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Research Article

EFFECTS OF WATER DEPRIVATION AND ENVIRONMENTAL TEMPERATURE ON BLOOD CONSTITUENTS OF DESERT GOATS

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ABSTRACT

Twenty eight Sudan Desert goats were used in these trials to study the effects of water deprivation and environmental temperature on blood constituents. The trial was laid out as randomized complete block design (RCBD). The experimental period lasted for 10 months. The result showed that Desert goat's PCV% was highest during winter and lowest during summer. Goats had the highest (P<0.001) Hb% during summer compared with rainy and winter seasons. Goats' highest plasma Ca levels were recorded during summer, and the lowest levels were during winter. Goat plasma P concentrations followed an opposite trend being highest (P<0.01) during winter season and lowest (P<0.01) during rainy. Seasonal main effects on blood metabolites were highly significant (P<0.01). The highest (P<0.001) goat's blood protein was during summer season, followed its values during rainy season and the lowest values (P<0.001) was during winter. Blood albumin levels were highest (P<0.001) for rainy season whereas blood glucose levels were highest (P<0.01) during winter season and lowest (P<0.01) during the rainy season. Blood protein, blood albumin and blood glucose levels were relatively higher (P>0.05) for goats under shade compared with those under direct sunlight. Goat's watered everyday had slightly lower blood protein and albumin and slightly higher blood glucose in comparison with goats watered every other day.

Keywords: Goats, serum, PCV, total protein, albumin, glucose, Ca, P.

INTRODUCTION

Most of goats in Sudan are of the Desert type. Sudanese Desert goats are mainly found in Western region of the Sudan including Darfur and Kordofan states. They are mainly raised for meat production especially in rural areas and they also provide milk for family needs (Itidal ,1989). Greater Kordofan total goats is estimated at 7.9 million with North Kordofan holding about 4.0 million heads according to Ministry of Animal Resources and Fisheries (MARF.2010). The majority of studies conducted on goats are on productive and reproductive performance. However, in comparison with other livestock, there is paucity of information regarding seasonality in physiological responses of goats to environmental stresses. Nutritional changes influence the composition of blood in goats. At high ambient, lower values of PCV and Hb concentrations obtained during dry summer in Nubian goats with low level of nutrition were attributed to depression of food intake of goats with rise in ambient temperature (Laden *et al.*, 1987; Forbes *et al.*, 1991). Salem *et al.,* (1998) found that serum total protein levels were higher in hot summer than in winter in Chios lambs. Plasma total protein levels are affected by season in small ruminants (Marai *et al.*, 2002). Blood glucose and total serum cholesterol levels are physiological adaptation mechanisms that can be affected by high ambient temperatures (Lu, 1989) The objectives are to study goats' responses to different watering and shading regimes seasonal physiological changes in hematological indices and blood metabolites seasonal changes in blood mineral profiles.

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MATERIALS AND METHODS

Study Area

This study was conducted at El-Obeid, Sheikan locality, North Kordofan State (latitudes 11°:15'-16°:30'N; longitudes 27-32°E; altitudes 560 meter asl). Average temperature varies between 30-35°C during most of the year with peaks of above 40°C during April, May and June. The rainy season extends from July to October with maximum rainfall in August. Long-term average annual rainfall is about 280 mm (Technoserve, 1987; El-Tahir *et al.*, 1999). According to MARF (2011) estimates, the livestock population in the Sudan counts 103,278,000 heads, including 28,618,000 heads of cattle, 39,296,000 sheep, 30,649,000 goats and 4,715,000 camels, distributed as follows: 30.7% in Darfur, 26% in Kordofan, 25.9% in the central region, 10.9% in the East, 4.7% in the Northern region and 1.3% in Khartoum state . Goats play important roles in the livelihood of rural area through income generation via sales of their products (milk, meat, skin, etc.) or the animals themselves. They, also, play an important role in the social systems.

Experimental animals and trials' layout

Twenty eight (28) Sudan Desert goats (3-4 month old, average body weight 11.8±1.35 kg) were used in these trials. Goats were ear-tagged, vaccinated against, goat pox and HS and treated with Ivomec (Ivomectin^{R}), a dose rate of 5ml/goat administered twice at an interval of three weeks, against internal and external parasites. All goats were allowed a one week adaptation period before the start of experiment The goats were randomly divided into two equal groups (14 goats) based on their initial body weight and age. One group was

randomly allocated to a shaded condition ,while the other group was left on the open with no shade. All goats were tethered and were provided with individual feeding and watering troughs. Each group was again randomly subdivided into two similar groups (7 goats) based on initial body weight and age. One group received water daily whereas the other one was watered every other day.

Hematological Indices:
Blood Collection and Processing:

Blood samples (10 ml) were drawn from the jugular vein using disposable syringes. five ml of blood was immediately transferred to a capped test tube containing an anticoagulant (KEDTA) for blood analysis. Three ml of the blood was kept in a test tube and after centrifugation; the plasma sample was used for glucose determination. the Retainer 2ml were used for Hb and PCV determination , the blood sample was allowed to stay for 4-5 hrs at room temperature and then centrifuged (Gallenkamp Junior) at 3000 rpm for 5 minutes Hemolysis-free serum was transferred to clean plastic vials and immediately frozen at -20°C for subsequent analysis.

Packed Cell Volume (PCV):

PCV was determined in duplicate using a micro-hematocrit centrifuge (Hettich, Tuttlingen, Germany). The hemoglobin concentration was determined by the cyano-methaemoglobin method (Schalm *et al.*, 1975).

Plasma Glucose:

Plasma glucose level was determined by the enzymatic colorimetric method using a kit (Randox Laboratories Ltd, London) according to the methods of (Tinder. 1969).

Serum Metabolites:

Serum total protein concentration was determined using Biuret reagent (King, and. Wootton, 1956). Serum albumin concentration was determined by a colorimetric method according to (Douman *et al.*, 1971).

Blood Minerals Concentrations:

Phosphorus and Calcium in blood plasma were determined according to the methods of (Henry and winkalman 1974).

Statistical Analysis:

The experimental data was analyzed as a completely randomized block design. Analysis of variance test (ANOVA) two- way interactions (Snedecor and Cochran,1980). Using the general linear model (GLM) procedure of (SPSS software version 16, 1999)

RESULTS AND DISCUSSION

Climatic Conditions

The ambient temperature and relative humidity prevailing during the experimental period (May 2010- February 2011), are shown in Table (1). The highest values of ambient temperature were recorded during May 2010 in summer while the minimum values were recorded during January 2011 in Rainy season. The relative humidity was at minimum during winter and the highest values were recorded in the rainy season.

Table (1). The ambient temperature (Ta) and relative humidity (RH) at El-Obeid during the experimental period

Season	Month	AT (°C) Min	AT (°C) Max	RH (%)
Summer	May	20.8	38.9	39.1
	June	19.1	35.3	68.2
	July	19.4	34.5	71.3
Rainy	August	19.3	36.3	26.7
	September	20.6	38.3	36.4
	October	13.6	38.2	24.7
Winter	December	09.6	34.7	26.4
	January	09.2	33.4	21.3
	February	12.3	40.4	12.5

Source: El-Obeid Agriculture Research Station (2012) *July is a summer month

Effects of season, housing condition and watering regimen on hematological indices and plasma Ca and P concentrations

The main effects of season, house condition and watering regimen on goat hematological indices and plasma calcium and phosphorus levels are displayed in Table (2). Seasonal differences on hematological indices and plasma Ca and P levels were highly significant (P<0.001). Desert goat PCV% were highest during winter and lowest during summer, with rainy season recording relatively similar (P>0.05) values to those of summer. Goats had the highest (P<0.001) Hb% during summer compared with rainy and winter seasons. Goat average Hb% during summer and rainy seasons were not different (P>0.05). Goat plasma Ca and P concentrations were significantly (P<0.001) affected by season. The highest plasma Ca levels during summer, followed by rainy season and lowest levels were during winter. Goat plasma P concentrations followed an opposite picture being highest (P<0.01) during winter season and lowest (P<0.01) during rainy and summers seasons, with no differences (P>0.05) between summer and rainy seasons (Table2). Housing condition exerted no main effect (P>0.05) on any of the hematological indices or plasma Ca and P concentrations. Nonetheless, goats under shade had comparatively higher PCV% and slightly lower Hb% in comparison with those under direct sunlight. Plasma Ca and P concentrations were slightly for goats under shade compared with those under direct sunlight. Interaction effects among the three factors studied (season, housing condition and watering regime) were not significant (P>0.05).

Factor (season)	PCV%	Hemoglobin Hb%	Ca (mg/100ml)	P (mg/100ml)
Summer	31.7a	95.8a	14.9a	9.9a
Rainy	32.1a	54.5b	13.4b	9.3a
Winter	52.5b	58.0b	8.6c	10.6b
SE±	2.07***	4.173 ***	0 .230***	0.26***
Housing Conditions:				
Shade	39.0	68.4	12.4	10.0
Sunlight	38.5	70.5	12.2	9.9
SE±	1.687 NS	3.410 NS	0.185 NS	0.2135 NS
Watering Regime:				
Every day	37.8	65.8	12.2	9.6
After day	39.7	73.1	12.3	10.3
SE±	1.69 NS	3.409 NS	0.185 NS	0.2135*
HC × WR	38.9	69.4	12.2	10.0
SE±	2.389NS	4.980 NS	0.261 NS	0.302 NS
HC × S	40.0	65.7	13.0	10.0
SE±	2.949NS	5.900 NS	0.324 NS	0.370 NS
WR × S	40.0	70.1	12.6	9.9
SE±	2.998 NS	5.899 NS	0.338 NS	0.369NS
HC × WR × S	39.5	69.2	13.0	10.4

SE±	4.329^{NS}	8.329 ^{NS}	0.466 ^{NS}	0.549 ^{NS}

^{a,b,c,} Means in the same column under the same factor with the different superscripts are significantly different (NS, Not Significant P>0.05, * Significant P<0.05, ** Highly Significant P<0.0

Effects of Season, Housing Condition and Watering Regimen on Blood Metabolites:

Table (3) depicts the main effects of season, housing condition and watering regimen on blood metabolites of Sudan Desert goats. Seasonal main effects on blood metabolites were highly significant (P<0.01). The highest (P<0.001) goat blood protein was during summer season, followed by rainy season and the lowest (P<0.001) was during winter. Goat blood albumen levels were highest (P<0.001) for rainy season and lowest (P<0.001) for winter season whereas blood glucose levels were highest (P<0.01) during winter season and lowest (P<0.01) during the rainy season., .Housing condition exerted no effect (P>0.05) on any of the three blood metabolites parameters studied. However, blood protein, blood albumin and blood glucose levels were relatively higher (P>0.05) for goats under shade compared with those under direct sunlight .Watering regimen had no effect (P>0.05) on goat blood protein, goat blood albumen or goat blood glucose. Nonetheless, goats' watered everyday had slightly lower blood protein and albumin and slightly higher blood glucose in comparison with goats watered every other day . No significant interaction effects (P>0.05) were revealed among the three factors studied.

Correlations among the Different Parameters

Table (4) displays simple correlation coefficients among the different parameters studied. Ambient temperature simple correlation coefficients blood albumin contents (r=0.69), but negatively correlated with blood glucose (r=-0.69) and PCV (r=-0.64). Relative humidity (RH) simple correlation coefficients with PCV (r=0.75) were highly positive (P<0.01). Blood glucose was negatively correlated (P<0.05) with blood protein (r=-0.66), blood albumin (r=-0.93), and ambient temperature (r=-0.69), but was positively correlated (P<0.01) with plasma phosphorus level (r=0.92). However, plasma P and Ca levels simple correlation coefficients with PCV, Hb, feed intake, water consumption, RR, RT, ambient temperature were not significant (P>0.05).

Table 3. Main effects of season, Housing Condition and watering regime on Serum Metabolites of Desert goat

Factor	Protein mg/100ml	Albumin mg/100ml	Glucose/ ml
Season:			
Summer	59.0a	31.2a	139.7a
Rainy	36.3b	40.5b	101.8b
Winter	30.3c	28.5c	200.9c
SE±	1.298***	0.591***	3.635**
Housing Conditions:			
Shade	42.5	33.8	170.0
Sunlight	41.2	32.9	124.9
SE±	1.062 ^{NS}	0.483 ^{NS}	29.748 ^{NS}
Watering Regime:			
Every day	41.5	33.2	170.9
After day	42.2	33.6	124.0
SE±	1.059 ^{NS}	0.482 ^{NS}	29.476 ^{NS}
Interaction:			
HC × WR	40.6	33.1	137.9
SE±	1.498^{NS}	0.685^{NS}	43.192^{NS}
HC × S	41.8	33.0	180.1
SE±	1.101^{NS}	0.682^{S}	51.690^{NS}
WR × S	41.09	33.98	141.2
SE±	1.828^{NS}	0 .849^{NS}	52.690^{NS}
HC × WR × S	42.3	34.0	155.6
SE±	2.613^{NS}	1.211^{NS}	70.556^{NS}

^{abc}, Means in the same column under the same factor with different superscripts are significantly different according to DMRT (^{NS}, Not Significant P>0.05,* Significant P<0.05, * ** Highly Significant P<0.01)

Table 4. Simple correlation coefficients among the different parameters

Parameter	Albumin	CP	P	Ca	PCV	Hb
Glucose	-.93**	-.66*	.69*	-.33ns	.27ns	-.36ns
Albumin		.48ns	-.47ns	.17ns	-.33ns	.27ns
CP			.92**	.09ns	-.24ns	.61ns
P				-.39ns	.20ns	-.62ns
Ca					-.06ns	.43ns
PCV						-.74*
Hb						

ns Not significant (P>0.05), * Significant (P<0.05), ** highly significant (P<0.01).

DISCUSSION

Effects of Housing Condition and Watering Regimen on Hematological Indices. PCV was affected either by housing condition or watering regime. This was in disagreement with the findings of some workers reported that Yankasa sheep (Aganga *et al.*, 1989 and Igbokwe, 1993; MacFarlane *et al.*, 1961), Awassi sheep (Jaber *et al.*, 2004; Laden *et al.*, 1987) and goats (Hassan, 1989; El-Nouty *et al.*, 1990; subjected to water restriction had increased PCV%. Nonetheless, the results of this study were supported by Ajibola (2000) who found no significant variation in PCV values of goats restricted to 50% and 30% of their free choice water intake but seasonal variations were different (P<0.01).The same results were obtained for Hb, with no main effects of housing condition and watering regimen but significant seasonal effects. This result was in line with Prakash and Rathore,(1991) working on goats, and Assane and Sere (1990), Salem *et al.,* (1991) and Okab *et al.,* (1993) working on sheep who found relatively high mean PCV values under restricted watering regimen. Lower PCV and Hb values during summer season could be ascribed to the lower nutritional value of grazing resources during the dry period of the year (Degen and Kam, 1992). Plasma Calcium and Phosphorus levels were not affected (P>0.05) by both housing condition and watering regime. This was in accord with the findings of Patel *et al.,* (1991) who reported that the Inorganic phosphorus level was not affected by exposure to direct sunlight from 8.30. (32.3°C) for 3 consecutive days in Patanwadi sheep but significantly affected by season. Baumgartner and Parnthaner (1994) noted that the inorganic phosphorus level was significantly lower during summer than in winter, in Karakul sheep, whereas in this study plasma P level was highest during winter and plasma Ca was highest during winter. On the contrary, More *et al.,* (1980) reported phosphorus level in Rambouillet, Chokla Malpura and Rambouillet x Malpura ram plasma to increase during hot conditions while Kumagai *et al.,* (1990) found that plasma Calcium concentration of goats on grasses was higher during wet season. Seasonal, Housing Condition and Watering Regimen effects on Blood Metabolites. Blood metabolites are affected by seasonal variations (Salem *et al.*, 1998). Serum total protein was lowest in winter and highest in summer, whereas serum albumin was highest during the

rainy season and lowest during the winter season. This was in disagreement with Kamal *et al.,* (1962) who report that serum total protein levels were lower in summer than in winter in Karakul sheep that serum total protein levels were higher in hot summer than in winter in Chios lambs. B. However, the results were supported by Miguel *et al.,.* (2016) who found that blood glucose level was not affected by either housing condition or watering regimen. Salama and Gerardo (2021) stated that blood glucose was not affected by exposure to direct sunlight from 8.30 (32.3oC) to 14.30 h (37.7oC) for three consecutive days during the last week of May and watering regime but showed high significance on seasonal differences. Blood glucose levels were highest during summer and lower during the rainy season, contrasting the findings of Webster (1976) and Marai *et al.,* (1992) who found that mature Ossimi ewes blood glucose levels were higher during summer than winter. Seasonal effects are substantiated by the significant negative correlation coefficients between ambient temperatures with blood metabolites.

CONCLUSION

Seasonality effects are reflected on goat's general performance and condition in terms of blood metabolites levels and blood minerals concentration.

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Attributes are paid to Late Dr El Shafei I M. May her soul rest in peace

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