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PHYSIOLOGICAL RESPONSES OF BARKI SHEEP TO WATER RESTRICTION UNDER DESERT CONDITIONS

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ABSTRACT

Two trials (winter and summer) were conducted to determine certain physiological effects of water restriction on Barki sheep (to 50 or 25% of their requirements). The traits concerned were, live body weight (LBW), thermoregulatory, hematological and biochemical responses. The study was carried out at Maryout Research Station of the Desert Research Center, 35 km southwest of Alexandria, Egypt. A total number of 27 Barki rams aged 12-18 months were used in this study: **(1)** 92-d trial, on 15 rams (averaged 40.87 ± 1.341Kg) during winter and **(2)** 77-d trial, on 12 rams (averaged 36.65±1.440 Kg) during summer.

Rectal temperature (RT, °C) and respiration rate (RR, rpm) behaved similar trends as they decreased significantly ($p<0.01$) as water restriction proceeded. Water restricted animals revealed significant reduction ($P<0.01$) in live body weight during both two seasons.

Hemoglobin concentration (Hb,g/dl); hematocrit (Ht,%) and erythrocyte (RBC's) count showed similar trends in which they increased significantly ($p<0.01$) as water stress proceeded while, leukocyte (WBC's) count remained constant by water restriction in both seasons.

Water stress caused significant increases ($P<0.01$) in blood total proteins (TP) concentration during both seasons. This increase was attributed to the increase in globulin (G) concentration ($P<0.01$) in winter and to the increase in albumin (A) concentration ($P<0.01$) in summer. Plasma cholesterol (CHO), creatinine (CRE) and alanine aminotransferase (ALT) activity were fluctuated among treated groups in both seasons. Plasma aspartate aminotransferase (AST) increased ($P<0.01$) in treated groups compared to the control in both seasons.

Keywords: Sheep, water restriction, thermoregulation, blood parameters

INTRODUCTION

Water is the largest component of the animal body and one of the primal components of the animal diet. Restriction in water availability may result in poor animal nutrition, though a small degree of restriction does not appear to be harmful in practice (Hadjigeorgios *et al.*, 2000). No apparent differences between breeds of sheep and goats were recorded in the inability to withstand water deprivation, restoration of body weight loss or physiological parameters (Mohammed Alamer, 2005 and 2006).

Water scarcity is often encountered by small ruminants in different seasons, (Mohammed Alamer, 2005 and 2006) and during walking stress especially to seeking the watering points particularly in desert areas (Badawy *et al.*, 2003). This expenditure of energy would be avoided and also an economy in water use obtained. Several studies have documented the capability of sheep and goats for tolerating lack or deficiency of water and their physiological adaptations to survive and maintain their body functions, especially during the hot summer months (Ahmed Muna and El Shafei, 2001;

Ahmed Muna and El Kheir, 2004 and Teixeira *et al.*, 2006). Thus, the present study was planned to estimate certain physiological adjustments in response to partial water restriction (50 or 25%) on Barki sheep and the length of period required to recover their various physiological changes after free re-watering during winter and summer seasons under desert conditions.

MATERIALS AND METHODS

Site and animal management:

The present study was carried out at Maryout Research Station of the Desert Research Center, 35 km to southwest of Alexandria, Egypt. A total number of twenty-seven Barki rams aged 12-18 months were used. Animals were housed in shaded pens. They were fed berseem hay (*ad lib.*) and concentrate supplement according to their body weight requirements (Morrison, 1959).

Experimental Design and Treatments:

The study included of two seasonal experiments as follows:

Experiment 1:

A 92-day trial during winter season was carried out on 15 rams. The trial included two periods: 90-d of water restriction followed by 2 days as a recovery period.

Experiment 2:

A 77-day trial during summer was carried out on 12 rams. The trial included two periods: 75-d of water restriction followed by 2 days as a recovery period.

In both seasons, animals were divided randomly into three equal groups. (I) Control group (C) was received free water requirement (previously determined at 3 liter/head/day). (II) Treated group (T1) was restricted to receive only 1.5 liter/head/day (50% of control group). (III) Treated group (T2) was restricted to receive only 0.750 liter/head/day (25% of control group).

Recovery period:

To estimate how long time spent for of water-stressed groups to return to their normal physiological measures after rewatering; two blood samples were taken for two consecutive days (sample every day). Body weight and the thermoregulatory measurements were also measured.

Measurements and Recordings:

Climatic conditions:

Indoor climatic data (ambient temperature, AT^{0}C and relative humidity, RH %) were recorded at thermo-respiratory measurements Mean values of AT (^{0}C) and RH (%) are shown in Table 1.

Table (1): Mean values of indoor climatic data during winter and summer seasons

Season	Ambient temperature (AT, °C)	Relative humidity (RH, %)
Winter	18.5±1.17	75±2.83
Summer	32.0±1.61	60±3.74
Change	**+13.5**	**-15**

Thermo-respiratory measurements

Rectal temperature (RT, °C) was measured using a clinical thermometer for one minute; respiration rate (RR, rpm) was measured by counting flank movements for one minute.

Hematological and biochemical measurements

Before offering feed and water, blood samples were collected via jugular vein puncture in 10ml test tubes containing lithium heparin as anticoagulant: nine samples in winter season (7 biweekly samples during the period of water restriction; 2 daily samples during a recovery period). In summer, eight samples were collected (6 biweekly samples during the period of water restriction; 2 daily samples during a recovery period). Part of the whole blood sample was intended for determination of the hematological measurements. Hemoglobin concentration (g/dl), Hematocrit value (%), the erythrocyte (RBC's, X 10^6 cells/mm^3) and leukocyte (WBC's, X 10^3 cells/mm^3) counts were estimated using standard procedures according to Cheryl,A *et al* ,(1992).The hematimetric indices were calculated according to the following formulate., mean corpuscular volume (MCV,fl = hematocrit X 10/RBC's); mean corpuscular hemoglobin (MCH, pg/cell = hemoglobin X 10/RBC's) and mean corpuscular hemoglobin concentration (MCHC, g/dl = hemoglobin X 100/hematocrit).

The largest portion of the blood samples (approximately 7ml) was centrifuged at 3500 rpm for 20 minutes, the obtained plasma was collected into glass vials and frozen at -20^{0}C then intended to estimate plasma biochemical analysis. Total plasma proteins, (TP, g/dl), albumin (A, g/dl), Plasma urea nitrogen, (PUN, mg/dl), plasma creatinine, (CRE, mg/dl), Plasma alanine aminotransferase (ALT, u/l), plasma aspartate aminotransferase (AST, u/l) activities and total plasma cholesterol levels (CHO, mg/dl) were determined using available commercial kits supplied by bioMe'ricux- Diagnostics France. Total plasma globulins concentration (G, g/dl) was calculated as the difference between total plasma proteins and plasma albumin, and then albumin/ globulin ratio (A/G, %) was calculated.

Statistical analysis

Data were analyzed as split plot repeated measurements using SAS (1998). The statistical model included Treatment (T), Period (P), Season (S) and their one-way interactions. Differences among means were examined using Multiple Range Test according to Duncan, (1955).

RESULTS AND DISCUSSION

1. Rectal temperature and respiration rate responses

Table 2 shows the mean values ± SE of rectal temperature (RT, °C) and respiration rate (RR, rpm) in Barki rams as affected by water restriction during winter and summer seasons. Regardless of treatment, the present data indicated that the difference between maximum and minimum values of RT were (0.4 *vs.* 1.42 °C) in winter and summer, respectively while, the corresponding values of RR were (14.1 *vs.* 16.5 rpm). These results show that, the maximum seasonal shift in both RT and RR was wider during summer than winter and those animals were capable to maintain their RT and RR within normal ranges during both seasons.

Regarding the effect of treatment, RT and RR declined significantly ($p<0.01$) as water restriction proceeded. In other words, the reduction values in RT due to water stress were -0.82 and -0.62% of initial values for T1 and T2, respectively, in winter. The corresponding values in summer were -0.88 and -1.75%. From these data, 50% (T1) restricted water caused decline in RT during winter and summer with approximately the same extent of decrease (-0.825 *vs.* -0.88%) while, 25% (T2) restricted water declined RT by about two times in summer than in winter (-0.62 *vs.* -1.75%). Moreover, The results in Table 2 showed that, the treated animals (T1 and T2) exhibited significant lower mean rectal temperature than control animals (38.64 and 38.60 *vs.* 38.82°C) in winter but similar mean values in summer. Khalil, *et al.* (1990) suggested that the lowering in RT of water-deprived sheep was accompanied by reduction in feed consumption. Bianca *et al.*, 1965 reported that, during 4 days of dehydration (at 15°C) significant decreases occurred in heat production and respiratory ventilation of steers. Also, Schmidt *et al.* (1980) stated that, at 2 and 4 days, steers restricted animals displayed both lowered rectal temperatures and respiratory rates than control animals.

Thus, the present results are in correspondence that the observed decrease in RT and RR is an indication of the depression in heat production. It's also in agreement with those reported by Hamed (2007) on Barki sheep and Baladi goats.

Concerning the mean reductions in RR were -37.63 and -29.94% of initial values for T1 and T2 groups, respectively due to water stress in winter, while the corresponding values in summer were -20.19 and -22.06%. Similar results on sheep obtained by Hamed (2007), Khalil (1990) and Khalil, *et al.* (1990). Also water restriction to 50% or 25% decreased RR value compared to the control either in summer (29.8 and 28.2 *vs.* 35.95 rpm) or in winter (45.08 and 41.33 *vs.* 53.08 rpm). This decline may be due to the ability of treated animals to reduce frequency of respiration breaths in order to control the water loss by panting by modifying the sensitivity to panting center in the body in particular under hot weather.

Table (2): Means ± SE of rectal temperature (RT, °C) and respiration rate (RR, rpm) of Barki rams as affected by water restriction during winter and summer seasons under desert conditions

Item	Winter			Summer			Overall			Period mean	(±) SE
	C	T1	T2	C	T1	T2	C	T1	T2		
RT (°C):											
Initial	38.78	38.88	38.76	38.55	39.77	39.97	38.66	39.32	39.36	**39.11^{b}**	
Final	38.92	38.56	38.52	39.67	39.42	39.27	39.29	38.99	38.89	**39.06^{a}**	0.02
Rehydrati	38.8	38.85	38.8	39.66	39.46	39.37	39.23	39.15	39.08	**39.16^{a}**	
Group mean	**38.82^{a}**	**38.64^{b}**	**38.6^{b}**	**39.6^{a}**	**39.59^{a}**	**39.61^{a}**	**39.06**	**39.15**	**39.11**		0.097
Season mean		**38.76^{b}**			**39.57^{a}**						**0.11**
RR (rpm):											
Initial	34	37.2	33.4	51.5	50.5	48.5	42.75	43.85	40.95	**42.52^{b}**	
Final	36	23.2	23.4	54.3	40.3	37.8	45.15	31.75	30.6	**35.83^{a}**	0.59
Rehydrati	37.3	33.6	33.7	51.62	48.5	44	44.46	41.05	38.85	**41.45^{a}**	
Group mean	**35.9^{a}**	**29.8^{b}**	**28.2^{c}**	**53.1^{a}**	**45.08^{b}**	**41.33^{c}**	**44.12**	**38.88**	**36.8**		1.83
Season mean		**31.32^{b}**			**46.49^{a}**						**2.07**

C= Control group (received 3L/head/day); T1= 50% water restriction (received 1.5L/head/day) T2= 25% water restriction (received 0.75L/head/day).

Hematological responses:

Table 3 shows the mean values ± SE of blood hemoglobin (Hb), haematocrit (Ht), erythrocyte (RBC's) and leukocyte counts (WBC's) of Barki rams as affected by water restriction during winter and summer seasons. Water restricted groups (50 and 25% of water needs) showed slight differences in their blood concentrations of hemoglobin, hematocrit and erythrocyte counts with highly ($p<0.01$) significant effects between the two seasons in these parameters (Table 3). The mean values of Hb and Ht concentrations in winter were (9.06 and 34.7%) the corresponding values in summer were (7.78g/dl and 29.23 %). The erythrocyte count recorded 9.92 and 7.79 X 10^6 cells/mm^3 for winter and summer respectively.

Regarding the effect of treatment, blood Hb concentration increased in summer by +10.61 and +18.75% for T1 and T2 groups, respectively. The corresponding vlues during winter were +4.71 and +5.33%. The higher increase of Hb concentration for 25% water-restricted group in summer is considered as index of good adaptability of Barki sheep to a hot environment. This result is in agreement with those reported by Pandy and Roy (1969). The present result revealed that the process of hemodilution or hemoconcentration are apparently dependent on percentage and duration of water restriction. According to Graf, (1984) and Li, *et al.*, (2000). The percent of changes in Ht during summer were +17.87 and +24.53% for T1 and T2 groups, respectively at the end of watering treatments period. The corresponding values during winter were +11.58 and +8.87% for T1 and T2 groups, respectively. This result revealed that, the response to water stress was more pronounced during summer ($p<0.01$) than winter. El-Hadi (1986) and (Màrtine, *et al*, 2001) obtained similar results.

Water restriction induced significant ($p<0.01$) elevations in Ht values, which were progressively increased with extend of water stress. This result was in accordance with those of Khalil, *et al.*, (1990), Mohammed Alamer, (2006) and Hamed (2007). Water restricted groups (to 50 and 25%) increased ($p<0.01$) their RBC's count with extending the lengthening in period of treatments. The changes as compared with the initial values recorded +7.63 and +8.92% for T1 and T2 respectively during winter. The corresponding values in summer were +18.52 and 12.43% for T1 and T2, respectively. Thus, the increases of Hb ,Ht and RBC's observed on animals subjected to water restriction, may be due to haemoconcentration (Hassan,1989; Badawy. *et al*, 1999 and El-Lamei 2003).

The mean values of WBC's was higher ($P<0.01$) in winter than in summer (11.52 vs. 10.58 X 10^3 cells/mm^3). Regarding the effect of treatment, statistical analysis showed that insignificant effect on leukocyte count. Concerning the effect of period, the number of WBC's remained constant with the lengthening the period of watering treatments in both seasons. yet there was insignificant differences between groups for treatment, period and their interaction. This result agrees with that of Gottardor, *et al*, (2002) who reported that, the number of WBC's was not affected by the absence of drinking water.

Table (3): Means ± S.E of blood hemoglobin (Hb), haematocrit (Ht), erythrocyte (RBC's) and leukocyte counts (WBC's) of Barki rams as affected by water restriction during winter and summer seasons under desert conditions

Item	Winter			Summer			Overall			Period mean	(±) SE
	C	T1	T2	C	T1	T2	C	T1	T2		
Hb, g/dl:											
Initial	8.8	8.92	9.0	7.70	7.35	7.20	8.25	8.13	8.1	8.20^{b}	
Final	8.84	9.34	9.48	7.70	8.13	8.55	8.27	8.73	9.01	8.70^{a}	0.05
Group mean	8.82^{b}	9.13^{b}	9.24^{a}	7.7^{a}	7.74^{a}	7.9^{a}	8.26	8.43	8.55		0.09
Season mean		**9.06^{a}**			**7.78^{b}**						**0.17**
Ht, %:											
Initial	32.6	32.8	33.8	29.3	26.3	26.5	30.95	29.55	30.15	**30.22^{b}**	
Final	33.4	36.6	36.8	29.5	31.0	33.0	31.45	33.8	34.9	**33.40^{a}**	0.29
Group mean	**33.0^{b}**	**35.0^{a}**	**36.0^{a}**	**29.4^{b}**	**28.6^{a}**	**29.7^{b}**	**31.2**	**31.7**	**32.5**		0.04
Season mean		**34.7^{a}**			**29.23^{b}**						**0.74**
RBC's (X 10^{6} cells/mm^{3}):											
Initial	9.81	9.57	9.64	7.54	7.02	7.48	8.70	8.30	8.56	**8.51^{b}**	
Final	9.91	10.3	10.5	7.98	8.32	8.41	8.94	9.31	9.45	**9.24^{a}**	0.06
Group mean	**9.8^{b}**	**9.9^{b}**	**10.07^{a}**	**7.76^{a}**	**7.67^{a}**	**7.94^{a}**	**8.82**	**8.80**	**9.0**		0.16
Season mean		**9.92^{a}**			**7.79^{b}**						**0.29**
WBC's, (X 10^{3} cells/mm^{3}):											
Initial	11.53	11.88	11.5	9.56	9.29	9.41	10.54	10.60	10.45	**10.53^{a}**	
Final	11.38	11.45	11.42	9.55	9.70	9.98	10.50	10.60	10.70	**10.58^{a}**	0.01
Group mean	**11.45^{a}**	**11.66^{a}**	**11.46^{a}**	**9.55^{a}**	**9.49^{a}**	**9.69^{a}**	**10.52**	**10.6**	**10.57**		0.14
Season mean		**11.52^{a}**			**9.57^{b}**						**0.26**

C=Control group (received 3L/head/day); T1= 50% water restriction (received 1.5L/head/day); T2= 25% water restriction (received 0.75L/head/day)

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Hemogram Indices:

For the hematimetric indices, Table 4 shows the means ± S.E of MCV; MCH and MCHC of Barki rams as affected by water restriction during winter and summer seasons. The results revealed that, MCV and MCH values were higher ($p<0.01$) in summer than in winter ones (37.66 *vs.* 34.47fl) for MCV and (10.04 *vs.* 9.06 pg/cell) for MCH. Regarding the effect of treatment, the values obtained for MCH and MCHC indicated that, little or no change occurred by the watering treatments within the same season.

The results indicated that there was inverse relationship between MCV and RBC's. Similar result is in accordance with Victor.,*et al.*(1999). The reduction in MCV with elevation in RBC's count may reflect the ability of these animals to compensate for red cells shrinkage by increasing these cells number to achieve a Ht value higher than that of the control group because of the hemoconcentration that accompanied the loss of water due to water restriction (Badawy. *et al*, 2003).

Plasma metabolites profile:

Plasma Proteins, (TP,g/dl), Albumin,(A,g/dl),Globulin,(G,g/dl) and A/G ratio.

The results presented in Table 5 revealed that, water stress (to 50 or 25%) increased ($P<0.01$) TP concentration in both two seasons. Similar results were reported by Hassan (1989) due to water deprivation, these increases were more pronounced in Anglo-Nubian than Baladi and crossbred goats. Also, water deprivation induced significant ($P<0.01$) elevation in TP during different seasons in two local sheep breed in Saudi Arabia (Mohammed Alamer, 2005) and in Barki sheep (Hamed 2007).

The change in TP concentrations of treated groups were 4.9 and 6.8% for T1 and T2, respectively in winter. The corresponding values in summer were 1.6 and 7.6%. This result indicated that, 25% water restriction recorded the highest change percent in both two seasons. This increase in TP was due to the obvious increase ($P<0.01$) in (G) concentration in winter and the increase ($P<0.01$) of (A) in summer.

The resultant increase ($P<0.01$) in A/G ratio probably makes it possible to maintain the high colloid osmotic pressure needed for holding more water in blood. Rewatering to treated rams did not affect TP concentration while, both (A) and (G) were significantly affected during the two seasons.

Plasma urea nitrogen (PUN, mg/dl):

The results in Table 6 indicated that, The change in PUN concentration of treated groups were +8.33 and +9.13% for T1 and T2, respectively in winter. The corresponding values in summer were +60.64 and +46.18%. Season had significant ($P<0.01$) effect on PUN, average summer values was higher than winter one (38.21 *vs.* 35.09 mg/dl). The increase in PUN has also been reported in sheep and goats during water deprivation under hot weather (Abdelatif and Ahmed, 1994, Ahmed and Abdelatif, 1995 and Martine *et al,* 2001). This may be related to a decline in urinary total N and urea output which results in an increase in N retention (More, 1982, Mousa *et al.*, 1983, Brosh *et al.*, 1987).

Table (4): Means ± S.E of the hematimetric indices (MCV; MCH and MCHC) of Barki rams as affected by water restriction during winter and summer seasons under desert conditions

Item	Winter			Summer			Overall			Period mean	(±) SE
	C	T1	T2	C	T1	T2	C	T1	T2		
MCV[1] (fl):											
Initial	33.26	34.24	35.1	39.07	37.87	35.71	36.16	36.05	35.04	**35.87^{b}**	
Final	33.68	35.39	35.21	36.98	37.25	39.25	35.33	36.32	37.23	**36.29^{a}**	0.14
Group mean	**33.47^{b}**	**34.81^{a}**	**35.15^{a}**	**38.02^{b}**	**37.56^{a}**	**37.48^{a}**	**35.74**	**36.18**	**36.13**		0.10
Season mean		**34.47^{b}**			**37.66^{a}**						**0.43**
MCH[2] (pg/ cell):											
Initial	8.98	9.31	9.10	10.3	10.6	9.73	9.64	9.95	9.41	**9.67^{a}**	
Final	8.92	9.03	9.07	9.65	9.77	10.2	9.28	9.4	9.63	**9.44^{a}**	0.05
Group mean	**8.95^{a}**	**9.17^{a}**	**9.08^{a}**	**9.97^{a}**	**10.18^{a}**	**9.96^{a}**	**9.46**	**9.67**	**9.52**		0.07
Season mean		**9.06^{b}**			**10.04^{a}**						**0.13**
MCHC[3] (%):											
Initial	27.08	27.23	26.69	26.43	28.09	27.18	26.75	27.66	26.93	**27.12^{b}**	
Final	26.52	25.23	25.77	26.12	26.23	25.92	26.32	25.73	25.84	**25.96^{a}**	0.09
Group mean	**26.8^{a}**	**26.23^{a}**	**26.23^{a}**	**26.27^{a}**	**27.16^{a}**	**26.55^{a}**	**26.53**	**26.69**	**26.38**		0.02
Season mean		**26.42^{a}**			**26.66^{a}**						**0.32**

C= Control group (received 3L/head/day); T1= 50% water restriction (received 1.5L/head/day); T2= 25% water restriction (received 0.75L/head/day)
1= Mean Corpuscular Volume; 2 = Mean Corpuscular Hemoglobin; 3 = Mean Corpuscular Hemoglobin Concentration.

Table (5): Means ±SE of total proteins (TP, g/dl); albumin (A, g/dl), globulin (G, g/dl) and A/G ratio in Barki Rams as affected by water restriction during winter and summer seasons under desert conditions

Item	Winter			Summer			Overall			Period mean	(±) SE
	C	T1	T2	C	T1	T2	C	T1	T2		
TP (g/dl):											
Initial	7.48	7.56	7.20	6.90	7.10	6.95	7.19	7.33	7.07	**7.20^{b}**	
Final	7.44	8.12	8.36	7.55	7.25	8.10	7.49	7.68	8.23	**7.80^{a}**	0.04
Rehydration	7.18	7.48	7.12	7.03	7.05	7.61	7.10	7.26	7.36	**7.24**	
Group mean	**7.36^{a}**	**7.72^{b}**	**7.56^{b}**	**7.16^{a}**	**7.13^{a}**	**7.55^{b}**	**7.26**	**7.42**	**7.55**		0.02
Season mean		**7.55^{a}**			**7.28^{b}**						**0.04**
A (g/dl):											
Initial	2.35	2.34	2.37	2.35	2.69	2.82	2.35	2.51	2.59	**2.49^{b}**	
Final	2.58	2.83	3.25	2.29	2.96	2.77	2.43	2.89	3.01	**2.78^{a}**	0.03
Rehydration	2.34	2.33	2.34	2.71	2.31	2.34	2.52	2.32	2.34	**2.39**	
Group mean	**2.42^{a}**	**2.5^{a}**	**2.65^{a}**	**2.45^{a}**	**2.65^{b}**	**2.64^{c}**	**2.43**	**2.57**	**2.65**		0.01
Season mean		**(1.797^{b})**			**(2.58^{a})**						**(0.11)**
G (g/dl):											
Initial	5.13	5.21	4.83	4.55	4.41	4.13	4.84	4.81	4.48	**4.71^{b}**	
Final	4.85	4.65	5.11	5.26	4.29	5.33	5.05	4.47	5.22	**4.91^{a}**	0.03
Rehydration	4.73	4.97	4.68	4.32	4.20	4.76	4.52	4.58	4.72	**4.61**	
Group mean	**4.90^{a}**	**4.94^{a}**	**4.87^{a}**	**4.71^{a}**	**4.30^{b}**	**4.74^{a}**	**4.80**	**4.52**	**4.81**		0.02
Season mean		**(4.90^{a})**			**(4.58^{b})**						**(0.04)**
A/G (%):											
Initial	0.459	0.459	0.499	0.517	0.612	0.684	0.488	0.535	0.591	**0.538^{b}**	
Final	0.545	0.613	0.641	0.451	0.705	0.541	0.498	0.659	0.591	**0.583^{a}**	0.01
Rehydration	0.50	0.47	0.50	0.63	0.52	0.47	0.565	0.495	0.485	**0.515**	
Group mean	**0.515^{a}**	**0.514^{a}**	**0.546^{a}**	**0.533^{b}**	**0.612^{a}**	**0.565^{a}**	**0.517**	**0.563**	**0.555**		0.003
Season mean		**(0.525^{b})**			**(0.57^{a})**						**(0.01)**

C= Control group (received 3L/head/day); T1= 50% water restriction (received 1.5L/head/day T2= 25% water restriction (received 0.75L/head/day).

Table (6): Means ±S.E of plasma urea nitrogen (PUN) and creatinine (CRE) concentrations in Barki rams as affected by water restriction during winter and summer seasons under desert conditions

Item	Winter			Summer			Overall			Period mean	(±)SE
	C	T1	T2	C	T1	T2	C	T1	T2		
PUN (mg/dl):											
Initial	36.05	34.32	31.99	32.08	32.09	33.65	34.06	33.20	32.82	**33.36[b]**	
Final	38.30	37.18	34.91	44.51	51.55	49.19	41.40	44.36	42.05	**44.44[a]**	0.51
Rehydration	34.48	33.82	34.77	33.73	33.71	33.37	34.10	33.76	34.07	**33.98**	
Group mean	**36.28[a]**	**35.11[a]**	**33.89[b]**	**36.77[a]**	**39.12[b]**	**38.74[b]**	**36.52**	**37.11**	**36.31**		0.05
Season mean		**35.09[b]**			**38.21[a]**						**0.42**
CRE. (mg/dl):											
Initial	0.959	0.975	0.931	0.975	1.05	1.09	0.967	1.01	1.01	**0.99[a]**	
Final	0.947	0.942	1.04	1.30	1.29	0.921	1.12	1.12	0.985	**1.07[ab]**	0.01
Rehydration	0.94	0.94	0.91	1.02	0.98	0.99	0.98	0.96	0.95	**0.96**	
Group mean	**0.95[a]**	**0.95[a]**	**0.96[b]**	**1.09[a]**	**1.11[c]**	**1.00[b]**	**1.02**	**1.06**	**0.982**		0.004
Season mean		**0.95[b]**			**1.07[a]**						**0.02**

C= Control group (received 3L/head/day); T1= 50% water restriction (received 1.5L/head/day; T2= 25% water restriction (received 0.75L/head/day).

The decline in the rate of urea excretion was associated with water restriction (Mousa *et al.*, 1983) and is expected as a reduction in glomerular filtration rate which is evident during water deprivation (Wittenberg *et al.*, 1986). Similar findings were reported by Choshniak *et al.* (1984) and may be related to a decrease in urea excretion and clearance rate indicating a tendency for urea retention (Laden *et al.*, 1987). On recovery period, this is not surprising as PUN concentration decreased in treated groups compared to control levels at the first blood sample taken in this period. The mean values of PUN concentration from two blood samples were 33.73, 33.71 and 33.37 mg/dl for C, T1 and T2, respectively during summer. The corresponding values in winter were 34.48, 33.82 and 34.77 mg/dl. This result showed that, the animals under study were able to rapid recovery.

Plasma creatinine concentration (CRE, mg/dl):

Data in Table 6 revealed that, T1 in winter and T2 in summer decreased (P<0.01) CRE concentrations, the rate of change was -3.4% and -15.5% for T1 and T2 respectively. On contrast T2 in winter and T1 in summer increased (P<0.01) CRE concentrations. The rate of change was +11.71 and +22.86% for T2 and T1, respectively.

Laden *et al.*, 1987 and Abd El-latif *et al.* (1997) reported a moderate increase (13%) in plasma CRE following 3 days of water restriction in Barki sheep. This increase in plasma CRE may be a consequence of a general reduction in the urinary excretion rate during water deprivation, as reported in sheep (More, 1982). This increase may also be related to change in the the endogenous CRE clearance rate,which was found to be correlated to the glomerular filtration rate in sheep (Nawaz and Shah, 1984). Therefore, the rise in plasma CRE could be related to the maintenance of renal function at a lower level, which consequently reduces the clearance rate of plasma CRE (Mohammed Alamer, 2006).

During recovery period, the mean values of plasma CRE concentration from two blood samples were (0.94, 0.94 and 0.91mg/dl for C, T1 and T2, respectively during winter season. The corresponding values in summer were 1.02, 098 and 0.99mg/dL. These results show that, the animals under study were able to rapid recovery from water stress.

Plasma CHO, (mg/dl), ALT, (u/l) and AST, (u/l) activities:

The results presented in Tables 7 showed that, the 25% water restriction behaved in uniform trends for total CHO, ALT and AST concentrations during winter and summer seasons. These results were in agreement with, Assad, (1997) on Barki sheep and Assad *et al*, (1997) on camels.

By the end of water stress period, plasma CHO, ALT and AST concentrations increased (P<0.01) significantly. The changes from the initial to the final measures in winter versus summer were (+55.47 *vs.* +19.3%) for CHO, (+16.38 *vs.* +15.33%) for ALT and (+18.16 *vs.* +9.94%) for AST. Similarly, the activity of plasma AST increased (P<0.01) significantly in group 50% water restriction during both seasons.

Table (7): Means ±S.E of total cholesterol (CHO); plasma alanine aminotransferase (ALT) and aspartate aminotransferase (AST) concentrations in Barki rams as affected by water restriction during winter and summer seasons under desert conditions

Item	Winter			Summer			Overall			Period mean	(±)SE
	C	T1	T2	C	T1	T2	C	T1	T2		
CHO (mg/dl):											
Initial	66.53	38.34	65.76	72.66	74.75	69.89	69.59	56.54	67.82	**64.65^{a}**	
Final	79.01	87.99	102.24	71.57	69.01	83.38	75.29	78.5	92.81	**82.20^{b}**	1.13
Rehydration	66.16	64.94	66.13	70.85	63.81	68.58	68.50	64.37	67.35	**66.81**	
Group mean	**70.57^{a}**	**63.76^{b}**	**78.04^{c}**	**71.69^{a}**	**69.19^{b}**	**73.95^{b}**	**71.13**	**66.47**	**75.99**		0.53
Season mean		**70.79^{a}**			**71.61^{a}**						**0.11**
ALT (u/l):											
Initial	14.23	14.25	14.10	13.92	13.94	13.76	14.07	14.09	13.93	**14.03^{a}**	
Final	13.25	13.83	16.41	12.88	13.46	15.87	13.06	13.64	16.14	**14.28^{b}**	0.10
Rehydration	14.15	13.97	13.81	13.46	11.95	12.65	13.80	12.96	13.23	**13.33**	
Group mean	**13.88^{a}**	**14.02^{b}**	**14.77^{c}**	**13.42^{a}**	**13.12^{b}**	**14.09^{ab}**	**13.64**	**13.56**	**14.43**		0.05
Season mean		**14.22^{a}**			**13.54^{b}**						**0.09**
AST (u/l):											
Initial	57.50	60.60	57.20	56.71	59.95	56.33	57.10	60.27	56.76	**58.04^{a}**	
Final	60.01	63.05	67.59	59.42	61.95	61.93	59.71	62.32	64.76	**62.32^{b}**	0.39
Rehydration	55.11	55.80	56.97	55.10	53.05	53.86	55.10	54.42	55.41	**54.98**	
Group mean	**57.54^{a}**	**59.82^{a}**	**60.59^{c}**	**57.08^{a}**	**58.32^{b}**	**57.37^{b}**	**57.30**	**59.00**	**58.98**		0.11
Season mean		**59.32^{a}**			**57.59^{b}**						**0.23**

C= Control group (received 3L/head/day); T1= 50% water restriction (received 1.5L/head/day) T2= 25% water restriction (received 0.75L/head/day).

The percent of change in this group was (+4.04 in winter *vs.* +3.34% in summer). Kataria, *et al.* (2002) reported that, dehydrated camels for 24 days in cold and 13 days in hot conditions increased (P<0.05) CHO concentration.

Contrarily 50% water restriction resulted in decline the CHO and ALT, the present data indicated that, ALT concentration declined (P<0.01) significantly in both seasons. The reduction at the end of water stress period were -2.95 and -3.5% in winter and summer, respectively.

Body Weight Changes:

The results as shown in Figures 1and 2 indicate that, water restriction caused highly (p<0.01) significant decrease in live body weight during both winter and summer seasons.

Body weight decreased gradually with advancing the period of watering treatments. Moreover, the extent of body weight loss was differed between treatments and seasons. This result is in agreement with those obtained by (Muna and Ammar, 2001). In winter, on D75 the percent reduction of body weight were -4.29% for T1 *vs.* -6.13% for T2. The corresponding values in summer season at the same time were -3.7% for T1 *vs.* -3.9% for T2. This result revealed that, the more stressed group (T2) has an clear response than T1 in both winter and summer seasons. The reduction in body weight reached to -4.63% for T1 vs. -6.62% for T2 at the end of watering treatments (on D90) during winter season.

Some previous studies indicated that, body weigh loss was associated with water deprivation which could be ascribed to a reduction in feed and water intake together with a loss in total body water. Evidence has indicated that most of body weight losses during dehydration were accounted for body water loss in sheep and goats (El-Hadi, 1986; Degan and Kam, 1992; Parker *et al.*, 2003 and Ellamie, 2003). However, some loss in body solids cannot be ignored, as there was a marked reduction in feed intake during water restriction (Martine *et al*, 2001 and Mohammed Alamer, 2006).

The treated groups restored their body weight condition at the end of recovery period to 40.800 and 40.570kg for 50 and 25%-restricted water in winter season, respectively. The corresponding values in summer were 37.02 and 35.312 Kg. The rate of change in winter recorded +4.35% for T1 vs. +6.48% for T2, respectively. The corresponding values in summer were +3.46 vs. +3.312%. The recovery of body weight during winter were 93.95 and 97.88% for T1 and T2, respectively. The corresponding values in summer were 94.02 and 83.01%.

Fig (1) Live body weight changes as affected by water restriction and rehydration during winter season

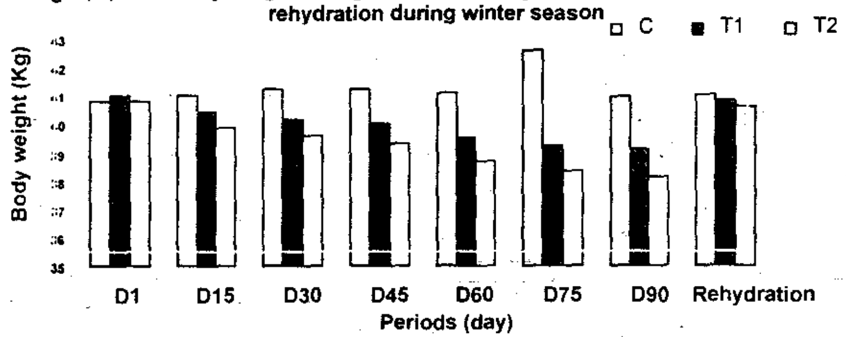
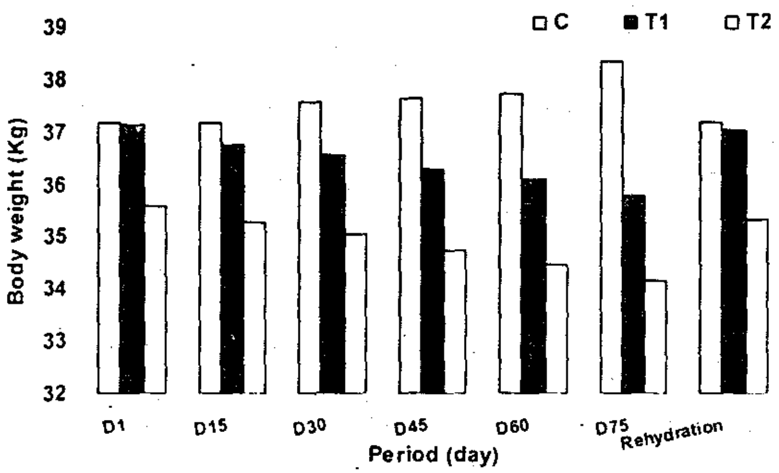


Fig.(2) Live body weight changes as affected by water restriction and rehydration during summer season



CONCLUSION

Water restriction in Barki rams (to 25% of the normal requirements) for 75 and 90 days during summer and winter season respectively caused significant increase in RT,RR,Ht, RBC's,TP and AST. The response to 25% restricted water was more pronounced during summer than winter It can be suggested that the reduction in plasma volume might be greater in summer than in winter season, while 50% water restriction was little effect on most physiological traits during summer or winter season. It can be concluded that, Barki sheep can tolerate well this level (50% water restriction) of water restriction and maintain their body functions in normal and had no adverse effect during summer or winter season.

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الاستجابات الفسيولوجية في الأغنام البرقي لنقص ماء الشرب تحت ظروف المناخ الصحراوي

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أجريت هذه الدراسة بمحطة بحوث مريوط التابعة لمركز بحوث الصحراء بهدف دراسة تأثير نقص ماء الشرب على الاستجابات الفسيولوجية للأغنام البرقي تحت الظروف الصحراوية وذلك على عدد ٢٧ ذكر أغنام برقي ناضج حيث شملت الدراسة تجربتين خلال موسمي الشتاء والصيف. ضمت تجربة الشتاء عدد ١٥ ذكر أغنام برقي ناضج متوسط الوزن ٤٠,٨٧ ± ١,٣٤١ كجم) بينما ضمت تجربة الصيف عدد ١٢ ذكر أغنام برقي ناضج (متوسط الوزن ٣٦,٦٥ ± ١,٤٤٠ كجم) وقسمت الحيوانات في كل موسم إلى ثلاثة مجموعات تجريبية متساوية

المجموعة الأولى: وهي مجموعة الكونترول حيث أعطيت ماء الشرب بحرية وقدر بمعدل (٣لتر/رأس/اليوم).

المجموعة الثانية: وهي مجموعة المعاملة الأولى حيث أعطيت نصف كمية ماء الشرب لمجموعة المقارنة أي (١,٥لتر/رأس/اليوم).

المجموعة الثالثة: وهي مجموعة المعاملة الثانية حيث أعطيت ربع كمية ماء الشرب لمجموعة المقارنة أي (٠,٧٥٠لتر/رأس/اليوم).

وتم قياس صفات التنظيم الحراري وتسجيل التغير في وزن الجسم وأخذت عينات الدم لعمل صورة دم وتقدير بعض القياسات البيوكيميائية في بلازما الدم ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلي:

١- انخفض وزن الجسم معنويا في حيوانات مجموعتي المعاملة وازداد معدل الفقد في الوزن بالتقدم في فترة المعاملة سواء في موسم الشتاء أو الصيف وقد سجلت المعاملة الثانية تأثرا سلبيا على الوزن أكبر عن المعاملة الأولى. بالمقارنة استطاعت حيوانات المعاملة استرداد ما بين ٨٣,٥ : ٩٧,٨٨% من الوزن المفقود وذلك خلال يومين ولكن في فترة الـــشرب الحر (Recovery Period)

٢- انخفضت درجة حرارة المستقيم ومعدل التنفس معنويا في حيوانات المعاملة سواء شتاء او صيفا مقارنة بالمجموعة الكنترول.

٣- سجل كل من تركيز هيموجلوبين الدم ونسبة المكونات الخلوية وكذلك عدد خلايا الدم الحمراء ارتفاعا معنويا في حيوانات مجموعتي المعاملة واتسم هذا الارتفاع بالتناغم مع تقدم فترة المعاملة شتاءا وصيفا والتي سريعا ما تراجعت الى القيم الطبيعية مع أول عينة دم في فترة اعادة الشرب الحر (الــ Post-stress Period).

٤- لم يكن للمعاملة أي تأثير معنوي على عدد خلايا الدم البيضاء بل ظلت ثابتة بالتقدم في فترة المعاملة شتاءا وصيفا إلا أن الموسم كان له تاثير معنوي على قيم هذه الصفة حيث سجلت القيم الأعلى شتاءا.

٥- اكدت النتائج على وجود علاق عكسية بين حجم خلايا الدم الحمراء MCV وعددها (تركيزها لكل مم٣).

٦- تاثرت بروتينات البلازما بالزيادة المعنوية في المعاملتين صيفا وشتاءا وقد يفسر ذلك ارتفاع تركيز الجلوبيولين شتاءا وارتفاع الألبيومين صيفا وقد انعكس ذلك على زيادة نسبة الألبيومين الى الجلوبيولين صيفا

٧- سجلت نسب التغير في قيم الكرياتينين تذبذبا في المعاملتين صيفا بينما لوحظ هذا التذبذب على المعاملة الاولى فقط شتاءا في حين اظهرت المعاملة الثانية شتاء زيادة معنوية وتدريجية بالتقدم في فترة المعاملة.

٨- اظهرت المعاملة الأولى تذبذبا في تركيز الكوليسترول الكلي بالدم حيث ارتفعت قيم الكوليستيرول معنويا شتاء بينما انخفضت معنويا صيفا في حين اتجهت المعاملة الثانية الى الارتفاع المعنوي شتاءا وصيفا.

٩- أظهرت المعاملتين تضادا في نشاط انزيم الكبد الــ ALT (الانين امينو ترانس فيراز) حيث زاد التركيز معنويا على المعاملة الأولى شتاءا وصيفا بينما انخفض التركيز معنويا على المعاملة الثانية شتاءا وصيفا.

١٠- أظهرت المعاملتين زيادة معنوية في كلا الموسمين في نشاط انزيم الكبد الــ AST (اسبارتات امينو ترانس فيراز) وكانت هذه الزيادة تدريجية ومتناغمة مع التقدم في فترة المعاملة.

يتضح من هذه الدراسة أن تعرض كباش الأغنام البرقي لظروف نقص الماء شتاء وصيفا أظهر قدرة هذه الحيوانات على تحمل عبء نقص المياه وعبء الظروف المناخية وخاصة بمنطقة الساحل الشمالي الغربي.