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PHYSIOLOGICAL RESPONSES OF BARKI AND SUFFOLK SHEEP AND THEIR CROSSBRED TO DEHYDRATION

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SUMMARY

Exposure of Barki, Suffolk and their crossbred sheep to water deprivation for three days in summer and in winter seasons significantly reduced the body weight and total water and feed intake. The reduction in body weight due to dehydration was the highest in crossbred (11.2%) followed by Barki (9.5%) and Suffolk (9.1 %) and was higher in summer (12.6%) than in winter (7.3%). The decrease in total dry matter intake was 55.0, 47.9 and 41.5% in Barki, crossbred and Suffolk, respectively and was more pronounced in winter (47.3 gm /kg $^{0.82}$/day) than in summer (38.6 gm/kg $^{0.82}$/ day). After rehydration the animals returned to consume more feed than during hydration. Water deprivation resulted in an increase of RT and a decrease of RR and PR. These effects were obvious during summer than winter. Blood and plasma volumes were decreased (P<0.01) in dehydrated animals indicating hemoconcentration particularly in Suffolk sheep. Therefore. RBC's, WBC's and Hb values increased during dehydration period particularly in Suffolk than the other two breeds. Meanwhile, PCV percentage was the highest in crossbred ewes. Blood glucose gradually decreased (P<0.01) due to dehydration in Barki followed by Suffolk then by crossbred sheep.

Keywords: Sheep, dehydration, season, physiological responses

INTRODUCTION

Sheep and goats have adapted themselves to most environmental conditions and have evolved relatively great water economies and have the ability to withstand water shortages (Terill, 1968). Therefore, these animals are suitable for rearing in the newly-reclaimed areas of Egypt where a sparse vegetation low in nitrogen, a lack of water and extreme variations in ambient temperature. Cross-breeding of local Egyptian breeds of sheep with imported exotic breeds from temperate regions (Merino, Suffolk, Rambouillet-Texal, etc.) was carried out to improve their genetic potential for meat production (El-Sheikh *et al.*, 1981). Information concerning the physiological responses of the local and imported breeds of sheep at various environmental conditions and their ability to withstand water deprivation are of practical importance in terms of adaptation. Thus, the aim of this study was to compare the reactions of Barki and Suffolk and their crossbred to dehydration during winter and summer seasons.

MATERIALS AND METHODS

The experiment was carried out at the Alexandria University Experimental Station. Twelve non-pregnant female sheep in three groups each of four ewes, (Barki (B), Suffolk (S), and crossbred (BxS, F_1) were used during summer and winter seasons. All ewes from each breed were born in the station, and the parents of the Suffolk were imported from the United Kingdom. The animals were 1.5 to 2 years of age and weighed 30-40 kg for Barki and 50-60 kg for Suffolk and Barki x Suffolk crossbred at the beginning of the experiment. The animals were individually confined in semi-open pens, in which feed and water intake can be measured. The pens provided enough shade and ventilation in summer and protection from air draft and rain in winter. They were fed on wheat straw and concentrate mixture that contained at least 61% total digestible nutrients (TDN) and 11.5% digestible protein according to their body weight requirements (Morrison, 1959). Unless the animals were dehydrated, water was offered to the animals twice daily in buckets in order to measure their water intake.

The experimental period involved three periods, of three days (72 hr.) each, of hydration (control, T_1) dehydration (water was withheld while feed supply continued, T_2) and rehydration (recovery, T_3). The three-day dehydration period was applied since sheep and goats in the desert of the northwestern coast of Egypt have access to drinking water every 2 - 3 days (Kamel, 1991).

Body weight was measured daily in the morning before access to feed and water. Feed intake of roughage and concentrates was recorded daily for each animal. Total daily water intake for each animal was calculated by adding the amount of drinking water to the amount of water in feed consumed. Rectal temperature (RT), respiration rate (RR) and pulse rate (PR) were measured two times daily (at 8.00 and 13.00 hr.) during the experimental period.

Daily blood samples were collected from the external jugular vein of the animals in the morning before access to feed and water. Hemoglobin (Hb), red blood cell (RBC) counts, packed cell volume (PCV) and leucocyte counts were determined by the conventional methods. Blood glucose concentration was measured in whole blood by O-toluidine method as described by Hyvarinen and Nikkila (1962). Blood and plasma volumes were determined using Evan's blue (T1824) dilution technique (Hawk *et al.*, 1976).

During the experimental period, the minimum and maximum ambient temperature, relative humidity and vapour pressure were 22.2°C and 30.8°C, 67.8 % and 23.5 (mbar), respectively during summer and 8.2°C and 18.7°C, 69.3 % and 10.7 (mbar), respectively during winter.

Data were analyzed as a factorial experiment with one way interaction as described by Steel and Torrie (1980). The analysis was conducted using Generalized Linear Model Procedures on SAS (1986). Duncan's multiple range test was used for comparing each two means (Steel and Torrie, 1980). The following model was assumed :

$Y_{ijkld} = U + B_i + S_j + Tr_k + D_1 + (BS)_{ij} + (BTr)_{ik} + (BD)_{kl} + (SD)_{jl} + e_{ijkld}$

Where :

Y_{ijkld}	the dependent variable studied.	
U	overall mean.	
B_i	the effect of i^{th} breed.	i = 1,2,3.
S_j	the effect of j^{th} season.	j = 1,2.
Tr_k	the effect of k^{th} treatment	k = 1,2,3.
D_1	the effect of 1^{th} of dehydration	1 = 1,2,3.
BS_{ij}	the interaction effect between breed and season.	
BTr_{ik}	the interaction effect between breed and treatment.	
STr_{jk}	the interaction effect between season and treatment	
Bd_{il}	the interaction effect between breed and day.	
SD_{jl}	the interaction effect between season and day.	
e_{ijkld}	the error term which assumed to be randomly and independently with zero mean and variance $\delta^2 e$	

RESULTS AND DISCUSSION

Body weight differed significantly (p<0.01) among breeds, being 55.9, 53.3 and 45.3 kg in crossbred, S and B, respectively. Season of the year had significant (p<0.01) effect on body weight, where the overall mean was higher in summer (53.1 ± 5.7 kg) than in winter (49.9 ± 4.8 kg). Body weight of all groups of animals gradually declined (p<0.01) with the advance of water deprivation (Fig. 1). After three days of dehydration, the loss of body weight was 11.2, 9.5 and 9.1 % of the initial body weight for crossbred, B and S, receptively. The difference among the response of breeds could be attributed to the effect of the genetic make up on their response to dehydration. Degen and Kam (1992) reported that during four days of dehydration, the rams of Dorper sheep lost 16.3 % (4.0 % daily) of their body mass. Additionally, Degen (1977) compared the response to dehydration in Awassi sheep, a breed well adapted to arid and semi-arid regions, and in German Mutton Merino sheep (GMM), a breed that evolved in temperate climate reporting higher loss in total body weight in GMM (27.5 %) than in Awassi (21.0 %) at the end of 60 days restriction period. Similar amount of weight loss was reported in Marwarri sheep (18%) (Purohit *et al.,* 1972) and Australian Merinos (25 %) (Macfarlane *et al.*, 1966) following total water deprivation at high ambient temperature.

The loss in body weight due to dehydration during summer was higher than in winter (12.6 and 7.3 %, respectively). These results agree with the findings of More and Sahni (1978) in Chokla ewes showing higher losses in body weight in summer (11.3%) than in winter (4.4%). The marked decrease in body weight of all animals during dehydration is mainly due to the reduction of feed and/or the body water deficit, (El-Hadi,1986; Dahlborn and Holtenius,1990 ; Degen and Kam,1992). Since there is a close relationship between the quantities of feed and water consumed by ruminants (More and Sahni, 1981). However, the water deficit seems to be the main factor because most animals can restore their initial body weight after rehydration (Fig. 1). Other investigators reported that weight loss entirely due to total body water

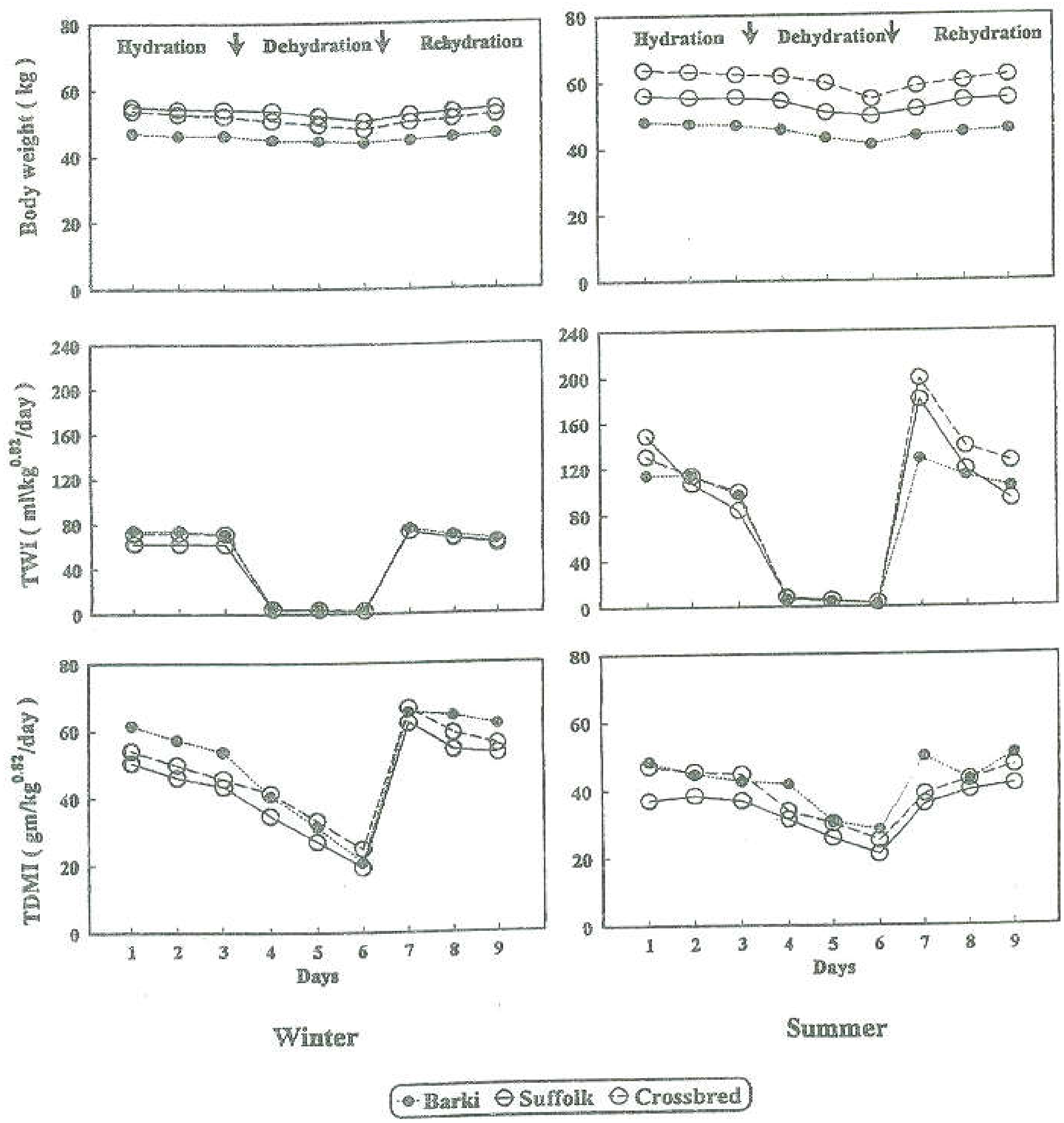

Figure 1 Changes in body weight, total water intake and total dry matter intake due to dehydration in Barki, Suffolk and their crossbred during winter and summer

(TBW) reduction (Shkolnik *et al.*, 1980) and losses in body solids (Degen 1977). The losses in body solids resulted from the marked reduction in feed intake during water deprivation.

Results presented in Fig. 1 showed that during hydration period there were significant ($p<0.05$) differences among breeds in water intake. The crossbred sheep consumed more water (93.1 ml/kg$^{0.82}$ / day) than B and S breeds (90.9 and 87.7 ml/ kg$^{0.82}$/ day, respectively). During dehydration, the reduction in water ingested by animals were 97.1, 96.8 and 96.5 for B, S and their crossbred, respectively compared with hydration period.

Total water intake was significantly ($p<0.01$) higher during summer than during winter (83.5 and 47.0 ml/kg $^{0.82}$/day, respectively). This trend agrees with previous findings of Degen, (1977) ; More and Sahni, (1978) and Gupta and Acharya, (1987). Increase of drinking water during summer is most probably due to cover the requirements for evaporative cooling.

Measuring the rate of drinking at the first drinking after dehy-dration indicated that S had the lowest rate followed by crossbred and B (1.9, 2.1 and 2.3 L/min., respectively). The capacity of drinking great amount of water in short time by native B sheep comparing with S and their crossbred may reflect the efficiency of B sheep to take its water requirement in short time. Consequently, this is of great benefit for surviving particularly in dry areas in which water sources are limited and/or during competition of animals for drinking.

Results presented in Fig. 1 indicated that during hydration period (control) the B sheep consumed more dry matter than crossbred and S (46.5, 43.7 and 38.8 gm/kg$^{0.82}$/day, respectively). Dehydration of animals induced a significant ($p<0.01$) decline in dry matter intake, being the highest in B followed by crossbred then by S, and the percentage of reduction for the three breeds were 50.7, 47.9 and 41.5 %, respectively. The observed decline percentage in dry matter intake due to dehydration was higher than that reported by El-Hadi (1986) in Sudanese desert sheep and goats at the end of three- days dehydration period (26.0 and 18.0% , respectively). However, the present findings were less than that reported by Laden *et al.* (1987) in Awassi sheep after five-days dehydration period (97%). Comparing the reduction in dry matter intake and body weight due to dehydration revealed that although B sheep reduced their feed intake more than crossbred and S but their reduction in body weight was lower than crossbred and almost similar to S.

Analysis of results presented in Fig. 2 indicated that there was breed difference ($p<0.01$) in RT, RR and PR. Crossbred sheep had higher RT ($38.7 \pm 0.3^{o}C$) and RR (42.3 ± 15.1 resp./min.) than that of B ($38.6 \pm 0.2^{o}C$, 42.0 ± 12.8 resp./ min.) and S ($38.5 \pm 0.3^{o}C$, 36.7 ± 11.4 resp./min.). However, pulse rate was higher in B followed by crossbred then by S (74.8 ± 5.8 , 74.1 ± 4.8 and 68.6 ± 6.4 pulse/min.,respectively). Additionally, there was a significant ($p<0.01$) season x breed interaction on RT, RR and PR, and this was due to the highest increases of RT and RR and highest decreases in PR in S than in B from winter to summer season. Three days of water deprivation caused a significant ($p<0.01$) increase in RT that amounted to about 1.3, 1.1 and 0.9 % for S, B and crossbred sheep, respectively. Meanwhile, water deprivation caused significant ($p<0.01$) reduction in RR and PR values. The reduction in RR was about 16.5, 16.4 and 13.5% for B, S and crossbred, respectively, while PR were reduced by about 12.4, 11.5 and 9.2 % for S,

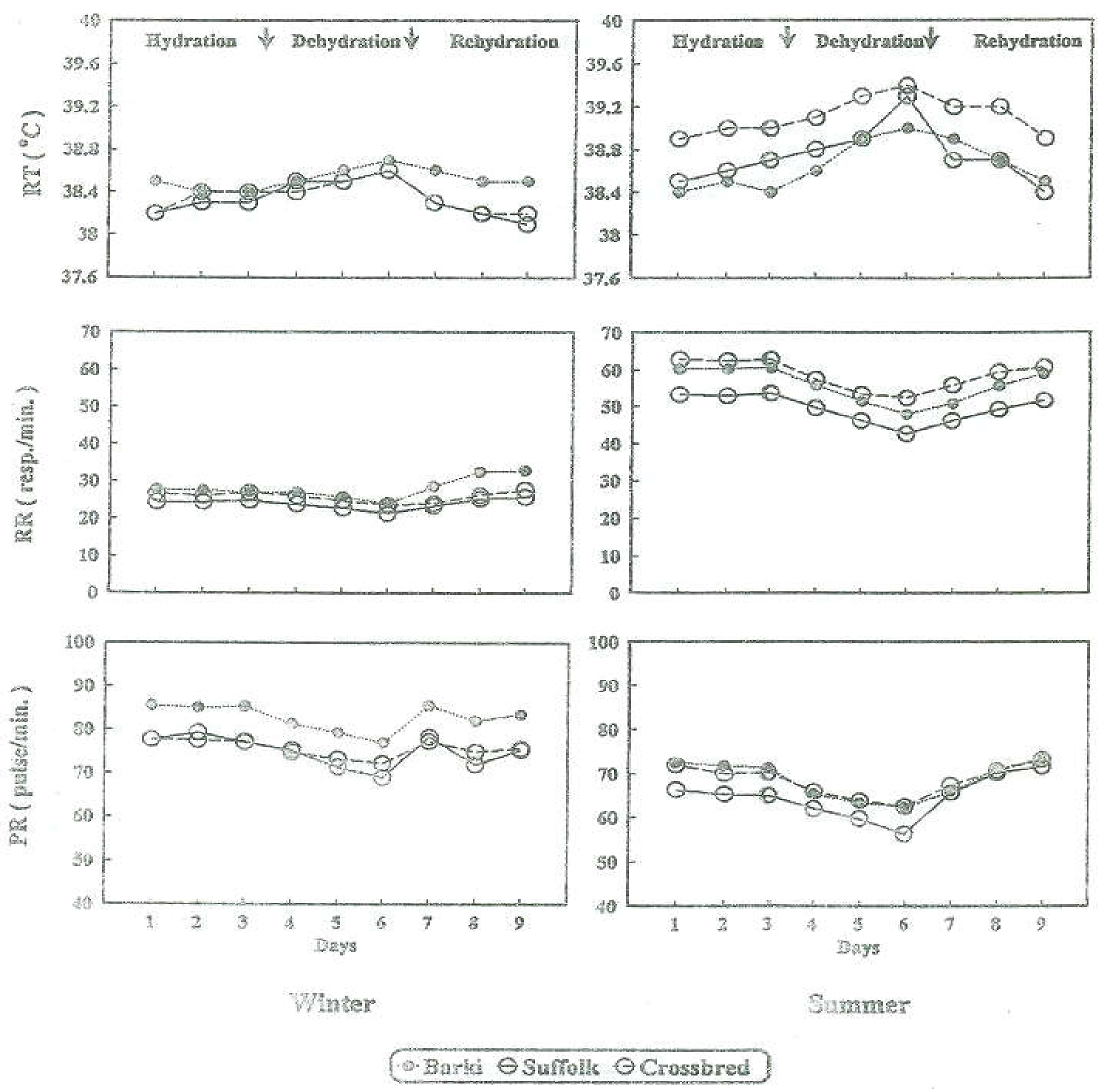

Figure 2. Changes in rectal temperature (RT), respiration rate (RR) and pulse rate (PR) due to dehydration in Barki, Suffolk and their crossbred during winter and summer

B and their crossbred, respectively. These results agree with those of Singh *et al.* (1982), who found a progressive increase in RT and a decrease in RR of Indian native and crossbred sheep subjected to three days water deprivation in summer. Thus, Kamel (1991) found that three days water deprivation of three breeds of goats caused a linear increase in RT and a linear decrease in RR and PR. The rise in RT in dehydrated animals could be attributed to the reduction in evaporative cooling. The total body water of dehydrated animals decreases markedly which cause a shortage in the amount of water needed for evaporation from the respiration tract and skin (Degen, 1977). On the other hand, the reduction in RR and PR could be necessary for water conservation, where animals were able to adapt to lower water intake by reducing water loss from the respiratory tract as well as by urinary and fecal water loss.

After rehydration (T_3), there was a gradual decrease in RT and gradual increase in RR and PR, and the values almost returned to the normal levels of each breed (Fig. 2). However, at the end of rehydration period in summer, the S and crossbred had lower RR values than that of hydration period (control). This may indicate that these animals did not return completely to its normal physiological status.

If the extent of increase in RT is taken as a criterion of heat tolerance, this indicates that dehydration (T_2) would decrease the heat tolerance of the S comparing the other two breeds.

Blood and plasma volumes insignificantly varied among breeds but were significantly ($p<0.01$) affected by season. Results presented in Fig. 3 indicated that exposure of animals to three days dehydration period caused a significant ($p<0.01$) reduction in blood and plasma volumes. This reduction being higher in S (21.6%) than in B (15.5 %) and in their crossbred sheep (15.2 %). The magnitude of changes in blood and plasma volume due to dehydration was higher in summer than in winter. Decreases in blood and plasma volume during dehydration are mainly due to the reduction of total body water (Degen and Kam, 1992 and El-Hadi, 1986). The great reduction in plasma and blood volumes due to dehydration in S particularly during summer compared with B and crossbred sheep indicated that the native breed and its crossbred is more adapted to water lack conditions.

Blood analysis showed that there were significant ($p<0.01$) breed differences in Hb concentration, PCV values, leucocyte counts and glucose (Fig. 4 and 5). Barki sheep had higher values of all hematological parameters than both S and crossbred, except for leucocyte counts. Since Hb content in the blood may be used as an indicator of the adaptability to the tropical conditions (Bahga *et al.,* 1980). The obtained higher Hb concentration in blood of B than in S and crossbred sheep indicates more adaptability of the B sheep relative to the other two breeds. During dehydration, there were gradual increase ($p<0.01$) in Hb concentration, RBC's count, PCV values and leucocyte counts, while there was gradual decrease ($p< 0.01$) in blood glucose concentration. When animals were rehydrated most of the parameters returned to their control values. The magnitude of changes was lower in B than that of both S and crossbred. Increase of blood constituents following water restriction have also been noted by Macfarlane *et al.* (1961) in Merino sheep; Singh *et al.* (1982) in crossbred sheep and El-Hadi (1986) in Sudanese sheep and goats. The increases in the values of Hb, RBC's count and PCV during dehydration are related mainly to hemo-concentration as a consequence of reductions in plasma

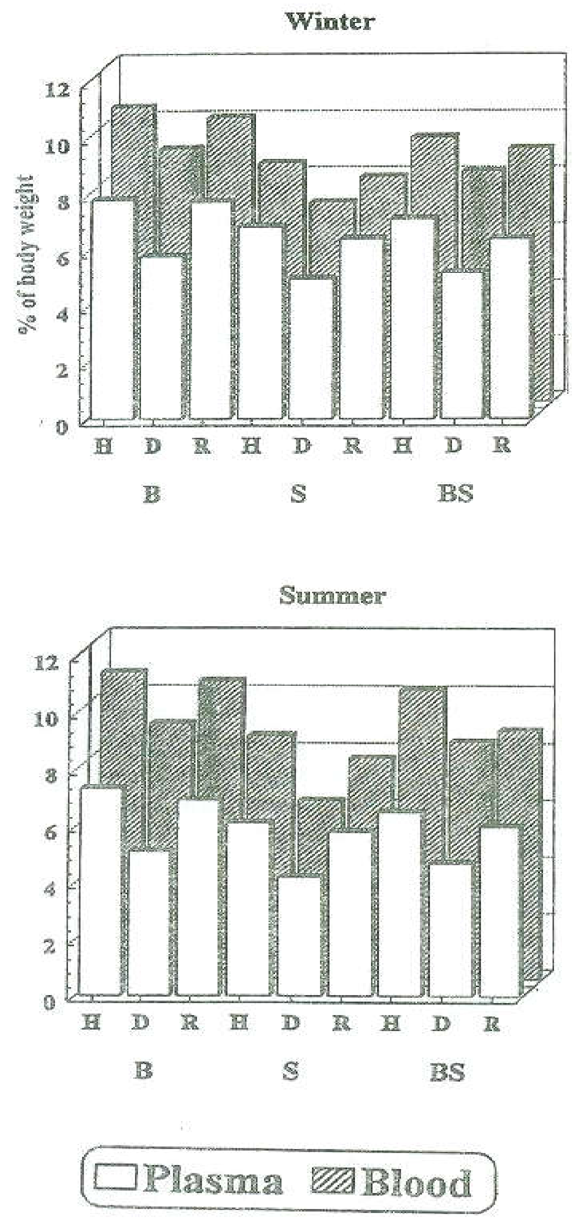

Figure 3. Changes in blood volume (BV) and plasma volume (PV) at hydration(H), dehydration (D)and rehydration (R) periods in Barki (B), Suffolk (S) and their crossbred (BS) sheep during winter and summer seasons

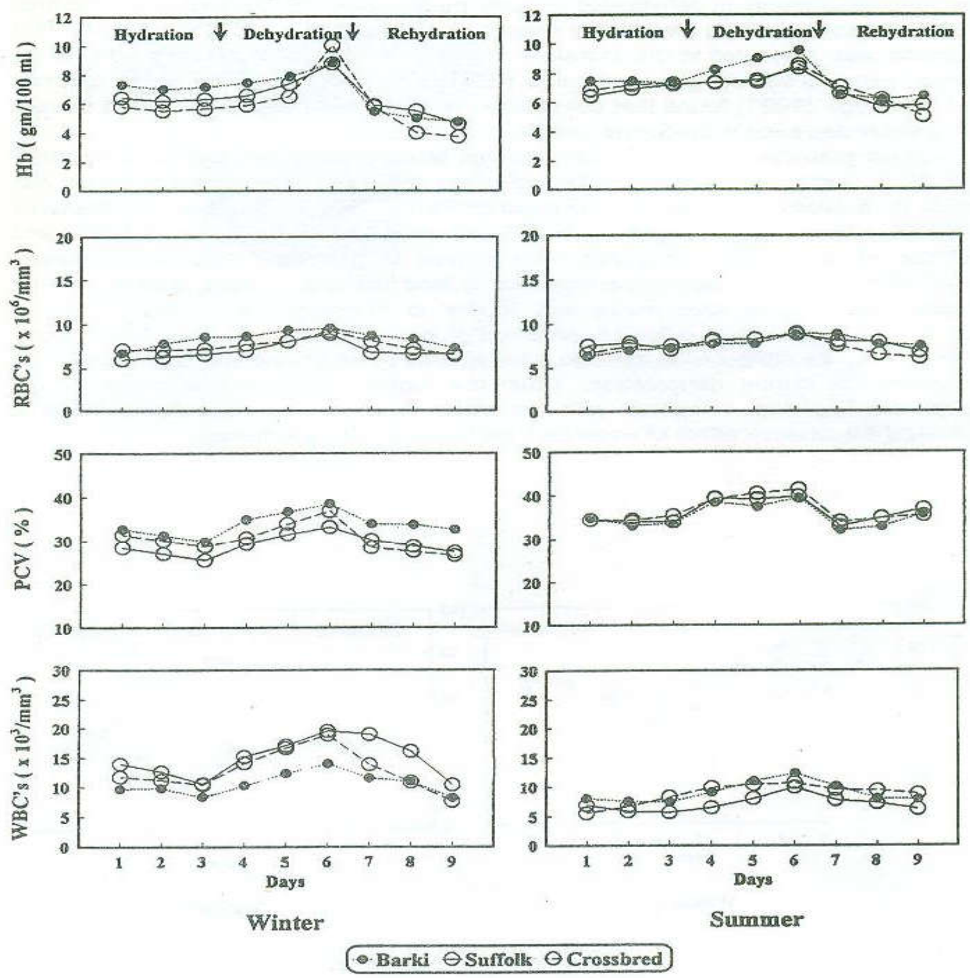

Figure 4. Changes in blood hemoglobin (Hb), red blood cells (RBC's), packed cell volume (BCV) and leucocyte counts (WBC's) due to dehydration in Barki, Suffolk and their crossbred during winter and summer seasons.

volume, blood volume and total body water. The reduction in percentages of blood and plasma volumes of dehydrated animals noted in Fig. 3. Leucocyte counts increased significantly in dehydrated animals particularly in S (59.8 %) and crossbred (63.7 %) sheep, where the percent changes in B sheep was (55.8%) (Fig. 4). This response was attributed to the increase in blood osmolality, which may activate the adrenal cortex to secrete glucocorticoids (El- Banna *et al.* 1981). However, Igbokwe and Ajuzieogu (1991) found that dehydration of Yankasa sheep for four days caused a significant decrease in leucocyte counts.

Results presented in Fig. 5 indicated that blood glucose decreas-ed significantly ($p<0.01$) during dehydration and the reduction at the end of dehydration period was higher in B breed (-43.14 %) followed by Sufflok (-32.26 %) then by crossbred (-27.13%). These results agree with that reported by Singh *et al.* (1982) and Mokhtar *et al.* (1989) in sheep. The decline in glucose concentration during dehydration could be due to the reduction in feed intake particularly during summer season. Reduction in feed intake was higher in B sheep than in S and crossbred (Fig.1), and this was reflected on blood glucose. Additionally, reduction in blood glucose may be attributed to specific mechanisms by which the animals reduce their metabolic rate during dehydration. Thus, the higher reduction in blood glucose of dehydrated B sheep compared with the other two breeds will benefit this breed to withstand the adverse effect of water lack particularly during summer.

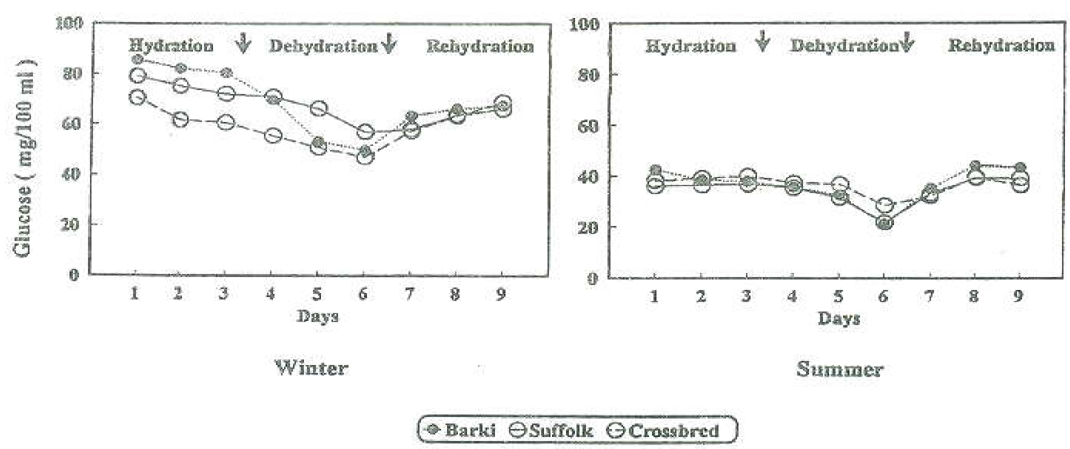

Figure 5. Changes in glucose due to dehydration in Barki ,Suffolk and their crossbred during winter and summer seasons.

Results of the present study indicated that exposure of sheep to water deprivation particularly in summer induce obvious changes in several physiological parameters including decreases of BW, FI and PR where RT and RR were increased. Thus, there was a marked hemoconcentration indicated by decreases of blood plasma volumes and increases of Hb, PCV, RBC and WBC values in dehydrated animals. Blood glucose was gradually decreased by advancing dehydration. The magnitude of changes in several physiological parameters due to dehyd-ration was higher in S compared with B and their crossbred sheep.

Therefore, the native B sheep and its crosses are suitable for rearing in the newly reclaimed areas of Egypt in which the animals are subject to asperse vegetation low in nitrogen, lack of water and extreme variation in environmental temperature particularly in summer season.

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الإستجابات الفسيولوجية لأغنام البرقي والسفولك وخليطهما للتعطيش

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هدفت الدراسة إلي معرفة الإستجابات الفسيولوجية لأغنام البرقي والسفولك وخليطهما للتعطيش لمدة ثلاثة أيام خلال موسمي الصيف والشتاء. أدي حرمان الحيوان من الماء إلي إنخفاض وزن الجسم وكمية الماء والغذاء الكلية المتناولة. الإنخفاض في وزن الجسم كان أعلي في الأغنام الخليطة (١١,٢٪) يليها البرقي (٩,٢٪) ثم السفولك (٩,١٪). والفقد في وزن الجسم كان أعلي في فصل الصيف (١٢,٦٪) عنه في الشتاء (٧,٣٪) خاصة في أغنام السفولك. الإنخفاض في الغذاء المتناول كان أعلي في البرقي (٥٥,٠٪) يليه الخليط (٤٧,٩٪) ثم السفولك (٤١,٥٪). أيضا كمية الغذاء المتناول قلت في الشتاء (٤٧,٣جم/كجم$^{٠،٨٢}$/يوم) عن الصيف (٣٨,٦جم/ كجم$^{٠،٨٢}$/يوم). عقب شرب الماء عادت الحيوانات المعطشة إلي إستهلاك كمية أكبر من الغذاء.

ولقد أدي التعطيش إلي حدوث زيادة في درجة حرارة المستقيم وإنخفاض في معدل النبض والتنفس خاصة في فترة الصيف. وصاحب التعطيش إنخفاض معنوي في حجم البلازما وحجم الدم وكذلك زيادة في تركيز الهيموجلوبين وعدد كرات الدم الحمراء والبيضاء وكان التأثير أوضح في السفولك عن البرقي والخليط. أيضا حدثت زيادة في قيم الهيماتوكريت وكانت أعلاها في الخليط. بينما حدث إنخفاض معنوي في تركيز الجلوكوز في الدم خاصة في البرقي يليه السفولك ثم الخليط.