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PHYSIOLOGICAL RESPONSES OF DESERT BARKI SHEEP AND GOATS TO DEHYDRATION AND REHYDRATION UNDER THE ARID CONDITIONS OF NORTH COSTAL ZONE OF EGYPT

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SUMMARY

Ten Barki ewes with average body weight 45.3±3.2 kg, plus ten Barki does averaged 30.9±3.6 kg at non-reproductive status aging 3-5 years were used in the study. They were exposed to water deprivation for 72 hours in Borg-Arab Research Farm located in North Western Coastal Zone (NWCZ) of Egypt, to investigate the physiological response of desert Barki sheep and goats to water deprivation in the arid areas. The most recognizable effects of water deprivation on Barki desert sheep and goats was the sharp decrease in their feed intake and consequently their body weight loss, it was reduced by 14.5 % and 17.5 % for sheep and goats, respectively, after 3 days of water deprivation. Respiration rate, heat production and Total body water decreased significantly ($p<0.01$) with water deprivation in both species. The highest declines were in intracellular and gut fluids, subsequently all serum components increased with advancing in water deprivation in both species. Within three minutes of rehydration, sheep and goats drank 14.4 % and 16.9 % of their body weights respectively which is directly related to the body weight loss due to dehydration. They recovered 97.9% and 96.4% of their body weight after rehydration respectively.

Keywords: Barki Desert sheep and goats, hot arid, dehydration and rehydration

INTRODUCTION

The North Western Coastal Zone (NWCZ) of Egypt is characterized by hot dry Summer and mild Winter with sporadic rain (< 150 mm annually). Animals grazed on communal pasture and depend on watering sites for their water needs. Poor range conditions force them to travel long distances in search of pasture before returning to the watering sites.

Ruminants, in hot arid areas have acquired various adaptation mechanisms to infrequent dranking; they maintain water balance by effective use of available water from dew browsing, food moisture and metabolic water (Kay, 1997). Goats and sheep native to hot dry regions possess similar physiological mechanisms of reduce appetite, rumen motility, saliva secretion, passage rate and metabolic heat production, for maintaining their fluid thermoregulatory homeostasis (Silanikove, 1992).

The aim of the study is to investigate the physiological response of desert Barki sheep and goats to dehydration and rehydration in the arid area of NWCZ of Egypt.

MATERIALS AND METHODS

Ten Barki ewes with average body weight 45.3±3.2 kg, plus ten Barki does averaged 30.9±3.6 kg at non-reproductive status aging 3-5 years were used in the study. They were exposed to water deprivation for 72 hours during May 2010. The experimental work was carried out at Borg-Arab Research Farm, Animal Production Research Institute, located in the hot dry area of NWCZ, (Latitude: 31° 31' 12" N; Longitude: 30° 10' 12" E; Elevation: 54 meters). Animals were housed in semi open pens. The animals were fed Berseem hay (R) and concentrate feed mixture (C) in group feeding (1 kg concentrate + 1 kg hay / head / day), residual if any were weighed to estimate daily feed intake.

Body weights were recorded before treatment and daily for the 3 days of water deprevation. Ambient temperature (AT), black bulb temperature (BbT) and relative humidity (RH) were measured daily throughout the experimental period and temperature-humidity index (THI) was estimated. Values of THI in Table (1) reflected mild heat stress conditions.

Rectal temperatures (RT), skin temperature (ST), ear temperature (ET) were measured at zero time, 24, 48 and 72 hours of treatment. Respiration rate (RR), gas volume (GV) were measured and tidal volume (TV) was estimated as GV/RR. Oxygen consumption (VO2) and carbon dioxide production (VCO2) were measured using the open-circuit technique. Heat production (HP) was estimated as fasting metabolic rate (k cal/$BW^{0.75}$ / day).

Blood samples were collected and hematocrit value (Ht), hemoglobin (Hb), plasma total protein (TP), plasma albumin (Al) and plasma Na+ concentrations were measured and plasma globulin (GL) was calculated.

Body fluids volumes were determined at zero time and at 24, 48 and 72 hours of water deprivation. Total body water (TBW) was determined by urea space. Extra cellular fluid (ECF) was determined by sodium thiocyanate. Plasma volume (PV) was determined by Evan's blue before water deprivation, while at 24, 48 and 72 hours plasma volume was calculated according to Dill and Costill (1974). Interstitial fluid volume (ISF) was obtained by subtracting PV from ECF – volume. Blood volume (BV) was derived from the plasma volume as BV (in ml)= PV/100-(Htx0.94) x 100.

At the end of the 72 hours of water deprivation, water was provided to animals individually and water consumption per minutes was recorded till they stopped drinking. Body weight was recorded directly after drinking, and at three and six hours of rehydration. Blood samples were collected after rehydration for hematocrit and hemoglobin measurement also plasma and blood volume were estimated.

RESULTS AND DISCUSSION

Feed Intake:

The most striking effect of water deprivation on the studied desert Barki sheep and goats was the sharp decrease in their feed intake in the two species (Figure 1). concentrate feed intake decreased from 10 kg in day zero to 1.7 kg in day 3, while roughage intake decreased from 10 kg in day zero to zero intake in day 3. This result may be attributed to roughage digestion need more water than concentrate and the heat increment of roughage is more than concentrate. Silanikove (1992) reported that water scarcity reduce appetite, rumen motility, saliva secretion and passage rate of feed. Reducing feed intake with water deprivation had been reported by many authors, (El-Hadi, 1986) using Sudanese desert sheep and goats, (Alamer and Al-hozab, 2004) in Awassi and Najdi sheep, (Alamer ,2006) in Saudi Arabia indigenous goats and (Abdelatif *et al*., 2010) in Sudanese Nubian goats.

Physiological Parameters:

Water deprivation had no significant effect on some physiological parameters of the studied desert sheep and goats. Rectal temperature, show no effect of water deprivation in both species (Table 2) Skin and ear temperature increased after 72 h. of water deprivation in sheep, but with less effect in goats. Under water deprivation animals seem to decease skin water evaporation resulting in slight increase in skin and ear temperature. Khalifa and Abdel Khalek (2008) reported that RT of crossbred sheep and goats was not affected by dehydration.

Respiration rate decreased significantly in sheep, while the decrease was not statistically significant in goats. This species difference could be attributed mainly to the difference of body weight. Respiration rate and gas volume were decreased by 26.1% and 14.3% respectively while tidal volume increased by 5.2% in sheep. In goats RR, GV and TV were deceased only by (2.7, 2.6 and 0.3% respectively). Khalifa (1999) and Khalifa and Abdel Khalek (2008), reported that percentage of reduction in gas volume was higher in sheep (76.0%) than in goats (26.5 %) due to the increase in tidal volume in goats after water deprivation than sheep . Alamer and Al-hozab, (2004) and Shkolnik and Choshniak, (2006) stated reduction in evaporative water loss during dehydration in hot weather through panting as one of the main water conservation mechanisms**.**

Heat Production:

Heat production decreased significantly with water deprivation in sheep, and goats. Heat production decrease by 34.7 % in sheep vs. 21.5 % in goats (Table 2). The decrease in heat production could be attributed to the sharp decease in feed intake and thereafter decrease in internal heat load and reducing water evaporation through panting. Shkolnik and Choshniak (2006) reported that one of the thermoregulatory mechanism of desert Bedouin goats to water deprivation was to reduce significantly their metabolic heat production by (25%). Khalifa and Abdel Khalek (2008) found that heat production decreased significantly with water deprivation in both sheep and goats, the reduction was more pronounced in sheep than in goats (63.1 and 38.5%, respectively).

Body weight and Fluids:

Water deprivation for 72 hours decreased insignificantly, body weight of both Barki sheep and goats. Sheep lost 14.5 % of their body weight after 72 hours of water deprivation, while goats lost 17.5 % of their body weight mainly due to the decrease in feed intake and total body water (Table 3).

Total body water decreased significantly ($P<0.01$) with the advance of water deprivation in both species. The highest decline was in intracellular and gut fluids (45.3% and 47.1%

for sheep and goats, respectively). The lowest decline was in blood volume (6.8 % and 4.4% for sheep and goats, respectively), the decrease in plasma volume and blood volume were statistically insignificant. These could be attributed to the increase of plasma albumin concentration in both species and increase in blood osmotic pressure and water movement from ISF and ICF to plasma. Siebert and Macfarlane (1975) attributed the tolerance to dehydration in camels to maintain plasma volume through the conservation of albumin and most of water lost from the intercellular fluids compartment. El-Hadi (1986) found that body water loss in Sudanese desert sheep and goats after 3 days of dehydration was mostly from intercellular fluids and gastrointestinal tract especially the rumen.

Blood Parameters:

Water deprivation caused a slight decrease in plasma volume resulting in a variable degree of hemoconcentration in the measured blood parameters with some differences between the two species may be attributed to the difference in their body weight. Khalifa and Abdel Khalek (2008) reported that water deprivation caused insignificant hemoconcentration, the effect was detected in sheep than in goats. On the other hand, Abdelatif *et al*. (2010) found that water deprivation in Nubian goats resulted in significant increase in serum TP, Alb and Ht, but not in serum sodium.

Rehydration

In the first three minutes of rehydration, sheep drank 5.3 litters of water in average, representing 14.4% of their body weight. While, goats drank 3.93 litters in average representing, 16.9 % of their body weight and stopped thereafter. One goat continued to drink up to the fourth minute of rehydration and drank similar amount of water (Figure2). Accordingly, within three minutes of rehydration, sheep and goats, recovered almost their total body weight losses due to dehydration (Figure 3). Brosh *et al.* (1986) found that Black Bedouin goats replenished all their water losses within 1-2 minutes of rehydration, they attributed that to their spacious rumen that could accommodate high amount of water during dehydration. On the other hand Nubian goats regained their body weight losses due to dehydration after four hours of rehydration (Abdelatif *et al*., 2010).

Plasma volume increased gradually after rehydration and recovered completely after six hours in both sheep and goats Hematocrit and hemoglobin concentration decreased gradually with rehydration in both sheep and goats, and return to their initial levels after six hours (Figure 3). Abdelatif *et al.* (2010) found that hematocrit value decreased significantly in Nubian goats after four hours of rehydration and reached their normal level after 2 days.

CONCLUSION

The most recognizable effects of water deprivation on Barki desert sheep and goats were the sharp decrease in their feed intake either from concentrate or roughage and consequently their body weight reduced by 14.5% and 17.5% for sheep and goats respectively after 3 days of water deprivation. Water scarcity reduce appetite, rumen motility, saliva secretion and passage rate consequently heat production decrease and internal heat load was reduce (Silanikov, 1992).

The mostly affected physiological parameter by water deprivation was respiration rate. It was decreased with the advancing of water deprivation in accordance to the decrease in heat production, to decrease water loss from respiratory system. Other physiological parameters were not significantly affected. Reduction in evaporative water loss with dehydration through panting is a mechanism for water conservation under hot weather. Similar thermoregulatory mechanism was found in desert Bedouin goats were reduced their metabolic heat production by 25 % with water deprivation (Shkolnik and Choshniak, 2006).

Total body water decreased significantly ($p<0.00$) with the advance of water deprivation in both species. The highest declines were in intracellular and gut fluids (45.3% and 47.1% for sheep and goats, respectively), subsequently all serum components increased with advancing in water deprivation

Sheep was more affected by water deprivation than goats. Respiration rate, gas volume and heat production decreased by 26.1%, 14.3% and 34.7% respectively, in sheep, while decreased only by 2.7, 2.6 and 21.5% respectively, in goats. Khalifa and Abdel Khalek (2008), reported that the rate of reduction of gas volume was much higher in sheep (76.0%) than in goats (26.5 %) and they attributed this result to body weight difference between the two species.

Hamadeh *et al*. (2006) stated that sheep and goats can survive water scarcity under arid and semiarid conditions. They tolerate dehydration more than any other ruminants except camels. Within three minutes of rehydration, sheep and goats drank 14.4 % and 16.9 % of their body weights respectively witch is directly related to the body weight loss due to dehydration. They recovered 97.9% and 96.4% of their body weight after rehydration respectively.

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Table 1. Meteorological parameters during water deprivation

Parameter	Water deprivation hours				
	0	**24**	**48**	**72**	**Overall**
Ambient temperature, °C	25.4	24.1	24.4	27.1	25.5±0.9
Relative humidity (%)	59.8	59.5	55.0	46.5	55.2±3.1
Black bulb temperature, °C	28.3	28.3	29.5	31.3	29.4±0.7
THI	71.2	69.7	70.5	75.0	71.6±1.2

Table 2. Physiological parameters (Mean±SE) during water deprivation trial in sheep and goats

Parameters	Dehydration hours				
	0	**24**	**48**	**72**	***P***
Sheep					
Rectal temperature,°C (RT)	39.6±0.16	39.5±0.18	39.1±0.08	39.5±0.08	NS
Skin temperature,°C (ST)	35.5±0.86	36.5±0.47	36.4±0.60	37.1±0.66	NS
Ear temperature,°C (ET)	35.1±0.82	36.1±0.63	35.7±0.69	37.5±0.45	NS
Respiration rate (RR) (ramp/min)	46.0±3.98	33.3±3.37	34.3±2.94	34.0±3.54	*
Gas Volume (l/min) (GV)	2.30±0.24	1.87±0.11	2.27±0.21	1.97±0.16	NS
Tidal volume (l/min) (TV)	38.2±2.82	52.3±5.32	59.6±3.96	52.4±3.86	NS
Heat Production (HP) (k cal/$BW^{0.75}$ / day)	25.9.±0.05	19.3 ±0.02	24.6±0.05	16.9±0.03	**
Goats					
Rectal temperature,°C (RT)	39.3±0.11	39.4±0.11	39.1±0.12	39.2±0.11	NS
Skin temperature,°C (ST)	36.9±0.26	36.5±0.55	36.5±0.61	37.1±0.52	NS
Ear temperature,°C (ET)	32.9±1.90	35.4±1.29	36.2±0.93	35.2±1.14	NS
Respiration rate (RR) (ramp/min)	31.2±2.40	32.02±2.31	28.7±1.23	30.3±3.03	NS
Gas Volume (l/min) (GV)	1.93±0.13	2.03±0.20	1.95±0.13	1.88±0.07	NS
Tidal volume (l/min) (TV)	56.8±6.42	57.1±5.28	61.0±4.62	56.6±5.82	NS
Heat Production (HP) (k cal/BW.75)	26.1±.05	19.3±0.03	20.7±0.05	20.5±0.02	*

NS = Non significant * = Significant (p<0.05) ** = Significant (p<0.01)

Table 3. Body weight and body fluids (Mean±SE) during water deprivation period in sheep

Parameters	Dehydration hours				
	0	**24**	**48**	**72**	***P***
Sheep					
Body weight (kg)	42.90± 2.13	40.98±2.17	38.20±2.01	36.70±1.92	NS
TBW (L)	27.52±1.7	21.39±1.15	17.98±1.30	16.64±1.11	**
ICF+GF (L)	17.93±1.03	12.86±0.69	10.52±0.78	9.81±0.65	**
BV (L)	3.52±0.19	3.50±0.19	3.39±0.17	3.28±0.17	NS
PV (L)	2.65±0.13	2.63±0.12	2.50±0.11	2.38±0.11	NS
ECF (L)	9.58±0.76	8.53±0.63	7.46±0.53	6.83±0.48	**
ISF (L)	6.94±0.65	5.90±0.54	4.96±0.48	4.45±0.44	**
Goats					
Body weight (kg)	28.25± 2.42	27.45±2.34	24.88±2.28	23.30±2.07	NS
TBW (L)	18.38±1.94	14.26±1.34	12.10±1.52	10.80±1.27	**
ICF+GF (L)	11.94±1.36	7.79±0.88	6.97±1.01	6.32±0.71	**
BV (L)	2.05±0.20	1.99±0.22	1.96±0.22	1.88±0.21	NS
PV (L)	1.63±0.14	1.57±0.16	1.53±0.15	1.45±0.15	NS
ECF (L)	6.44±0.66	6.08±0.98	4.77±0.65	4.48±0.57	*
ISF (L)	4.81±0.65	4.53±0.86	3.26 ±0.50	3.04±0.44	**

NS = Non significant * = Significant (p<0.05) ** = Significant (p<0.01)

Table 4. Blood parameters (Mean±SE) during water deprivation period in sheep and goats

Parameters	Dehydration hours				
	0	**24**	**48**	**72**	***P***
Sheep					
Ht (%)	26.17±0.83	26.33±0.84	27.67±1.12	29.17±1.33	NS
Hb (g/dl)	8.78±0.28	8.80±0.28	9.24±0.37	9.74±0.44	**
TP (g/dl)	5.04± 0.39	6.16±.0.55	7.19±0.52	8.74±0.31	*
Alb (g/dl)	3.07± 030	3.79±.0.32	4.52±0.34	5.62±0.47	*
Glub (g/dl)	1.97± 0.23	2.37±.0.37	2.67±0.39	3.12±0.35	*
Na (m mol/l)	128.9±9.15	142.4±11.10	159.1±7.86	168.6±7.26	*
Goats					
Ht (%)	21.17±1.25	22.17±1.01	22.67±1.05	24.00±0.86	NS
Hb (g/dl)	7.07±0.42	7.40±0.34	7.57±0.35	8.02±0.29	**
TP (g/dl)	5.33± 0.49	6.70±.0.50	8.14±0.39	8.98±0.35	*
Alb (g/dl)	2.87± 0.19	3.54±.0.35	4.65±0.43	5.62±0.37	*
Glub (g/dl)	2.45± 0.44	3.16±.0.36	3.49±0.40	3.36±0.39	*
Na (m mol/l)	127.3±11.3	141.5±10.33	150.7±9.95	161.8±8.86	*

NS = Non significant * = Significant (p<0.05) ** = Significant (p<0.01)

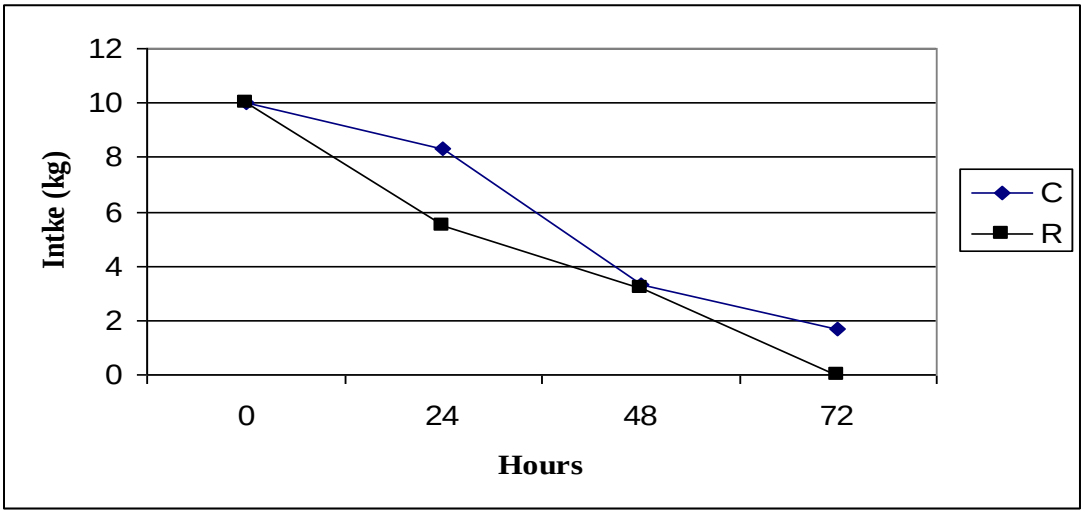

Figure 1. Effect of water deprivation hours on concentrate (C) and roughage (R) intake.

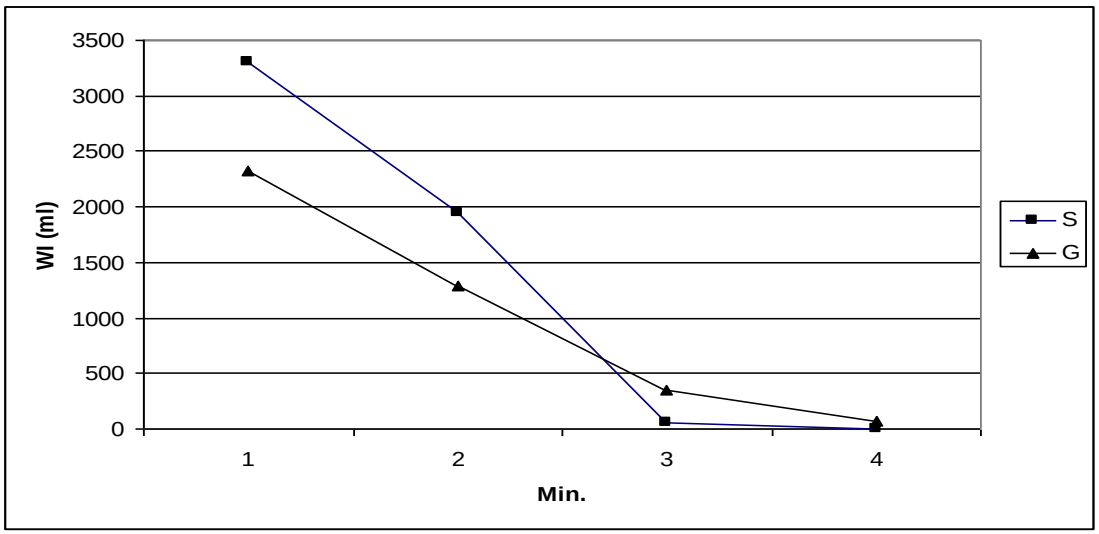

Figure 2. Water intake during first four minutes after rehydration of sheep (S) and goats (G)

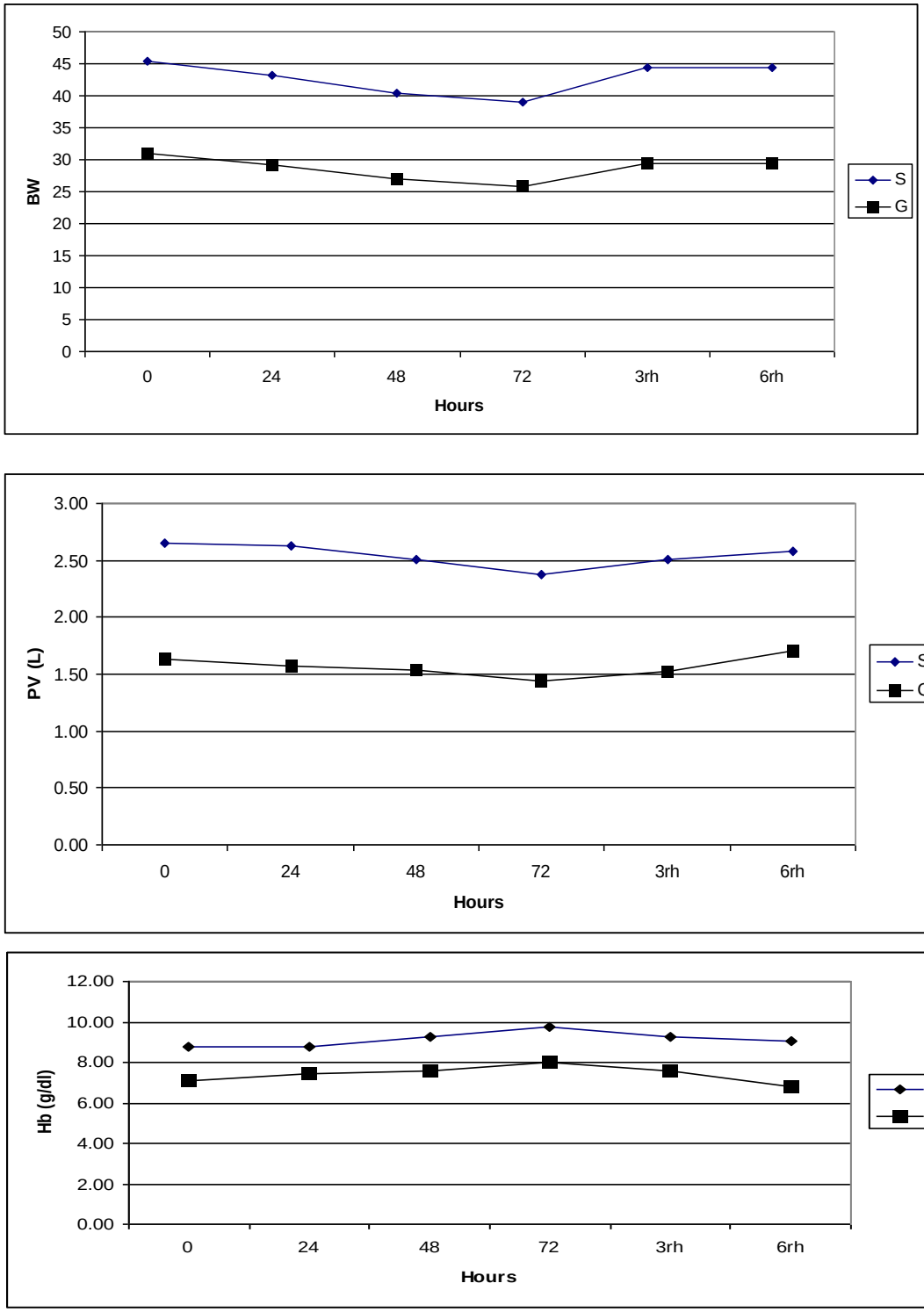

Figure 3. Changes in body weight, plasma volume and hemoglobin during dehydration and rehydration in sheep and goats

الإستجابات الفسيولوجية للأغنام و الماعز البرقي للتعطيش والإرتواء تحت الظروف الجافة للساحل الشمالى الغربي لمصر

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أستخدم فى هذه الدراسة عدد ١٠ نعاج برقى متوسط أوزانهم ٤٥.٣ كجم و عدد ١٠ عنزات برقي متوسط أوزانهم ٣٠.٩ كجم. تم تعريض هذه الحيوانات للتعطيش لمدة ٧٢ ساعة بمحطة بحوث برج العرب بالساحل الشمالي الغربي لمصر لدراسة الإستجابات الفسيولوجية للأغنام و الماعز الصحراوية للتعطيش تحت ظروف البيئة الجافة. و أظهرت النتائج أن الأثر الأكبر للتعطيش هو إنخفاض المأكول من كل من العليقة المركزة و المالئة مما تبعه إنخفاض فى وزن الجسم بنسبة ١٤.٥ ، ١٧.٥ % للأغنام و الماعز على التوالي و إنخفض معنويا كل من معدل التنفس و الإنتاج الحراري الكلي وسوائل الجسم الكلية لكل من الأغنام و الماعز و كان أكبر تناقص فى سوائل الجسم من داخل الخلايا و القناة الهضمية فى حين إرتفعت مكونات البلاما نتيجة التعطيش . فى نهاية مدة التعطيش تم تقديم المياه لكل حيوان على حده و خلال ثلاث دقائق شربت الأغنام ما يعادل ١٤.٤ % من وزنها فى حين شربت الماعز ما يعادل ١٦.٩ % من وزنها، و بناء عليه تم تعويض ٩٧.٩ % و ٩٦.٤ % من النقص فى وزن الحسم نتيجة التعطيش للأغنام و الماعز على التوالي. كما أستعيدت القيم الأصلية لكل من حجم البلازما و الهماتوكريت و الهيموجلوبين قبل التعطيش بعد ٦ ساعات من الشرب.