

EFFECT OF SHADING ON IMPROVING ADAPTIVE PERFORMANCE OF BLACK BEDOUIN GOATS UNDER EL-SHALATEEN- HALAIEB- ABOU- RAMAD TRIANGLE CONDITIONS

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ABSTRACT

This study was undertaken in Hadraba Research Station, El-Shalateen- Halaieb- Abou- Ramad triangle, belonging to Desert Research Center (DRC), which lies 1400 km southeast of Cairo (Latitude 22°N, Longitude 36°E). The study aimed to investigate the effects of providing shading to alleviate heat stress on black Bedouin goats in summer season. Twenty black Bedouin male goats were divided into two groups (10 each). The first group one (G1) was kept in wire-fenced yard beneath shade of thatch while the second group (G2) was left unshaded just inside wire-fenced yard exposing to climatic conditions. Meteorological data (radiant; RAT, ambient temperatures; AT and relative humidity; RH) and thermo- cardio- respiratory responses (rectal; RT, skin, ST, coat temperatures, CT, respiration, RR and heart rates, HR) were recorded twice daily at 08.00 and 14.00 hr. Hemoglobin (Hb), packed cell volume (PCV) and mean of corpuscular hemoglobin concentration (MCHC) were determined.

The results demonstrated that providing shading at the hottest period of the day (14.00 hr.) during summer reduced AT and RAT values by 7.00 and 6.00 °C, respectively. As a result, shaded Bedouin goats had significantly lower values of RT, ST, CT and RR and non-significant HR as compared to the unshaded ones. At 14.00 hr., the heat gradient from body core to the surrounding environment temperature was wider for the shaded goats than that of their counterparts (1.44 vs. -2.59 °C). Shading was found to increase insignificantly PCV, Hb, and MCHC.

The study gave an idea about the advantage of shading in alleviating the heat load falling on the Bedouin goats raised in El-Shalateen- Halaieb- Abou- Ramad region during summer.

Keywords: Bedouin goats, shading, Thermo- respiratory responses, Hematological parameters, El-Shalateen- Halaieb- Abou- Ramad triangle.

INTRODUCTION

Goats are believed to have the widest ecological range of domestic livestock, ranging from extremes of tropical rain forests to dry deserts. Climatic conditions have direct and indirect effects on physiological performance of livestock. Animals raised in El-Shalateen- Halaieb- Abou- Ramad region are exposed to high ambient temperatures during the hot dry summer. Ambient temperature may exceed 45 °C under solar radiation at mid-day. Accordingly, animals during such period may be subjected to heat stress. In desert areas, many attempts have been devoted to modify the surrounding adverse microclimate towards the thermally comfort conditions known for the domesticated animals. Under such optimum conditions, the animals would be expected to exhibit better physiological functions and

improve their productive and reproductive performance. Shading may be a good avenue to avoid such heat stress and solar radiation impacts through lowering the natural heat stress on the animals.

Therefore, the present investigation was designed to study the effects of providing possible protection against the heat stress on some physiological responses and hematological responses of Bedouin goats raised in El-Shalateen- Halaieb- Abo- Ramad triangle.

MATERIALS AND METHODS

1- Location of study:

The present study was carried out at Hadraba Research Station, El-Shalateen- Halaieb- Abou- Ramad triangle, located southeast of Egypt about 400 Km of Aswan Governorate, which belongs to Desert Research Center, Ministry of Agriculture and Land Reclamation.

2- Aim of study:

This research aimed to study the effect of providing shading to protect Bedouin goats from the climatic extremes on their physiological performance.

3- Experimental animals and treatments:

Twenty adult male black Bedouin goats (aged 12- 18 months and weighed 18.80 ± 0.930 kg) were randomly divided into two groups (10 each). One group was kept in wire-fenced yard beneath the shade of thatch (shaded group) while the other group was left unshaded just inside wire-fenced yard exposing to the open climatic conditions (unshaded group) for five days. Drinking water was available for the two groups twice a day. The animals received their nutritional requirements according to Kearn (1982).

4- Measurements and observations:

Ambient temperature (AT, °C), radiant ambient temperature (RAT, °C) and relative humidity (RH, %) were recorded, at shaded and unshaded pens, twice daily at 08.00 and 14.00 hr. during experimental period. Both AT and RH were recorded using thermo-hygrometer, while RAT was recorded using a bulb made of copper (16 cm. diameter) painted black and fixed with a thermometer.

Respiration rate (RR, breaths/ min) by counting the flank movements in minute, rectal temperature (RT, °C) by using a standard clinical thermometer, coat (CT, °C) and skin temperatures (ST, °C) by using an electronic digital telethermometer as well as heart rate (HR, beats/ min) by using stethoscope were recorded twice daily at 08.00 and 14.00 hr..

5- Hematological parameters:

Jugular blood samples were collected daily, just before offering ration and water, into clean tube containing EDTA (Na_2 Ethylene diaminetetra acetic acid disodium salt). Hemoglobin concentration (Hb) according to Drabkin and Austin (1932) as well as packed cell volume (PCV, %) were immediately determined in the fresh blood. The mean corpuscular hemoglobin concentration (MCHC, %) were calculated as follows: $\text{MCHC} = (\text{Hb} \times 100) / \text{PCV}$ (%).

6- Statistical analysis:

Data were analyzed using General Linear Model procedure (SAS, 1998). Differences among means were tested according to Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

1- Meteorological data:

The ambient (AT) and radiant ambient temperatures (RAT) increased from the morning (08.00hr.) to the afternoon (14.00 hr.) in both experimental pens (Table 1). Similar diurnal changes in AT and RAT were reported by many investigators, e.g., Badawy *et al.* (1999), Shaker *et al.* (2005) and El- Rayes (2005). The present results indicated that shading reduced both of AT and RAT in the morning and the afternoon by about 0.45 °C and 6.00 °C for AT and 1.50 and 6.00 °C, for RAT, respectively. Likewise, Azamel *et al.* (1994) reported that AT was less by 3.38 °C while RAT was less by about 15.12 °C at 14.00hr. It is worthy to mention that shading resulted in more control on the magnitude of diurnal variation in AT (between 08.00 and 14.00hr.) to be only 5.40°C as compared with 10.95 °C recorded in unshaded pen. However, this variation increased in the case RAT to be 13.50 vs. 9.00 °C, respectively. Goats when kept unshaded especially in summer, would suffer from relatively heat stress particularly at mid-day, since the thermoneutral zone of Egyptian goats ranged from 20 to 30°C (El-Sherbiny *et al.*, 1983). Ahmed (1991) studied different kinds of shades in summer and reported that the values of reduction in AT at 06.00hr. represented 15.78, 17.10, 12.68 and 11.84% inside asbestos, plastic, metallic and thatch roofed pens, respectively of AT value in the unshaded site. The corresponding values at 14.00 hr. were 5.96, 6.20, 2.89 and 6.20%. The lowest reduction at the morning and the highest reduction at afternoon in AT were found in thatch pen site, meaning that the roof of natural material might ensure more comfort ambient temperature for goats.

Table (1): Mean values of meteorological data recorded at both unshaded and shaded pens.

Variable	Unshaded pen	Shaded pen	Change ¹
Ambient temperature (AT); °C			
08.00 hr.	33.05	32.60	- 0.45
14.00 hr.	44.00	38.00	- 6.00
Change ²	+ 10.95	+ 5.40	
Radiant ambient temperature (RAT) ; °C			
08.00 hr.	33.50	32.00	- 1.50
14.00 hr.	47.00	41.00	- 6.00
Change ²	+ 13.50	+ 9.00	
Relative humidity (RH); %			
08.00 hr.	38.00	39.00	+ 1.00
14.00 hr.	24.53	30.24	+ 5.71
Change ²	-13.47	- 8.76	

1, change due to shading.

2, change due to day-time.

On the contrary, relative humidity (RH%) showed an inverse diurnal trend to that of AT and RAT, being higher in the morning than in the afternoon in both experimental sites. This observation was previously reported by El-Sherif (1983), Azamel *et al.* (1994), El-Shafie (1997), and Badawy *et al.* (1999).

In conclusion, the present results indicated that modification of the surrounding microclimate by providing shading would reduce the environmental heat stress in summer.

2- Thermo- cardio- respiratory responses:

2- 1- Thermal responses:

Providing shading resulted in reducing the mean values of thermal responses (RT, ST and CT) for shaded goats compared with those of their counterparts left unshaded with difference being highly significant (Table 2). These reductions in RT, ST and CT values due to sheltering might be achieved through the alleviation of AT and RAT falling on the shaded animals as compared to their counterparts left unshaded. Working on goats (Ahmed, 1991; Badawy *et al.*, 1999 and Shaker *et al.*, 2005) and sheep (Azamel, 1994) found a significant decrease in animals' thermal parameters mean values in summer and the reduction observed in RT was lower than those of ST and CT even for shaded or unshaded groups which might be attributed to the homeothermy. Montsma *et al.* (1985) reported that the effect of ambient temperature on ST was more significant than on RT of the animals.

Table (2): Least square means±SE of the physiological parameters and their changes for the two experimental groups during summer

Item	RT	ST	CT	RR	HR
Overall means	40.04±0.107	39.73±0.143	39.73±0.140	50.44±1.870	76.08±0.799
Treatments:	(±0.050)**	(±0.068)**	(±0.084)**	(±0.908)**	(±0.750)**
Shaded	39.26 a	38.92 a	39.03 a	48.49 a	73.04 a
Unshaded	40.78 b	40.49 b	40.42 b	50.25 b	76.90 b
(Change; °C)	(- 1.52)	(- 1.57)	(- 1.39)	(- 1.76)	(+ 3.86)
Time of day:	(±0.050)**	(±0.068)**	(±0.084)**	(±0.908)**	(±0.750)**
08.00hr.	39.61 a	38.86 a	39.05 a	35.85 a	71.32 a
14.00hr.	40.43 b	40.57 b	40.40 b	64.89 b	78.62 b
(Change; °C)	(+ 0.82)	(+ 1.71)	(+ 1.35)	(+ 29.04)	(+ 7.30)
Treatment X Time:	(±0.070)**	(±0.098)**	(±0.123)**	(±1.285)**	(±1.061)**
Shaded: 08.00hr.	39.07a	38.24a	38.29a	35.40a	68.44a
Shaded: 14.00hr.	39.44b	39.62b	39.77b	61.57b	77.64b
(Change; °C)	(+ 0.37)	(+ 1.38)	(+ 1.48)	(+ 26.17)	(+ 9.20)
Unshaded: 8.00hr.	40.15a	39.48b	39.80b	36.30a	74.20c
Unshaded: 4.00hr.	41.41d	41.52c	41.34c	68.20c	79.60b
(Change; °C)	(+ 1.26)	(+ 2.04)	(+ 1.54)	(+ 31.90)	(+ 5.40)

ns, non-significant

**₁, P < 0.01

RT, rectal temperature; °C.

ST, skin temperature; °C.

CT, coat temperature; °C.

RR, respiration rate; breaths/minute.

HR, heart rate.

Mean in the same column, in a certain item having the same letter do not differ significantly.

Finch *et al.* (1980) reported that black goats were found to absorb between 50 and 100% more heat when exposed to the sun. Consistently, Barghout *et al.* (1995) found that CT was positively correlated with AT. Diurnal changes in mean values of RT, ST, and CT, which increased from the morning to the afternoon, were highly significant (Table 2). This diurnal changes in ST values was attributed to the serious increases in AT and RAT from 08.00 to 14.00hr. (Table 1). Similar results were obtained by many authors, e.g., El-Shafie (1997) and El-Ganaïeny and Abdou (1999).

These diurnal trends were observed in both experimental groups. The diurnal increases in RT of both shaded (0.37 °C) and unshaded (1.26 °C) groups were parallel to the wide increases in both AT and RAT (Table 1). The present results were in accordance with those obtained by Montsma *et al.* (1985), Ahmed (1991), Badawy *et al.* (1999) and El-Ganaïeny *et al.* (2001). However, the mean diurnal change in RT values for unsheltered goats was higher significantly ($P < 0.01$) than that of their sheltered counterparts. This result explained the significant sheltering x time of day interaction on RT parameter (Table 2). So providing sheltering for Bedouin goats improved their heat tolerance since the rectal temperature is used for monitoring the core temperature of the animal's body although the latter is still slightly higher than the former. Similar results were found by Azamel *et al.* (1994) who reported that the sun-exposed ewes and goats had a higher change magnitude in RT values as compared to their counterparts kept under sheltering.

The changes in mean values of thermal responses for shaded group were more limited than those of the unsheltered one indicating the relative difference in heat loads falling on both groups. The shaded goats might be able to minimize the changes of their thermal parameters, being received lower magnitude of AT and RAT at 14.00 hr. than unshaded group (Table 1). The present results would support those of Azamel *et al.* (1994), Badawy *et al.* (1999) and Shaker *et al.* (2005) that the shade is a simple means for modifying the environmental conditions of the tropics.

The mean values of RT, ST, and CT for shaded group were lower than those of unshaded one either in the morning or in the afternoon. The present results indicated that shaded goats were likely less suffering environmental heat stress as compared to their counterparts left unsheltered. This may be due to the resultant reduction in RAT included providing sheltering.

2- 2- Respiration rate:

Concerning the shading effects, the mean values of respiration rate were reduced as a result of providing shade with difference being highly significant (Table 2). Likewise, Shaker *et al.* (2005) reported that the mean values of RR reduce significantly because of providing natural shade. Furthermore, Baccari *et al.* (1997) found that the RR value of sun-exposed goats was significantly greater than shaded ones.

Irrespective of sheltering treatment, the diurnal increase in RR values was significant (Table 2). Similar results were reported by many authors, e.g., Ahmed (1991), Azamel *et al.* (1994), Badawy *et al.* (1999), El-Ganaïeny *et al.* (2001), Shaker *et al.* (2005), and El- Rayes (2005). Correlation coefficient

between RR mean value and AT value was reported to be significant (Ghosh *et al.*, 1993).

The magnitude of diurnal changes between the two treatment groups were in proportional with the magnitude of diurnal change in AT and RAT of each pens. These results showed that thatch, as a natural material was an effective mean to lessen the heat stress on the animals particularly during the hottest period of the day (14.00hr.).

At 08.00 and 14.00 hr. shaded goats had lower RR values than unshaded ones. This would be expected as shading reduced the heat load falling on shaded animals as compared with unshaded ones. Such reduction in RR might be an effective mechanism to conserve water that would be lost through respiratory tract of the stressed animals especially under desert conditions. Azamel *et al.* (1994) demonstrated that providing shelters to the desert animals would be advantageous for better adaptation and efficient production through saving the already rare food and water.

2- 3- Heart rate:

Concerning the shading effects, the mean values of heart rate for shaded Bedouin goats were lower insignificantly than those of unshaded ones (Table 2). This reduction due to shading was achieved through the reduction recorded in AT and RAT at shaded pen as compared with unshaded one (Table 1). In consistency, Ghosh *et al.* (1993) found that mean values of HR of goats were positively related to AT. Kumar and Singh (1994) found that exposure to TSR for 8 hrs (40 °C AT) increased the HR of Indian goats.

Irrespective to the shading effect, results demonstrated that the mean values of heart rate increased significantly ($P < 0.01$) from the morning to the afternoon for shaded and unshaded Bedouin goats being higher in unshaded pen than shaded one (Table 2). Working at the same location and on the same breed, El-Rayes (2005) reported that HR increased ($P < 0.01$) at 14.00 hr. than at 07.00hr. In agreement, El-Sherif (1983) reported average HR of goats overall the year to be 80.81 bpm at morning and 87.14 bpm at afternoon. Kumar and Singh (1994) reported that the increase in HR followed that the increases in AT and RAT. Ghosh *et al.* (1993) stated that HR of goats was positively related to ambient temperature.

3- Body- environmental temperature gradients:

At both day times (08.00 and 14.00 hr.), the inner temperature gradient between RT- ST value for shaded group was higher than for the unshaded one (Table 3). This might be attributed to the effect of shade in reducing the RT values, which in turn facilitate the heat flow from RT to ST especially under sun exposure. The results of medium temperature gradient between ST-CT demonstrated that all Bedouin goats in the experimental pens had negative ST- CT values in the morning and the afternoon, which indicated the role of coat in thermoregulation (Table 3). The high AT in the unshaded sites (44; °C, Table 1) caused increases of the coat surface temperature of the unshaded animals. Also, the results revealed that the least gradient values were for skin-coat temperature, which might reflect an efficient role of the coat in thermoregulation in climatic conditions (El- Ganaieny and Abdou, 1999). The

means of outer gradient (CT- AT) demonstrated that the heat transfer in afternoon of shaded goats was more readily as compared with their counterparts left unshaded (Table 3).

At 08.00 hr., total gradient between body core and environmental temperature (RT- AT) values was lower for shaded goats than that for unshaded ones which might be resulted from the lower values of the AT and RT of shaded group as compared with those of unshaded one (Tables 1 and 2). However, in the afternoon, the value of RT- AT of shaded group was higher than that of unshaded ones, which might be owing to the reduction in ambient temperature or load falling on goats and in turn increases total temperature gradient, which enhanced the heat flow to the hot environment (Shaker *et al.*, 2005).

4- Hematological parameters:

4- 1- Packed cell volume:

Mean values of PCV (%) recorded for shaded goats exceeded insignificantly that of unshaded ones (Table 4). There is an inverse relationship between the PCV values and AT (El-Shafie, 1997). El-Sherif *et al.* (1996) reported that providing sheltering to sheep resulted in non-significant increase in PCV values.

Table (3): Means of environmental- body temperature gradients (°C) for the two experimental Bedouin goats groups during summer

	RT- ST	ST- CT	CT- AT	RT- AT
At 08.00 hr.				
Shaded group	0.83	-0.05	5.69	6.47
Unshaded group	0.67	-0.32	6.75	7.10
At 14.00 hr.				
Shaded group	-0.18	-0.15	1.77	1.44
Unshaded group	-0.11	0.18	- 2.66	- 2.59

AT, ambient temperature.

CT, coat temperature.

ST, skin temperature.

RT, rectal temperature.

Table (4): Least square means± SE of the hematological parameters for the two experimental Bedouin goats groups during summer

Parameter	Shaded group	Unshaded group	Overall mean
PCV	23.25± 0.232	22.80± 0.232	23.03± 0.174
Hb	8.79± 0.426	8.29± 0.426	8.45± 0.299
MCHC	38.61± 1.838	35.76± 1.838	37.18± 1.326

PCV, packed cell volume (%).

Hb, hemoglobin (g/dl).

MCHC, mean corpuscular hemoglobin concentration (%)

Likewise, Azamel (1984) reported that the difference in PCV value between asbestos shaded ewes and unshaded ones was not significant. Hassanin *et al.* (1996) revealed that shading, as resulted in decreasing AT, increased the PCV values of goats. Exposure to sun could cause a state of hemodilution, since the unshaded animals had higher ($P<0.01$) blood and plasma volume as compared to shaded ones (El-Sherif *et al.*, 1996). This in turn might decrease PCV (%) values.

4- 2- Hemoglobin and corpuscular hemoglobin concentrations:

The insignificant increase in Hb and MCHC concentrations due to shading could be attributed to significant decrease in RAT in sheltered site. Similar trends were reported by Shaker *et al.* (2005) on Baladi and El-Shafie (1997) on Baladi and Damascus goats. Consistently, Barghout *et al.* (1995) found that Hb concentration was negatively correlated with environmental temperature. The decrease in hemoglobin concentration at high ambient temperature might be due to the reduction in the concentration of RBC's in the blood as an attempt to reduce O₂ carrying capacity of blood to depress the metabolic rate under heat stress condition. This reduction in RBC's is a result of blood dilution due to increase water intake and/or adjusted by increasing storage in spleen (Reece, 1991).

Conclusion

In conclusion, providing shading to Bedouin goats in summer could be an effective mean for alleviating the adverse effect of environmental heat stress and improving their heat tolerance as indicated by their lower physiological parameters at mid-day. Moreover, shading provide a constant thermal condition surrounding the Bedouin goats as indicated by the narrow changes in meteorological and thermo- cardio- respiratory responses from the morning to the afternoon under such desert condition prevailed in El- Shalateen – Halaieb- Abo- Ramad triangle.

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تأثير التظليل على تحسين تأقلم الماعز البدوي الاسود في مثلث حلايب- شلاتين - ابو

رماد

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قسم فسيولوجيا الحيوان والدواجن - شعبة الانتاج الحيوانى والدواجن - مركز بحوث الصحراء- المطرية- القاهرة

أجريت هذه الدراسة في محطة بحوث حدرية مثلث حلايب- شلاتين - ابو رماد ١٤٠٠ كيلومتر جنوب شرق القاهرة والتابعة لمركز بحوث الصحراء. كان الهدف من هذا البحث دراسة تأثير التظليل لتخفيف الاجهاد الحرارى للماعز البدوي الاسود اثناء فصل الصيف. استخدم في هذه التجربة ٢٠ عشرين ذكر ماعز بدوي اسود بمتوسط عمر من ١٢- ١٨ شهر ومتوسط وزن $18,80 \pm 0,93$ كيلوجرام قسمت الحيوانات الى مجموعتين: المجموعة الاولى وضعت تحت الظل أما المجموعة الثانية فقد وضعت معرضة للظروف المناخية. تم تسجيل البيانات الارصادية (درجة حرارة البيئة المحيطة بالحيوانات، درجة حرارة الاشعاع الشمسى، درجة الرطوبة النسبية) مرتين يوميا كما تم أخذ القراءات الفسيولوجية (درجة حرارة كل من المستقيم- الجلد- غطاء الجسم بالإضافة الى معدل التنفس ومعدل ضربات القلب) مرتين يوميا (٨ صباحا ، ٢ ظهرا). كما تم جمع عينات الدم وتقدير كل من نسبة الهيماتوكريت، تركيز الهيموجلوبين وحساب النسبة المئوية لتركيز الهيموجلوبين داخل خلايا الدم الحمراء المنضغطة.

أظهرت النتائج أن التظليل في فصل الصيف خاصة اثناء فترة الظهيرة أدى الى انخفاض كل من درجة حرارة البيئة المحيطة بالحيوانات ودرجة حرارة الاشعاع الشمسى وكنتيجه لذلك فان الماعز البدوي الاسود المظلة سجلت قيم اقل بشكل معنوى ($P < 0.01$) لكل من درجة حرارة المستقيم و الجلد وغطاء الجسم بالإضافة الى معدل التنفس كما أدى الى انخفاض غير معنوى في معدل ضربات القلب بالمقارنة بمثيلاتها الغير مظلة.

اوضحت النتائج ان معدل انتقال الحرارة من الجسم الى البيئة المحيطة بالحيوانات كان افضل فى الماعز المظلة عنه فى تلك التى تركت بدون تظليل. كما أدى التظليل الى تحسين صفات الدم المدروسة ولكن بشكل غير معنوى.

الخلاصة: خلصت التجربة الى ان التظليل صيفا قد أدى الى تحسين الظروف البيئية المحيطة بالحيوانات ممثلة فى الاستجابات الفسيولوجية للحيوانات وكذلك معدل فقد أو اكتساب الحرارة وصفات الدم للماعز البدوي الاسود المرماه فى مثلث حلايب- شلاتين- أبو رماد جنوب الصحراء الشرقية لمصر.