

Relative Adaptability of some Local and Foreign Breeds of Sheep to Sahara Desert*

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CHANGES in respiration rate (RR), pulse rate (PR) and rectal temperature (RT) were observed in three local and three foreign breeds of rams during exposure to heat and solar radiation and deprivation of feed and water. Exposure for 4 hr caused a significant increase in RR and a non-significant increase in RT above the pre-exposure levels in all breeds. PR was not significantly affected during exposure indicating lack of increases in heat production. Foreign breeds showed significantly higher overall means of RR and RT indicating a higher heat load in these animals. Part of this could be due to their higher metabolic rates as suggested by their higher averages in PR than those in the local breeds.

From these measurements heat tolerance indices were calculated and results showed that foreign breeds were less adapted to heat than the local breeds. Within foreign breeds, Rhoad's co-efficient agreed with the past record of reproductive performance under desert conditions and showed that Ile-de-France was the most adapted, while Finnish was the least adapted to heat. Within local breeds Rahmani showed the highest heat tolerance followed by Ossimi then by Barky.

Significant differences between breeds were also observed in serum Ca/IP ratio and enzyme alkaline phosphatase. Levels of the enzyme were higher in the larger breeds and lower in the small size breeds, but serum levels in Ile-de-France and Suffolk were much higher than the reported averages for sheep. It is possible that changes in the levels of alkaline phosphatase in these foreign breeds of sheep are adaptive mechanisms to the new environment involving complex interactions between rates of Ca, P, parathyroid hormone and vitamin D metabolism which can vary according to differences in growth rates and in the adaptability of these animals.

The adaptability of sheep to desert conditions is of great importance to animal breeders in many areas of the world. In Egypt, Barky sheep are of major economic value to the Beduins of the Sahara. In addition, various breeds of sheep of European origin have been imported to Egypt for the purpose of crossing with local breeds to improve their productive performance. Thus, these foreign breeds or their crosses should be relatively heat tolerant if they are to thrive in the newly reclaimed land of desert areas. Heat tolerance, or the ability of animals to withstand thermal stress by maintaining a balance between heat production and heat loss, has been measured by changes in rectal temperature (RT) and respiration rate (RR) (Bianca, 1963).

Thus the objectives of the present study were :

- a. To estimate the heat tolerance indices of three foreign and three local breeds of sheep as measured by changes in their RT and RR after exposure to heat and solar radiation during deprivation of feed and water.
- b. To evaluate the possible mechanisms underlying the degree of adaptability of these animals to heat stress, in terms of measurements of some biochemically important blood constituents.

M a t e r i a l a n d M e t h o d s

Animals, feed and management

The present studies were carried out on several local and foreign breeds of rams. The local breeds were 5 Barky (B), 6 Rahmani (R) and 6 Ossimi (O), with mean values of body weights of 62.1 ± 5.8 , 64.8 ± 2.4 and 65.9 ± 4.2 kg for B, R and O, respectively. Their ages were between 2-3 years. The foreign breeds were 4 Finnish (F), 6 Ile-de-France (Ile D) and 4 Suffolk (S), with mean values of body weights of 52.9 ± 2.8 , 74.1 ± 3.5 and 76.1 ± 1.8 kg for F, Ile D and S, respectively. The foreign breeds were imported from Spain at the age of about 8 months, and their ages at the time of experiment were about $2 \frac{1}{2}$ years.

The animals were maintained at El-Azema Animal Production Experimental Station, located in the North Sector of Tahrir Province on the North Western Coast of Egypt. Before conducting

these experiments, all animals were kept outdoors under open sheds day and night. They were fed on hay and concentrates according to their body weight requirements (Morrison, 1959). Water was provided *ad libitum* twice daily during the pre-experimental period.

Effects of heat, accompanied with solar radiation and thirst, on rectal temperature and cardiorespiratory activities

The present experiments were designed to measure some physiological responses of sheep to hot arid environments. Some of these physiological responses were respiration rate (RR), pulse rate (PR) and rectal temperature (RT). RR was measured by counting flank movements, PR was measured by a clinical stethoscope and RT by a clinical thermometer.

All these parameters were recorded under shed just before the exposure of animals to direct sunlight. This was followed by immediate exposure and measurements of these parameters at 2 hourly intervals. The micro-meteorological data were also recorded at these intervals. These studies were carried out during the summer, and the animals were deprived of food and water during the time of exposure.

Biochemical studies

Blood samples were collected from the jugular vein immediately before exposure, while the animals were under shed. Serum of each sample was analysed for several biochemical parameters. Total proteins were determined by the Biuret method as described by Armstrong and Carr (1964). Albumin (A) was measured as a result of the reaction with bromocresol green at pH 4.2 (Dumas *et al.*, 1971). Globulin (G) was estimated by the difference between serum total proteins and serum albumin, then the A/G ratio was obtained. The levels of serum inorganic phosphorus (IP) were measured by the method of Fiske and Subbarow as described by Armstrong and Carr (1964). Serum Ca was determined by the method of Gindler and King (1972). The Ca/IP ratio was then obtained.

Enzyme alkaline phosphatase was measured by a colorimetric method originated by Kind and King and described by Belfield and Goldberg (1971).

Results and Discussion

Rectal temperature and cardiorespiratory activities

The mean values \pm S.E. of RR, PR and RT for all the 6 breeds, at the different intervals of exposure, are presented in Table 1. Analysis of variance showed that there were significant differences between breeds in the mean values of each of these parameters. There were also significant differences in the mean values of RR and RT at the different intervals of exposure. The interactions between breeds and intervals were non-significant for all parameters, indicating that all breeds behaved similarly to solar radiation at these intervals with regard to changes in RR, PR and RT (Table 1). Differences in these parameters will be discussed first according to intervals then according to breeds.

Intervals

With regard to RR, the overall mean for all breeds before exposure was 54.4 rpm. At 2 and 4 hr post-exposure, the means were 118.6 and 84.3 rpm., respectively. Duncan's Multiple Range Test (DMRT) showed that there were significant differences ($P < .05$) in RR (s) between all intervals, with maximum activity occurring at 2 hr post-exposure. The activity decreased at 4 hr, but continued to be higher than that at the pre-exposure level. This was consistent in all breeds (Table 1).

The overall means of RT were 39.55, 39.93 and 39.72° at pre-exposure, 2 and 4 hr post-exposure, respectively. DMT showed a significant increase ($P < .05$) above the pre-exposure level occurring at 2 hr post-exposure. At 4 hr, RT was not significantly different from that at pre-exposure (Table 1).

PR showed somewhat inconsistent trend upon exposure to heat and solar radiation. While at 2 hr of exposure it increased in O, R and Ile D, it decreased in other breeds. Analysis of variance, however, showed that these changes were not significant (Table 1).

TABLE 1. Effect of heat accompanied with solar radiation and thirst on rectal temperature and cardiorespiratory activities of some local and foreign breeds of rams.

Breed	Hours of Exposure	Respiration Rate	Pulse Rate	Rectal Temperature
Barky	Before	40.7 ± 4.5	73.5 ± 4.2	39.2 ± 0.1
	2 hrs.	56.3 ± 12.0	65.1 ± 4.1	39.8 ± 0.2
	4 hrs.	75.7 ± 6.4	71.0 ± 9.6	39.4 ± 0.1
Cuzini	Before	33.7 ± 2.4	66.7 ± 2.5	39.2 ± 0.1
	2 hrs.	99.8 ± 20.3	81.0 ± 4.6	39.5 ± 0.06
	4 hrs.	68.0 ± 6.6	77.0 ± 3.2	39.3 ± 0.1
Nahmani	Before	33.8 ± 1.7	64.0 ± 1.6	39.1 ± 0.1
	2 hrs.	89.8 ± 9.3	77.7 ± 2.6	39.2 ± 0.2
	4 hrs.	47.3 ± 5.0	66.6 ± 3.9	39.3 ± 0.1
Finnish	Before	73.0 ± 16.1	82.5 ± 6.7	40.6 ± 0.2
	2 hrs.	159.0 ± 9.2	79.5 ± 3.9	41.0 ± 0.2
	4 hrs.	122.0 ± 10.0	75.0 ± 2.2	40.7 ± 0.1
Ile-de-France	Before	83.0 ± 7.9	77.2 ± 1.4	39.7 ± 0.2
	2 hrs.	149.1 ± 5.3	80.0 ± 2.9	40.2 ± 0.2
	4 hrs.	128.0 ± 7.2	81.2 ± 2.7	39.9 ± 0.1
Suffolk	Before	76.3 ± 6.3	88.0 ± 11.0	39.9 ± 0.1
	2 hrs.	137.0 ± 13.6	82.5 ± 3.8	40.6 ± 0.1
	4 hrs.	104.0 ± 6.9	73.0 ± 9.8	40.2 ± 0.1
Mean Breeds:				
Barky		70.9	73.7	39.46
Cuzini		60.5	76.2	39.32
Nahmani		57.0	67.8	39.25
Finnish		117.6	80.0	40.75
Ile-de-France		120.1	79.2	39.90
Suffolk		105.8	81.2	40.22
Mean Intervals:				
Before exposure		51.4	75.45	39.55
2 hrs. exposure		115.6	78.17	39.93
4 hrs. exposure		84.1	74.12	39.72
Analysis of Variance:				
Between breeds (B)		P < .001	P < .05	P < .001
Between intervals (I)		P < .001	NS	P < .001
B x I		NS	NS	NS
Climatological Data				
		Ta	T _{bb}	RH
		(Ambient Temperature °C)	(Black body temperature °C)	(Relative humidity %)
Before exposure		30.3	26.7	49.8
2 hrs. exposure		37.0	41.1	35.0
4 hrs. exposure		32.0	37.8	47.0
Mean		32.5	35.0	43.9

Breeds

With regard to RR, there were some breed differences in the rate of response to solar radiation. O and R showed the highest percentage increase in RR after a 2 hr exposure period, while S and Ile D showed the lowest response. But these differences were not significant since the interaction between breeds and intervals

was not significant (Table 1). The overall means of RR in the foreign breeds were 120.1, 117.7 and 105.8 rpm for Ile D, F and S, respectively. DMRT indicated that these values were not statistically different. The local breeds also showed no significant differences in the mean value of their RR. The values were 70.9 for B, 60.5 for O and 57.0 for R. On the other hand, the overall mean of RR for any foreign breed was significantly higher ($P < .05$) than that for any local breed. (Table 1).

DMRT also showed that there were significant differences ($P < .05$) between all the foreign breeds in their overall means of RT. The values were highest in the F (40.75°), followed by the S (40.22°) then by Ile D (39.90°). In addition, the mean value of RT in any of these foreign breeds was significantly higher than that in any local breed. On the other hand, there were no significant differences in RT between all the local breeds. (Table 1).

With regard to PR, DMRT indicated that there were no significant differences between the overall means for any of the foreign breeds. However, the mean value of PR for any foreign breed or for the O was significantly higher than that for the R (Table 1).

In conclusion, the above results indicate that exposure to solar radiation for 2 hr resulted in significant increases in RR and RT in all breeds. But by increasing the time of exposure to 4 hr, both parameters declined reaching levels in which there was a significant increase in RR and a non-significant increase in RT above the pre-exposure levels (Table 1). The increase in RR under these conditions enabled the animals to dissipate heat in amounts roughly equivalent to the latent heat of vaporization of moisture in the respired air and was sufficient to prevent a significant rise in RT. This increase in RR is also known to increase heat production (Kamal, 1965). But the animals did not show significant changes in PR during exposure, indicating lack of increases in heat production (Kibler and Brody, 1949; Yousef and Johnson, 1966), and suggesting that the metabolic rates in these animals could not be stimulated during the excessive respiratory activity. This increased RR accompanied by a reduced metabolic rate decreases the animal's thermal load and is a typical adaptive mechanism to help the animal tolerate heat and solar radiation.

Foreign breeds showed significantly higher overall means of RR and RT (Table 1) indicating a higher heat load in these animals. Part of this could be due to their higher metabolic rates as suggested by their higher averages in PR than those in the local breeds (Table 1). Within foreign breeds, Ile D had the lowest RT and PR but was highest in RR. S was highest in PR and F was highest in RT. Within local breeds, R showed the lowest values of all three parameters and seems to be the most adapted, followed by O then by B.

To measure the physiological adaptability to heat stress in these breeds, a numerical value or index is required. Two indices were developed to measure "heat tolerance" in farm animals: Rhoad's co-efficient and Benezra's index (Bianca, 1963). The formulas used for calculation of heat tolerance are:

- 1) Rhoad's co-efficient = $100 - (18 (RT-38.3))$.
- 2) Benezra's index = $RT/38.3 + RR/23$.

By applying these formulas, the indices of heat tolerance for the 6 breeds were calculated and presented in Table 2. Results showed that the foreign breeds are less adapted to heat than the local breeds. The degree of their heat tolerance compared to the local breeds were 79.0 and 62.1% using Rhoad's co-efficient and Benezra's index, respectively. Within the foreign breeds, Rhoad's co-efficient showed that Ile D was the most adapted, and F was the least adapted to heat. However, by applying Benezra's index Ile D together with the F were the least tolerant. This is because both breeds showed high levels of RR which was included in the calculation of Benezra's index, while in Rhoad's co-efficient only RT was used. Bianca (1963) found that the final RT during heat exposure is the base index for evaluation of heat tolerance for individual calves: the animals with their final RT showed better records of weight gains and protective performance. Also, reproductive performance was evaluated for the three foreign breeds of rams that were used in the present study; and results indicate that during the last two years under desert conditions the fertility rates and women quality were best in Ile D, while fertility rates were lowest in the F (unpublished observations). These data are in favour of using Rhoad's co-efficient for the estimation of heat tolerance in these animals. However, additional work

is required to substantiate this conclusion, and would require measurements of some other parameters such as hormones, enzymes and blood constituents.

TABLE 2. Heat tolerance indices for some local and foreign breeds of rams.

Breed	Overall mean RT (°C)	Overall mean RR (rpm)	Rhod's co-efficient	Benezra's index
Barky	39.46	70.89	79.1	4.1
Rahmani	39.25	57.00	82.9	3.5
Ossimi	39.32	60.50	81.6	3.7
<u>Mean of local breeds</u>			81.2	3.77
Finnish	40.75	117.67	55.9	6.2
Ile-de-France	39.90	120.11	71.2	6.3
Suffolk	40.22	105.75	65.4	5.7
<u>Mean of foreign breeds</u>			64.7	6.07

Within the local breeds, R showed the highest heat tolerance followed by O then by B, regardless of the index used (Table 2). B sheep, however, predominate in the Sahara desert (North-western coast of Egypt and Libya) because of its smaller size that would allow the animal to adapt to conditions of scarce food, and to be able to travel long distances looking for widespread pastures and water sources.

Biochemical studies

The mean values and the corresponding standard errors for the estimated blood constituents are presented in Table 3. Analysis of variance revealed significant differences ($P < .01$) between breeds in serum Ca/IP ratio and alkaline phosphatase. With regard to alkaline phosphatase, DMRT showed that the mean value for Ile D was significantly higher ($P < .05$) than for any other breed. Also alkaline phosphatase in S was significantly higher than in F. DMRT also showed that Ca/IP ratio was significantly lower in B than in any other local or foreign breed. Other breed differences in alkaline phosphatase or in Ca/IP ratio were non-significant.

TABLE 3. Some biochemical parameters in blood of local and foreign breeds of rams

Breeds	No.	Total Proteins (g/100ml)	Albumin (A) (g/100ml)	Globulin (G) (g/100ml)	A/G Ratio	Ch (mg%)	TP (g/100ml)	Ca/TP Ratio	Alkaline Phosphatase (U/ml & mg units)
Barki	5	7.47 ± 0.38	3.39 ± 0.21	4.34 ± 0.26	0.79 ± 0.06	3.11 ± 0.72	13.44 ± 0.82	0.60 ± 0.09	10.70 ± 1.16
Ossimi	4	7.28 ± 0.24	3.24 ± 0.08	4.04 ± 0.24	0.81 ± 0.05	11.04 ± 0.61	10.20 ± 0.77	0.99 ± 0.10	15.92 ± 3.79
Rahmani	6	0.99 ± 0.69	3.18 ± 0.06	5.80 ± 0.68	0.55 ± 0.16	10.62 ± 0.62	8.80 ± 0.39	1.21 ± 0.06	14.94 ± 1.51
Finnish	4	8.12 ± 0.41	3.20 ± 0.22	4.91 ± 0.33	0.66 ± 0.06	9.85 ± 0.52	7.95 ± 0.61	1.24 ± 0.17	6.10 ± 1.32
Ile-de-France	6	7.80 ± 0.32	3.14 ± 0.16	4.67 ± 0.36	0.67 ± 0.07	9.91 ± 0.42	10.26 ± 1.60	0.96 ± 0.04	32.15 ± 4.41
Suffolk	4	8.19 ± 0.29	3.04 ± 0.07	5.15 ± 0.24	0.59 ± 0.02	9.62 ± 0.35	8.05 ± 1.44	1.20 ± 0.22	20.51 ± 5.22

The physiological functions of enzyme alkaline phosphatase remains unknown (Moss and Butterworth, 1974), but high serum levels of the enzyme are found in all cases of disturbed bone metabolism, hyperparathyroidism as well as liver and biliary dysfunction. The present data indicate, however, that the increased levels of alkaline phosphatase in Ile D and S were not due to hyperparathyroidism since Ca/IP ratio in these breeds were not significantly different from that in the F (Table 3), a breed which showed the lowest levels of this enzyme. In addition, the increased levels of the enzyme in Ile D and S do not reflect disturbances in bone metabolism or liver function in these breeds since they showed higher heat tolerance indices (Table 2) as well as better record of reproductive performance than F.

It is interesting to note that in the present study, the levels of serum alkaline phosphatase in these foreign and local breeds differ according to their body weights. The breeds with the smallest body weights (F and B) showed the lowest levels of alkaline phosphatase, those with the largest body weights (Ile D and S) showed the highest levels of the enzyme, while R and O were halfway between these two groups of animals in both parameters (Table 3). Thus, it is possible to speculate that differences in serum alkaline phosphate in these breeds of sheep could reflect the differences in their growth rates. This is supported by the fact that the enzyme levels are usually higher in the young, fast growing animals than in the adult, mature animals (Kelly, 1974). However, the serum levels of the enzyme in Ile D and S (Table 3) were much higher than the reported averages for sheep (Farahat, 1975). Nevertheless, it is possible that changes in the levels of alkaline phosphatase in these foreign breeds of sheep are adaptive mechanisms to the new environment involving complex interactions between rates of Ca, P, parathyroid hormone and vitamin D metabolism which can vary according to differences in growth rates and in the adaptability of these animals.

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مقارنة بين معدل التأقلم لبعض الأنواع المحلية الاجنبية من الاغنام تحت ظروف البيئة الصحراوية

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درست التغيرات فى معدلات التنفس والنبض ودرجة حرارة الجسم فى ثلاث سلالات محلية وثلاث سلالات اجنبية من الكباش خلال تعريضها للحرارة واشعة الشمس ومنعها عن الماء والغذاء .

وفى جميع السلالات نتج عن التعريض لمدة اربع ساعات زيادة معنوية فى معدلات التنفس وزيادة غير معنوية فى درجة حرارة الجسم عن مستوياتها قبل التعريض . اما معدلات النبض فلم تتأثر تأثرا معنويا خلال فترة التعريض ما يدل على عدم وجود اى زيادة فى الانتاج الحرارى لهذه الحيوانات . وكانت السلالات الاجنبية زائدة زيادة معنوية عن السلالات المحلية فى المتوسطات الكلية لكل من معدلات التنفس ودرجات حرارة الجسم مما يدل على زيادة الحمل الحرارى فى هذه الحيوانات

وقد يعزى جزء من ذلك الى زيادة معدلات تمثيلها الغذائى كما هو واضح من زيادة متوسطات معدلات نبضها عن السلالات المحلية .

ومن هذه القياسات قدرت معاملات التحمل الحرارى فى هذه الحيوانات وقد اشارت النتائج الى ان السلالات الاجنبية كانت اقل تأقلا للحرارة عن السلالات المحلية .

وقد اتفق « معامل روود » مع سجلات الكفاءة التناسلية لهذه الحيوانات تحت ظروف البيئة الصحراوية على ان ايل دى فرانس كان اكثر السلالات الاجنبية تأقلا فى حين ان الفنش كان اقلها تأقلا . وكان الرحمانى اكثر السلالات المحلية تأقلا يتبعه الاوسيمى ثم البرقى .

وقد وجدت اختلافات معنوية بين السلالات فى نسبة الكالسيوم الى الفوسفور الغير عضوى فى السيرم وكذلك فى مستوى انزيم الفوسفاتيز القاعدى . وكان مستوى الانزيم عاليا فى السلالات الكبيرة الحجم ومنخفضا فى السلالات الصغيرة الحجم ، لكن كانت تراكيزاته فى سيرم سلالات الايل دى فرانس والسفولك اعلى بكثير من متوسط التركيزات المعروفة فى الاغنام .

ومن المحتمل ان التغيرات التى قد حدثت فى مستويات انزيم الفوسفاتيز القاعدى فى هذه السلالات الاجنبية هى احد وسائل التأقلم للبيئة الجديدة والتى تتضمن تفاعلات متشابهة بين معدلات تمثيل الكالسيوم وأفسفور وهرمون الباراثيرويد وفيتامين د والتى قد تتغير تبعا للاختلافات فى معدلات النمو لهذه الحيوانات ومقدرتها على التأقلم .