	0.21 ns	0.15 ns

ns: non significant; ** significant at P< 0.01.

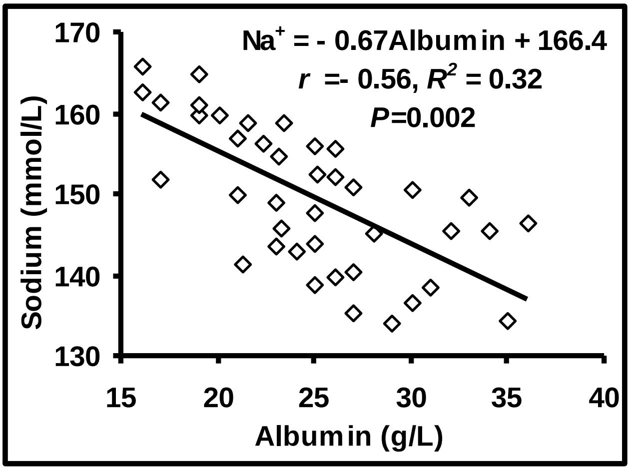

Fig. 1: Linear regression equation, regression factor (R^2) and correlation factor (r) between the individual data of plasma albumin and sodium concentrations of the internal parasite infested goats

DISCUSSION

The mean values of the concentrations of plasma albumin and consequently total protein in the current study were significantly lower in the parasited goats than control ones. Goats infested with fascioliasis lost more albumin with a resultant loss of more total protein than goats infested with gastrointestinal nematodes, suggesting that fascioliasis has a more deleterious effect on protein metabolism than the gastrointestinal nematodes. Although, Devaney *et al.* (1992) found no change in serum albumin and increased total serum protein in calves infected with low levels of internal nematodes. However, a common feature of parasitic gastrointestinal infections is an increased loss of endogenous protein into the gastrointestinal tract as reported by Hucker and Yong (1986), Xiao and Gibbs (1992b), Holmes (1993) and Coop and Holmes (1996). This loss is partly attributable to increased leakage of plasma protein, increased sloughing of epithelial cells and increased secretion of mucoproteins (MacRae, 1993). Furthermore, Symons and Jones (1975) declared that the reduction in the availability of absorbed amino acids for metabolism correlates with the reduced rates of protein synthesis in the tissues of parasitized animals. It is of wrthy to say that some of the protein passing into the lumen of the gastrointestinal tract is reabsorbed, depending on whether the lesions are in the anterior or the distal tract (Yakoob *et al.*, 1983). Despite some reabsorption, protein losses are large (Coop and Holmes, 1996). It has been estimated that the amount of non re-absorbable endogenous nitrogen leaving the terminal ileum of parasitized sheep can be as high as 4-5g nitrogen/day (Coop and Kyriazakis, 2001). On the other hand, hypoproteinaemia due to hypoalbuminaemia is one of the hallmarks of acute and chronic fascioliasis (Urquhart *et al.*, 1996), because of the failure of hepatic function (Kaneko, 1997). The decreased A/G ratio in goats suffering from nematodiasis and fascioliasis in the current study suggests that albumin had subjected to decreased synthesis in the liver, disturbed metabolism and impaired absorption (Kaneko, 1997). The decreased albumin in control goats during hot-dry climate than temperate climate is in accordance with Collier *et al.* (1982). It has suggested that albumin may be filtered and redistributed into the extravascular spaces during thermal stress (Igbokwe, 1997).

At low humidity and high wind velocity under opened tropical summer environment, animals are highly ventilated (Schmidt-Nielsen, 1997). Concomitantly, in the presence of intensified solar radiation, water is vigorously lost as a result of the higher sweating rate and rapid evaporation (Willmer, *et al.*, 2000). Also, as usual for desert resources, Abdel-Raheem (1998) noticed higher Na^+ content in both untreated water and browsing pasture in Egyptian oasis (average 5.4 % and 0.025 % respectively) if compared with riverine resources (0.05 % and 0.003 % respectively). Heat stressed animals in the dry deserts drink enormous volume of water to substitute the water loss by sweating rate and rapid evaporation (Igbokwe, 1997). However, in the current work, the concentration of sodium in the control group during both environments was normal and did not largely differ than the reference values cited by Kaneko et al. (1997) and Gholap and Dixit (2004) for goats. It seems that the ingested sodium is excreted with sweating in normal goats (Duncan and Prasse, 2003).

Our results showed that goats infested with internal parasite retain more sodium in the plasma during hot-dry climate than did the healthy control ones and more than the corresponding groups in the temperate climate. Dakkak *et al.* (1981) found insignificant change in blood sodium, potassium and chloride concentrations after internal parasitic infestation in sheep. This could be explained by the reports of Duncan and Prasse (2003) informed that sodium is retained in the body by various mechanisms including reduction of water turnover rate, lowered glomerular filtration rate and reduced urine output. Plasma osmolality and blood volume are depending mainly on sodium and albumin concentrations than other osmotic ingredients (Collier *et al.* 1982). Consequently, the increased plasma sodium in goats infested with internal parasites during hot-dry climate seems to be a functional compensatory mechanism to substitute the loss of albumin for retention of body water to insure efficient evaporative cooling.

Pearson's correlation coefficient (r), linear regression equation and the regression factor (R^2) between the individual biochemical data of the internal parasite infested goats revealed that there were a significant negative correlation (r= -0.56, R^2 =0.32, P=0.002) between plasma sodium and albumin concentrations. This confirms the suggestion that these goats try to adapt to the hot-dry weather throughout retaining body water by a state of selective sodium retention against the obligatory depletion of albumin.

In conclusion, desert goats infested with internal parasites eventually try to adapt themselves to the hot-dry weather throughout retaining body water by a state of selective sodium retention against the obligatory depletion of albumin due to internal parasitic infection.

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