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The Adaptive Responses to Water Deprivation in Local and Crossbred Sheep

M.H. Khalil, H.H. Khalifa, H.M. El-Gabbas* and M. Sh. Abdel-Fattah

*Anim. Prod. Dept., Fac. of Agric., Al-Azhar Univ., Nasr City and *Anim. Prod. Dept., Desert Res. Inst., Matareya, Cairo, Egypt.*

A TOTAL of 76 ewes obtained from five different breed groups, Ossimi (O), Rahmani (R), 3/4 O + 1/4 Finish Landrace (3/4 O), 3/4 R + 1/4 F (3/4 R) and 3/4 Barki + 1/4 F (3/4 B), were involved in this study. The ewes of each group were divided into two subgroups ; one was given water Ad **libitum** while the other was deprived of water for 7 days in summer and 8 days in winter. Respiration rate (RR), rectal temperature (Tre), skin temperature (Tsk), plasma total protein (TP), albumin (AL), globulin (GL), hemoglobin (Hb) and packed cell volume (PCV) were determined at middays and at midnights, while body weight (BW) was recorded only at middays throughout the experiment.

The water deprived ewes showed higher TP, AL, GL, Hb, PCV% and Tsk and lower RR than the control ewes. As the periods of the deprivation proceeded, TP, AL, GL, Hb, PCV% increased. The loss in BW also increased with reduced rates and such loss was higher in summer. Local breeds showed lower Tre, Tsk, RR, Hb and PCV than that the crossbred, which could indicate the adaptability to the prevailing conditions. It is noticeable that Hb, Tre and RR were higher at middays than at midnights. Both local and crossbred animals can survive and tolerate water deprivation for periods of 7 days in summer and 8 days in winter.

Key words : Sheep, water deprivation, Adaptation.

Most of the Egyptian sheep population are raised under semi-arid conditions in which sheep are usually faced with a long hot and dry summer together with limited amount of water. These constraints affect the productivity as well as the survival of the livestock (Hafez, 1968). However different breeds of sheep are varied in their resistance to these restrictions (Shoukry, 1981). Hence, investigating the response of some local and crossbred sheep to these restrictions would be of great interest.

The present study was initiated to study the response of different physiological and hematological parameters to one of these constraints, dehydration. Water turnover rate is considered to be of great importance to survival. Progressive dehydration leads to death of cattle in 3 to 5 days, sheep in 6 to 7 days and camel in 15 days or more (Hafez, 1968). Under Egyptian prevailing conditions, Khalil *et al.* (1985) found that dehydrated sheep could survive 4 days in summer and 5 days in winter.

Material and Methods

Ewes from 2 local breeds, Ossimi (O) and Rahmani (R) as well as 3 crossbreds having approximately 1/4 Finish Landrace blood (3/4 O, 3/4 R and 3/4 Barki (B)), were included in the present study. Forty two ewes located at Moustord Experiment Station, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt. The number of the ewes provided from these five groups in winter (December) were 12, 10, 6, 8 and 6 from O, R, 3/4 O, 3/4 R and 3/4 B, respectively. Respective numbers in summer (July) were 8, 8, 6, 6 and 6 in the same respective order. The ewes were 2-2.5 years old. To avoid the effect of wool coat on the studied parameters (Khalil, 1980), ewes were shorn 3 months before the experiment. Animals were fed on hay and concentrates according to their body weight requirements (Morrison, 1959).

The ewes of each group were divided randomly into two subgroups; one was given water *Ad libitum* (control) while the other was deprived of water. The experiment was carried out during winter for 192 hr (8 days) and was repeated in summer for 168 hr. (7 days). During these periods all the ewes were kept under shade.

Body weight (BW) was recorded daily at 12.00 midday during the experiment. Respiration rate (RR), rectal temperature (Tre) and skin temperature (Tsk) were taken at 12.00 hr (midday) and 24.00 hr. (midnight) throughout the experiment. At the same time blood samples were collected. Plasma were immediately separated and kept frozen at —20°C for further analysis.

Hemoglobin concentration (Hb) was measured as described by Bauer (1970-a) and packed cell volume (PCV%) by the method of Bauer (1070-b). Total plasma proteins (TP) were determined by Biuret method (Armstrong and Carr, 1964). Albumin (AL) was measured as a result of the reaction with bromocresol green at pH

4.2 (Doumas *et al.*, 1971). Globulin (GL) was calculated by subtraction of AL from TP, and A/G ratio was obtained by calculation.

Rectal temperature and Tsk were measured using a Yellow Spring Telethermometer. Respiration rate was done by counting the flank movement for a minute. The meteorological data were recorded throughout the experiment and showed that ambient temperature (Ta) was higher in summer than in winter (29.5 $\pm$ 1.8°C vs. 15.0 $\pm$ 1.4°C). Soil temperature (Ts) indicated the same trend (31.9 $\pm$ 1.6°C vs. 14.1 $\pm$ 0.8°C). On the other hand, Ta indicated higher values at midday than at midnight in both summer (34.5 $\pm$ 0.5°C vs. 23.4 $\pm$ 0.3°C) and winter (18.8 $\pm$ 0.3°C vs. 10.3 $\pm$ 0.7°C). Soil temperature exhibited the same trend in summer (35.9 $\pm$ 1.7°C vs. 26.9 $\pm$ 0.5°C) and in witer (16.3 $\pm$ 0.2°C vs. 11.4 $\pm$ 0.5°C).

Analysis of variance of multifactor experiments having repeated measures on the same animal calculated in each season according to Winer (1971).

Results and Discussion

Body weight (Fig. 1)

Water deprivation for 8 days in winter caused a significant ($p < 0.01$) decrease in body weight by 33.0%. In summer after 7 days of water deprivation, body weight decreased significantly ($p < 0.01$) by 38.1%. Hafez (1968) ; Khalil (1980) and Khalifa (1982) reported that sheep can survive the loss of 27% to 32% of their body weight during dehydration. In both summer and winter, the loss of body weight was higher in the first two days (11%-13.5%) than that during the subsequent days (2-3%) as an adaptive mechanism to conserve water. Similar trend was observed by Macfarlane *et al.* (1958).

Blood and plasma components (Figs. 2, 3, 4, 5, 6 & 7)

Total protein (TP) increased significantly in summer ($p < 0.01$) and winter ($p < 0.05$) by water deprivation (Fig. 2). The rate of increase, however, was higher in summer than in winter (46.2% vs. 38.9%). This increase in plasma total protein concentration may be due to the reduction in plasma volume (Khalil, 1980). This is supported by the present study in which PCV% also increased. Also,

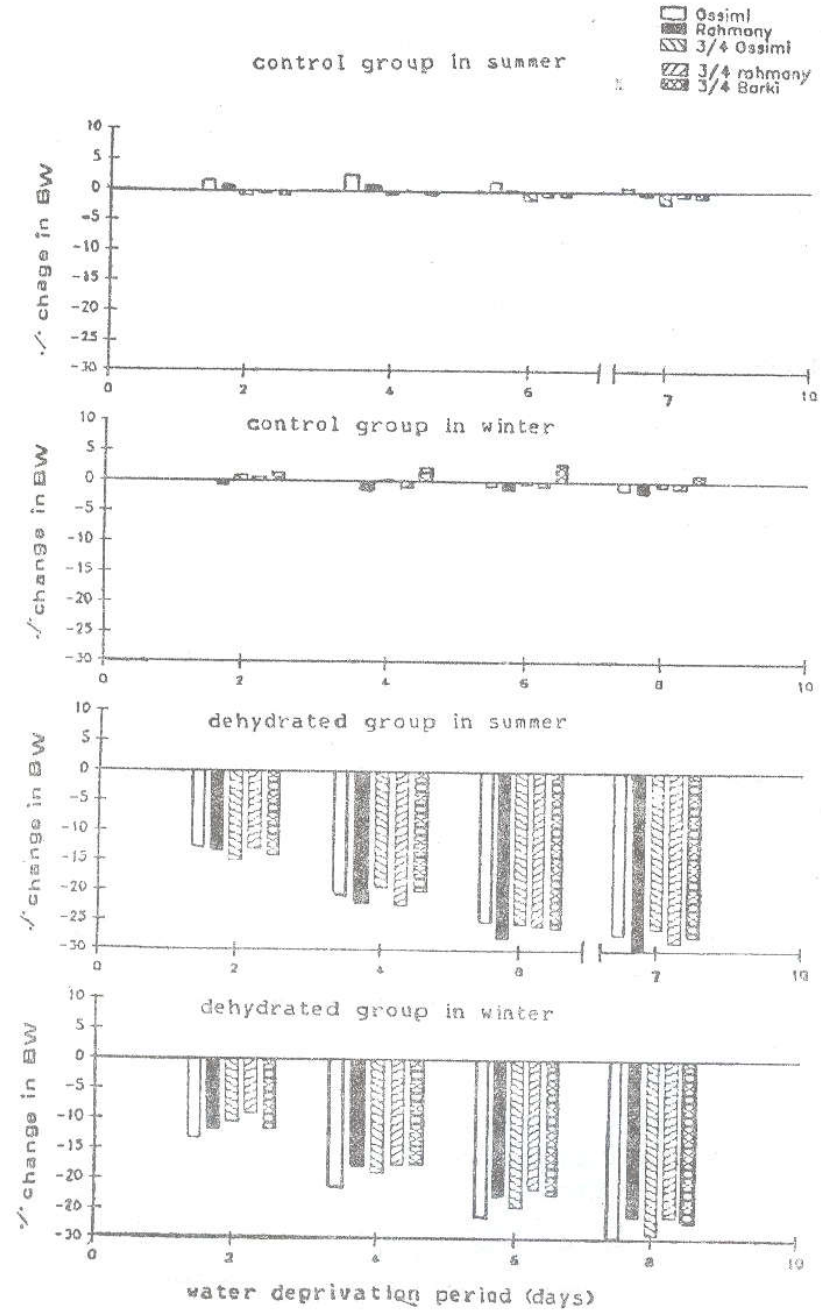

Fig. 1. The percent changes in body weight (BW) during dehydration in summer and winter.

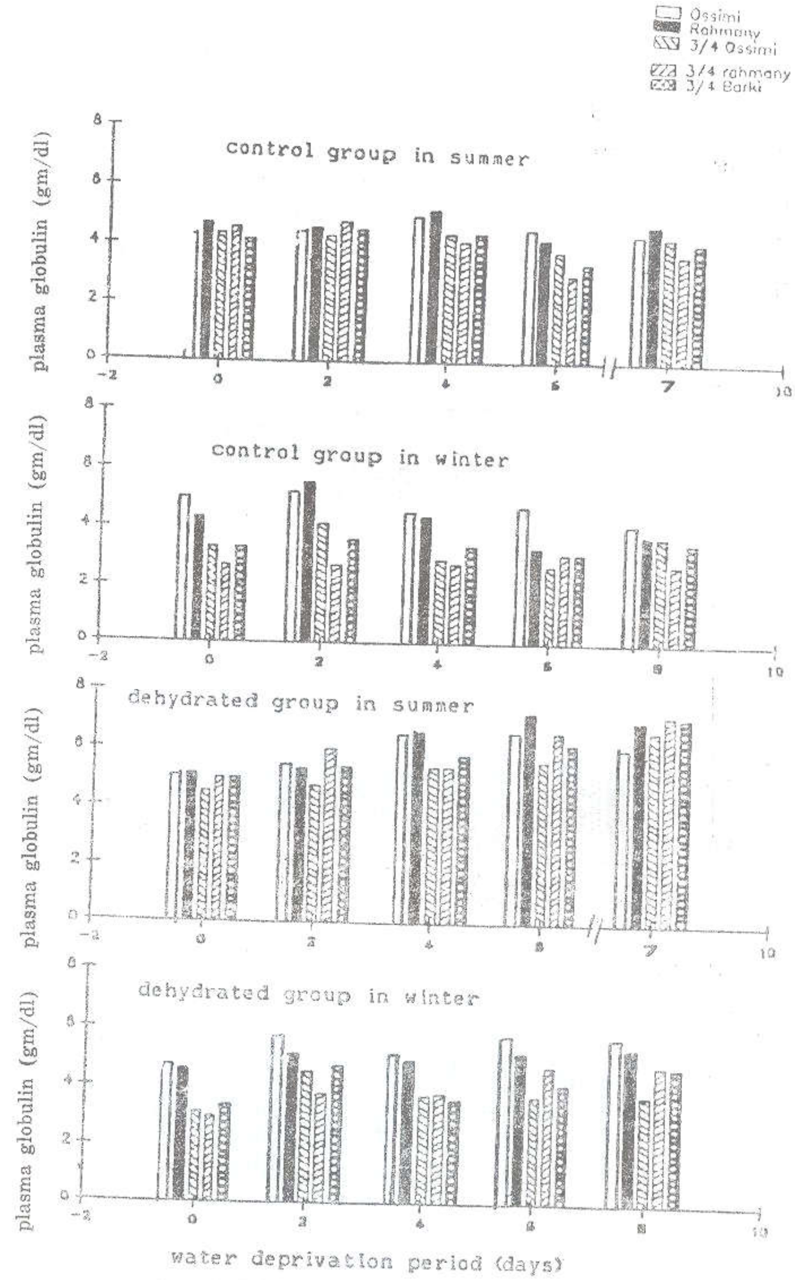

Fig. 2. **Plasma total protein of dehydrated and normal breed groups at different dehydration intervals in summer and winter.**

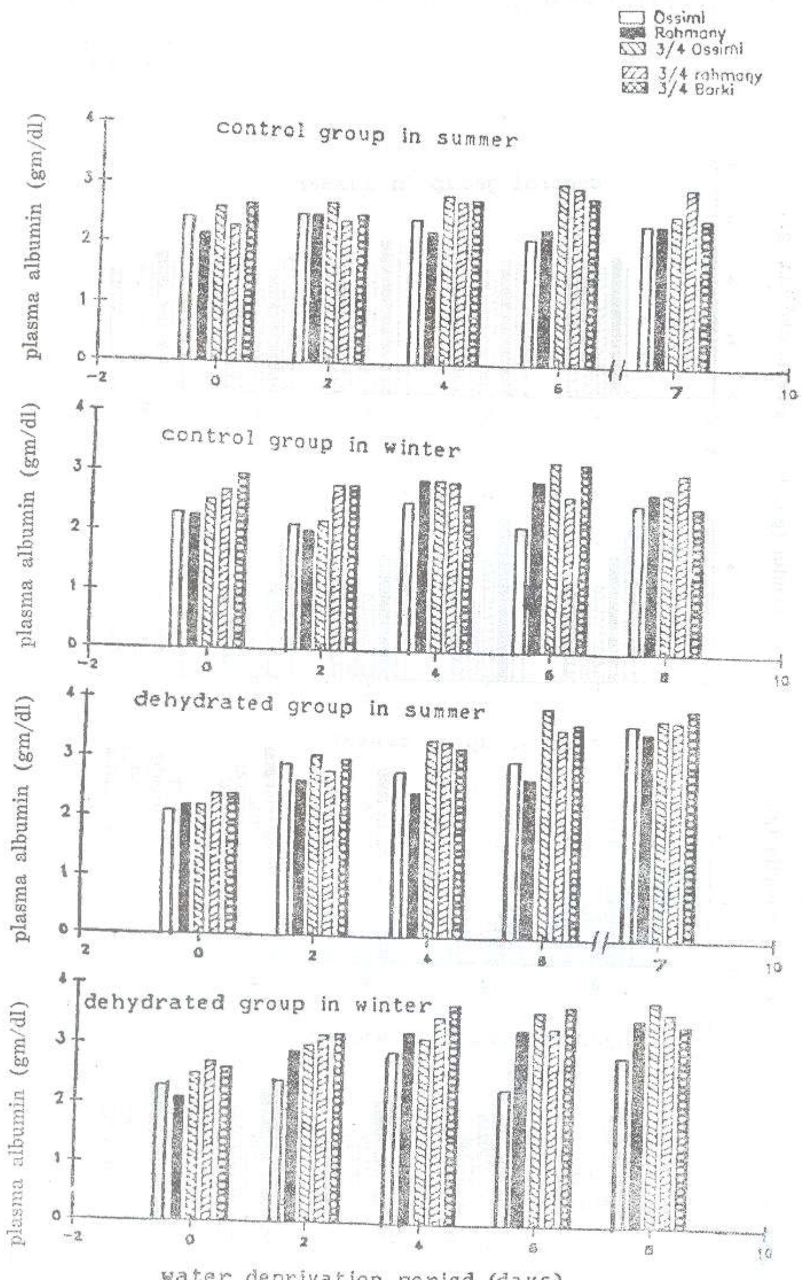

Fig. 3. Plasma albumin (gm/dl) of dehydrated and normal breed groups at different dehydration intervals in summer and winter.

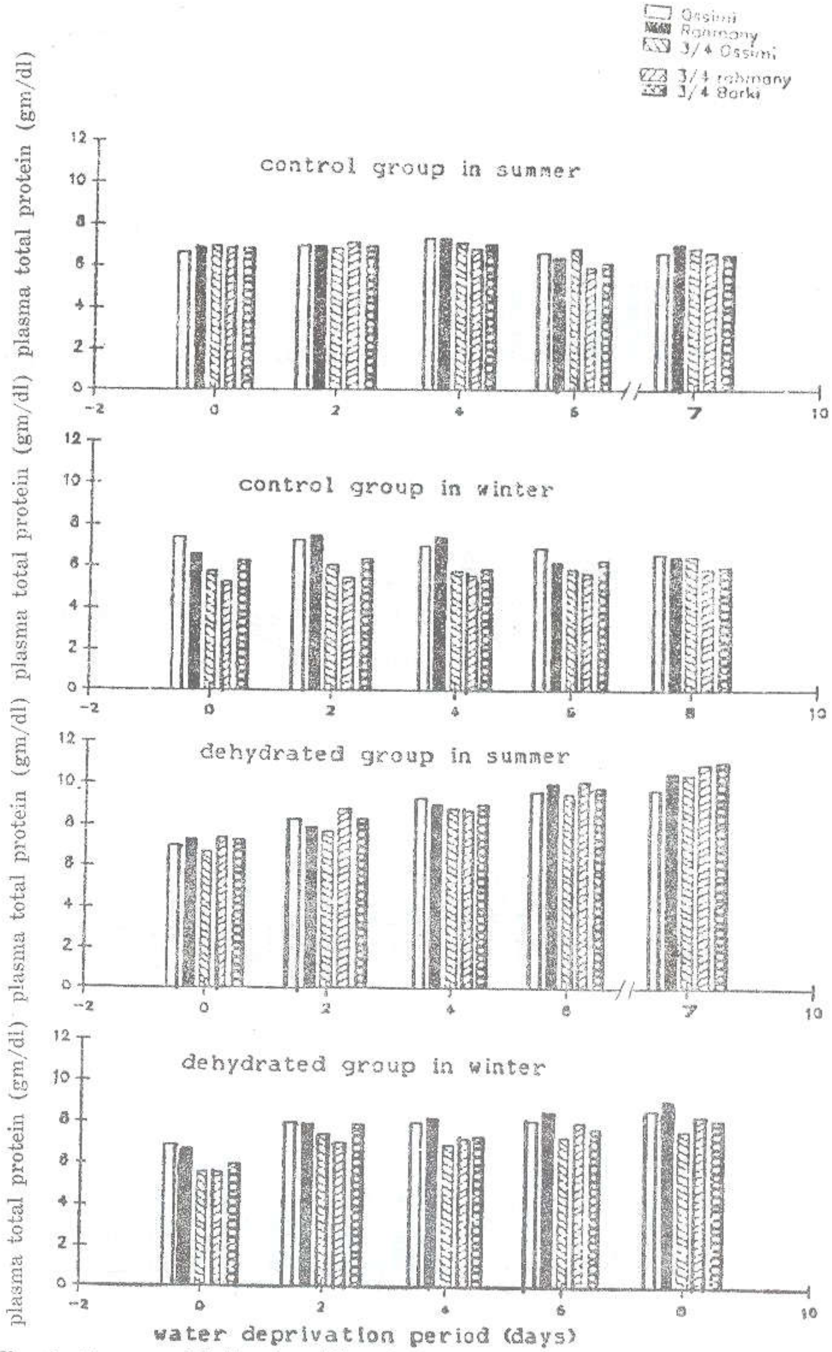

Fig. 4. Plasma globulin (gm/dl) of dehydration intervals in summer and winter.

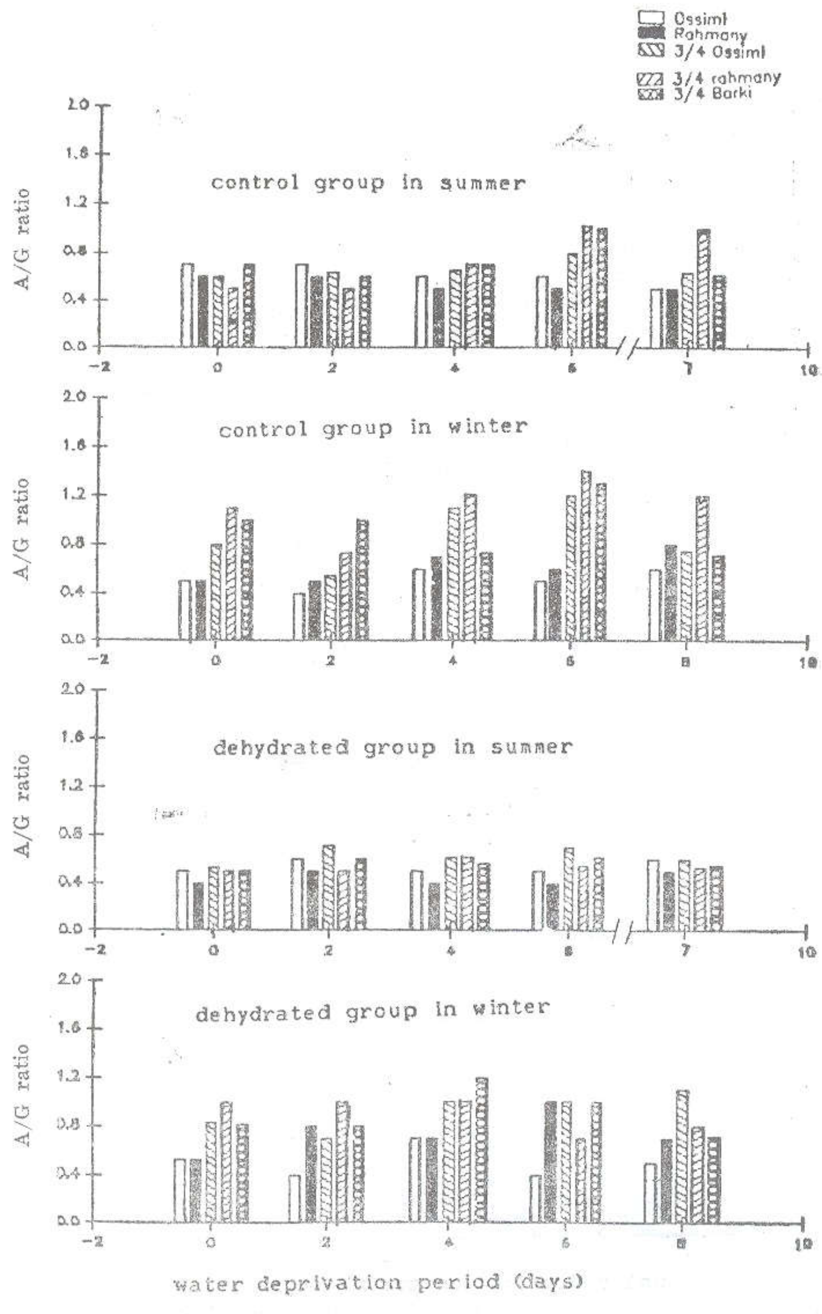

Fig. 5. The ratio between albumin to globulin (A/G ratio) of dehydrated and normal breed groups at difefrent dehydration intervals in summer and winter.

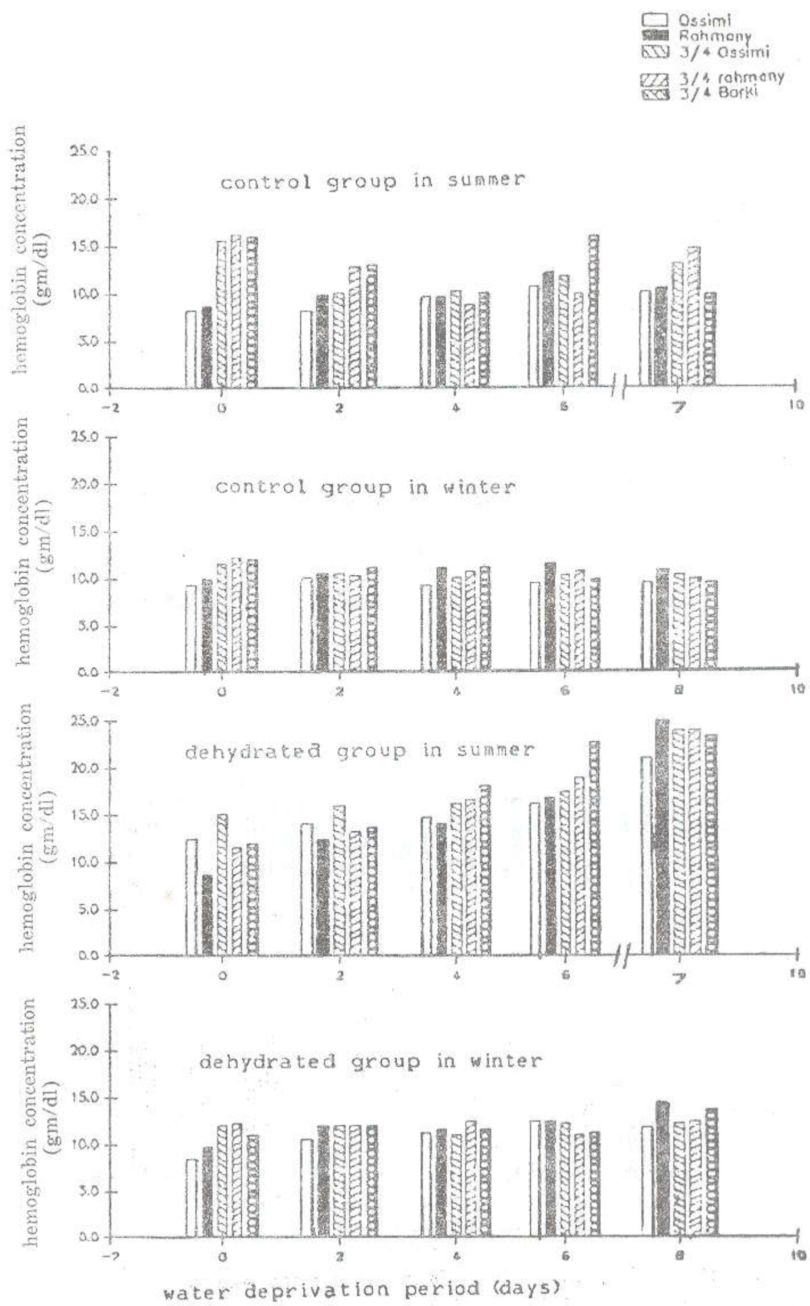

Fig. 6. Hemoglobin concentration (gm/dl) of dehydrated and normal breed groups at different dehydration intervals in summer and winter.

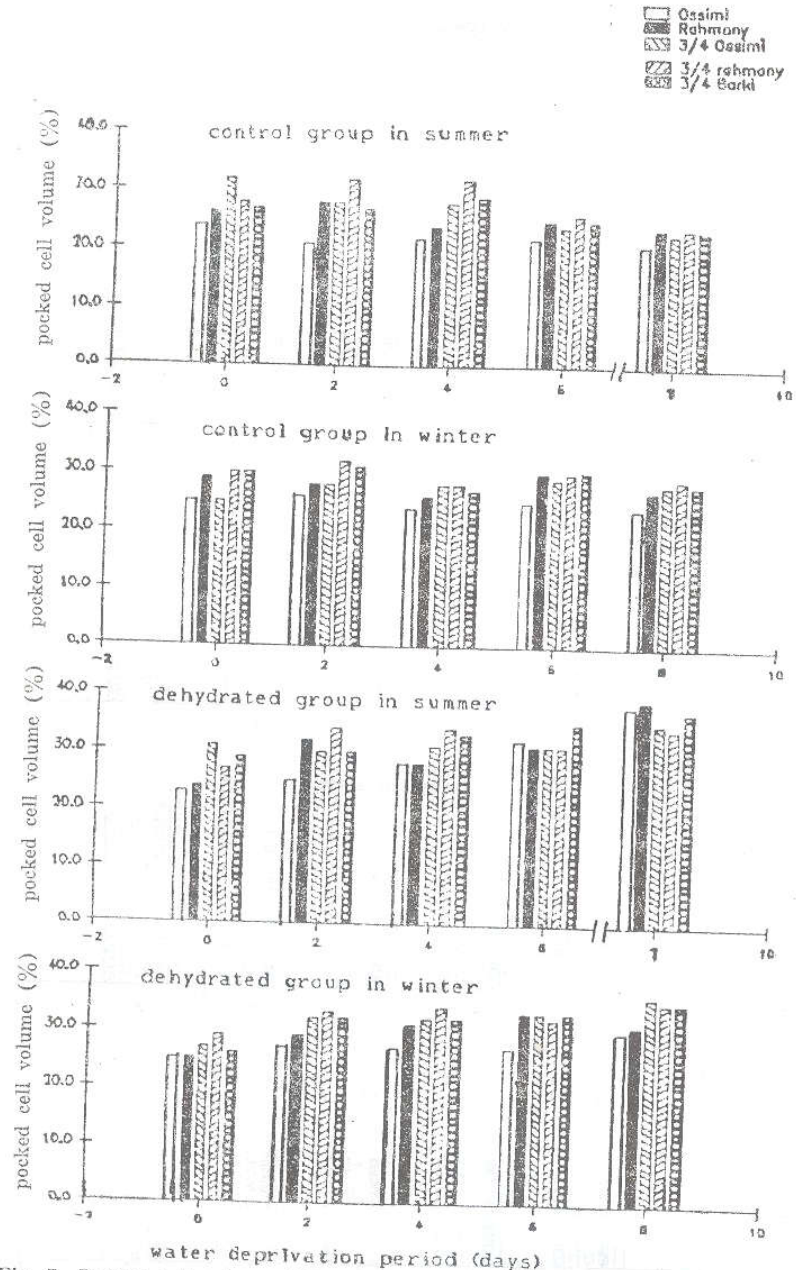

Fig. 7. Packed cell volume (%) of dehydrated and normal breed groups at different dehydration intervals in summer and winter.

albumin and A/G ratio increased by dehydration in both seasons. Albumin increased significantly ($p < 0.05$) by 62.8% and 41.8% in summer and winter, respectively. The corresponding values for GL were 38.6% and 29.8% and for A/G ratio were 12.5% and 5.6% in the same respective order. The increase in TP, AL and GL may be due to the reduction in plasma volume obtained by dehydration (Khalil, 1980 and Khalil *et al.,* 1985). Moreover, dehydration increased AL with higher rates compared with GL that follows by an increase in A/G ratio.

This increase in A/G ratio caused an increase in plasma colloid osmotic pressure which may help the animal to conserve water. The above view had been supported by previous studies on sheep (Khalifa, 1982).

Crossbred sheep, compared with local ones had slightly non-significant higher AL and A/G ratio as well as lower GL and TP. Shoukry (1981) indicated no breed differences in plasma proteins among some local and foreign breeds of sheep (Fig. 2). This may led to suggest that the genetic constitution of the animal may be of minor effect while the environmental factors may play an important role in the expression of these characters.

In summer, TP and GL were significantly ($p < 0.05$) higher than in winter (7.9 ± 0.22 gm/dl vs. 7.0 ± 0.13 gm/dl) and (5.2 ± 0.18 gm/dl vs. 4.1 ± 0.13 gm/dl), respectively. On the contrary, A/G ratio was lower in summer than in winter (0.60 ± 0.02 vs. 0.79 ± 0.03), while AL remained almost constant in both seasons. Ambient temperature could be a reason for higher TP and GL in summer than in winter.

Globulin was reported to be higher in summer (Doxey, 1977). Blood volume as well as plasma TP was found to increase in tropical summer (Bass & Henschel, 1956). This increase in TP during summer could partly attained through the increase in GL concentration as a response to the exposure to heat. This trend might be due to either mobilization of proteins from the lymphatics to the blood circulation or to the activation of the lymphoid tissue to produce antibodies, α-globulin as a suggestion of Bass & Henschel, (1956) and Shoukry, (1981).

During water deprivation period, Hb concentration and PCV% behaved the same trend in which they increased significantly ($p < 0.05$) as water deprivation proceeded (Fig. 6 & 7). Regardless of season, interval and breed group, the overall mean of Hb was 13.8 ± 0.60 gm/dl in the water deprived group while it was 10.3 ± 0.27 gm/dl in the control one. The corresponding values for PCV% were 31.3 ± 0.61% and 27.5 ± 0.42%, respectively.

Towards the end of water deprivation period, water deprivated ewes showed an increase in Hb concentration by 102.6% in summer and 23.3% in winter. Meanwhile, PCV% increased by 38.8% in summer and 26.5% in winter. The increase in Hb concentration and PCV% as water deprivation proceeded confirmed the finding of Khalifa, (1982). This increase in Hb and PCV (Hemoconcentration) is mainly due to loss of water from the plasma and sometimes from the red cells.

Regardless of season, interval and treatment, local breeds had lower Hb concentration of 11.6 ± 0.49 gm/dl vs. 12.5 ± 0.58 gm/dl for the crossbreds. The corresponding values for PCV% were 26.8 ± 0.42% and 30.9 ± 0.51%, respectively. This trend was similar to that of the physiological parameters studied. Low Hb concentration might be related to lower RR (Khalifa, 1982). Since blood Hb is an oxygen carrier, therefore it is expected that crossbreds might need more oxygen *i.e.* more Hb to cope with higher RR compared with local sheep. This might also indicate that the variability of the blood composition could play a basic role in physiological response of sheep to climatic changes.

Temperature pattern & Respiration rate Figs. (8, 9 and 10)

As an overal means, Tre was significantly ($p < 0.05$) higher at middays than at midnights (39.6 ± 0.07°C vs. 39.1 ± 0.08°C). Moreover, deprived group indicated a significant ($p < 0.05$) higher Tre at mid-days (39.8 ± 0.13°C vs. 39.4 ± 0.08°C) and a significant ($p < 0.05$) lower Tre at midnights (38.9 ± 0.11°C vs. 39.3 ± 0.09°C) compared with the controls. The deprived ewes were not capable for increasing heat dissipation during midday hours, thus Tre increased. On the other hand, during midnight hours, they had lower heat production may be due to lower metabolic rate obtained by

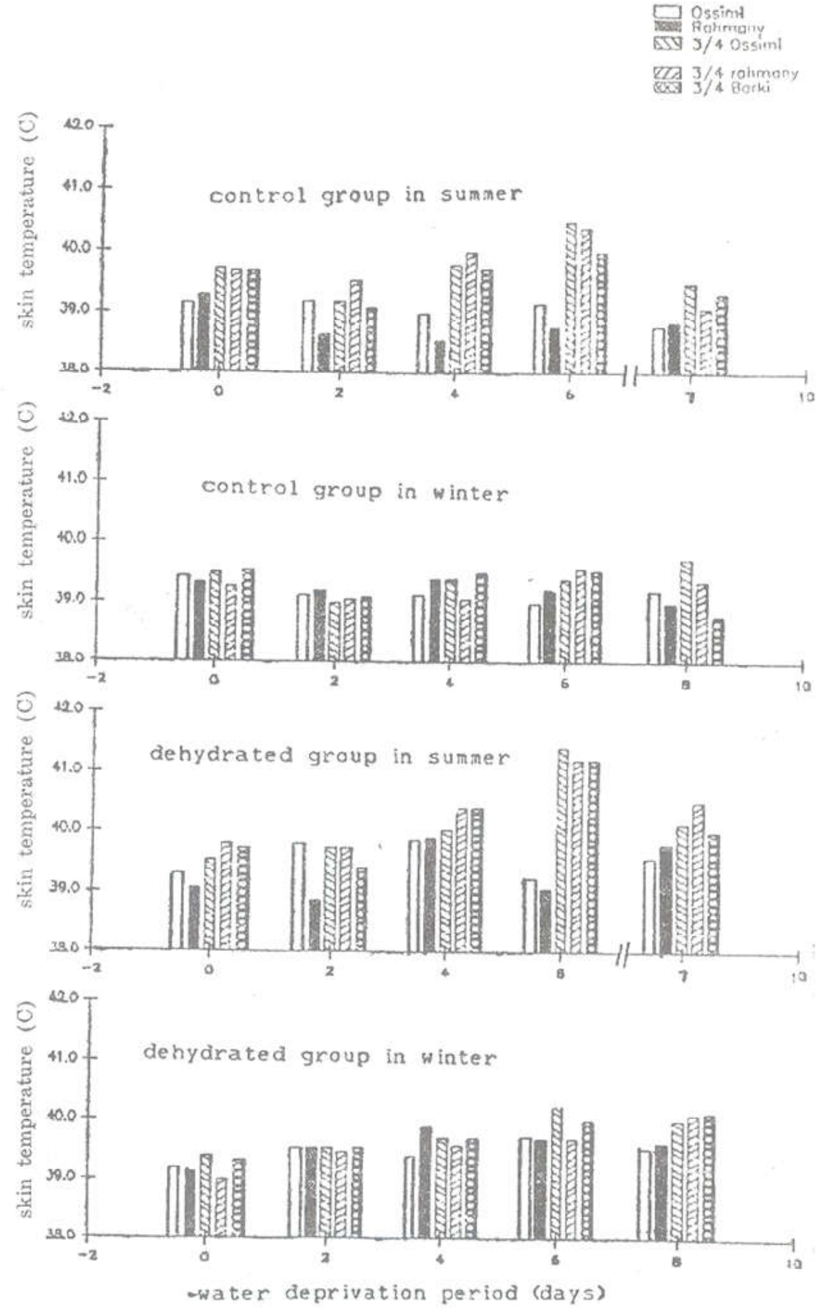

Fig. 8. Rectal temperature (°C) of dehydrated and normal breed groups at different dehydration intervals in summer and winter.

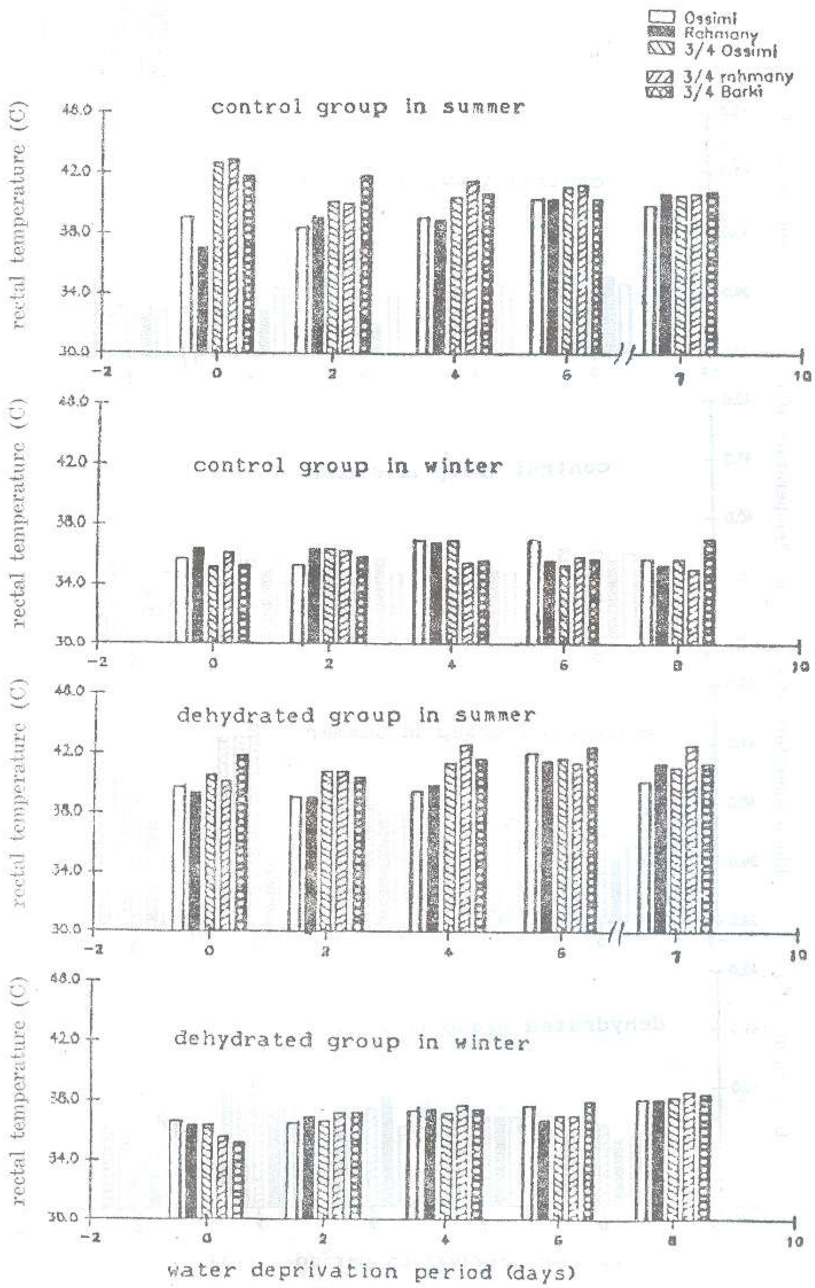

Fig. 9. Skin temperature (°C) of dehydrated and normal breed groups at different dehydration intervals in summer and winter.

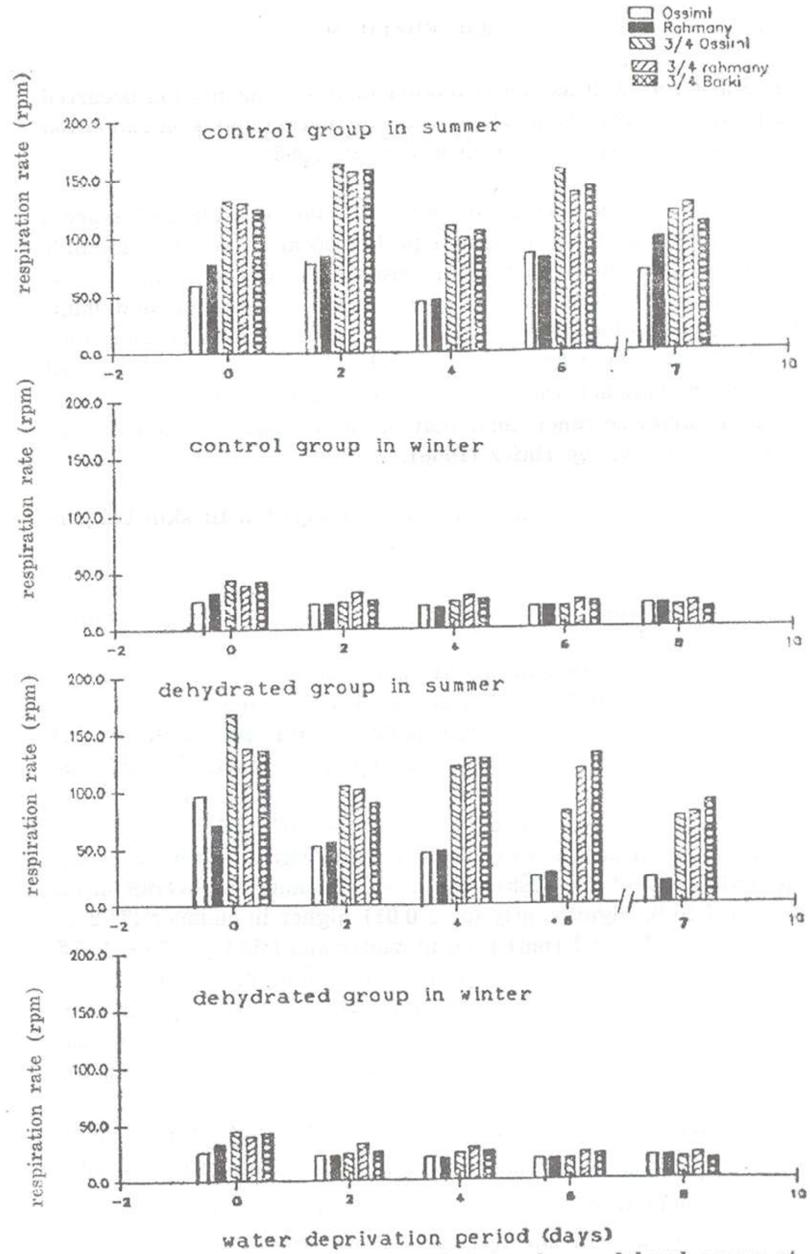

Fig. 10. **Respiration rate (rpm) of dehydrated and normal breed groups at different dehydration intervals in summer and winter.**

dehydration as well as the reduction in feed consumption occurred during water deprivation. The above explanation had been supported by previous studies on sheep (Khalil *et al.*, 1985).

The present data (Fig. 8) indicated that regardless of season, treatment and water deprivation period, local breeds had slightly non significant lower Tre than crossbreds (39.2 ± 0.08°C vs. 39.6 ± 0.09°C). The difference between the maximum and minimum Tre of the local breeds was 1.9°C and that for the crossbreds was 2.6°C. These results indicate that local breeds are well adapted than the crossbreds because they are more capable to maintain their Tre in a narrower range than that of the crossbreds. Similar conclusion was drown by Hafez (1968).

Similar trends to that of Tre was observed with skin temperature (Figs. 8 & 9).

As dehydration, increased RR tended to decrease significantly in winter and in summer ($p < 0.01$ and $p < 0.05$, respectively) (Fig. 10). As an overall mean, RR were found to be lower for the dehydrated ewes (40.1 ± 5.7 rpm vs. 55.5 ± 6.0 rpm) compared with the control and for local breeds (38.1 ± 6.1 rpm vs. 57.6 ± 7.3 rpm) compared with the crossbred group. The reduction in RR due to dehydration may obtain a reduction in oxygen consumption and in turn lower metabolic rate (heat production) (Khalifa, 1982) which is an adaptive mechanism to conserve water (Khalil, 1980; Khalifa, 1982 and Khalil *et al.*, 1985). On the other hand, the overall mean RR tended to be significantly ($p < 0.01$) higher in summer (71.2 ± 6.8 rpm vs. 28. 1 ± 1.1 rpm) than in winter and middays (65.8 ± 5.5 rpm vs. 33.5 ± 2.7 rpm) compared with midnight measurements. Several studies reported a positive relationship between RR and Ta in order to increase or decrease heat dissipation through respiratory evaporation (Khalifa, 1979 & 1982 and Khalil *et al.*, 1985).

Although water deprivation increased TP and PCV% which reveal a reduction in plasma volume, it had a slight effect on Tre and all animals were still alive. This means that both local and crossbred animals can survive and tolerate water deprivation for periods of 7 days in summer and 8 days in winter.

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تأقلم بعض الاغنام المحلية والخليطة لظروف التعطيش

مدحت حسين خليل محمد ، هشام حسين خليفة ، حسنين محمد الجباس ، محسن شاكر عبد الفتاح

قسم الانتاج الحيوانى ـ كلية الزراعة ـ جامعة الازهر ـ مدينة نصر ومعهد بحوث الصحراء ـ المطرية ـ القاهرة ـ مصر .

استخدمت فى هذه الدراسة ٧٦ نعجة من خمس سلالات (أوسيمى ـ رحمانى ـ ثلاث أرباع أوسيمى + ربع فينيس لاندريس ـ ثلاث أرباع رحمانى + ربع فينيس لاندريس ـ ثلاث أرباع برقى + ربع فينيس لاندريس) قسمت النعاج الممثلة لكل سلالة الى مجموعتين اخذت احداها احتياجاتها الطبيعية من الماء بينما منع الماء عن المجموعة الاخرى لمدة ١٩٢ فى الشتاء و ١٦٨ ساعة فى الصيف ثم قياس معدل التنفس ـ درجة حرارة كلا من الجلد والمستقيم ـ تركيز البروتينات الكلية فى البلازما ـ تركيز الالبيومين ـ تركيز الجلوبيولين ـ الهيموجلوبين ـ الهيماتوكريت وذلك فى منتصف النهار والليل ، بينما تم وزن الحيوانات فى منتصف كل يوم من ايام التجربة .

أظهرت النعاج المعطشة نسبةاعلىمنالبروتيناتالكلية ـ الالبيومين ـ الجلوبيولين ـ الهيموجلوبين ـ الهيماتوكريت بالاضافة الى ارتفاع درجة حرارة الجلد بينما اظهرت معدل تنفس منخفضة . بتقدم التعطيش زاد تركيز البروتينات الكلية ـ الالبيومين ـ الجلوليولين ـ الهيموجلوبين والهيماتوكريت . بينما نقصت اوزان الحيوانات بمعدلات متناقصة وكان هذا النقص اكبر فى خلال الصيف . كان تركيز الهيموجلوبين وكذلك درجة حرارة المستقيم ومعدل التنفس اعلى فى منتصف اليوم . أوضحت الاغنام المحلية انخفاضا اكبر فى درجة حرارة كلا من الجلد والمستقيم ومعدل التنفس وتركيز الهيموجلوبين والهيماتوكريت والتى قد تؤخذ كدلالة على تأقلم هذه الحيوانات للظروف السائدة .