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Some Physiological Responses in Nubian Goats Exposed to Heat load

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Abstract— *Goats make a very valuable contribution for most of rural area. This study was conducted to know some responses of Nubian goats when it exposed to thermal stress in the natural pasture. Twelve Nubian goats were used in the study and divided into two groups: group (A) Goats under the sun and group (B) Goats under shadow. Physiological parameters (rectal temperature, respiratory rate and pulse rate) were determined in both, goats under the sun and goats under shadow. Blood samples were collected from each goat at the last day of the experiment. Hemoglobin concentration (Hb), packed-cell volume (PCV), red blood cells count (RBCs) and total white cells (TWBCs) were determined using the standard laboratory methods. Rectal temperature did not vary between the goats under the sun and the goats under shadow. Respiratory rate and pulse rate varied significantly (p<0.05) between the two group. Goats under the sun registered significantly higher values for respiratory rate (37.28+8.90 breaths/min) and pulse rate (84.78+4.42 beats/min) compared with goats under shadow (26.83+5.69, 77.06+3.67), respectively. Hb, PCV, RBCs count and TWBCs did not vary significantly between the goats under the sun and the goats under shadow. It was concluded that, Nubian goats adapted to the AlBtana environment.*

Keywords— *Heat stress; Goat; Physiological parameters.*

I. INTRODUCTION

Heat stress is the major important factor influencing livestock production in the changing climatic condition. Thus, research efforts are needed to identify thermo-tolerant breeds which can help to optimize livestock production during thermal stress challenges [1]. Goats play a preponderant role in the economy of million people, and have provided meat, milk, skin and fiber for centuries [2]. Also, these animals are well adapted under different environmental conditions including extreme and harsh climates [3], [4], and perform better than other domesticated ruminants [2]. However, goats tend to tolerate heat better than sheeps [5], [6]. High ambient temperatures and high direct and indirect solar radiations are environmental stressing factors, according to the climatic changes [7].

Physiological adjustments are very essential to maintain normal body temperature and prevent hyperthermia [8]. Physiological parameters like respiratory rate, heart rate and rectal temperature give an immediate response to heat stress [9], [10]. Changes in respiratory rate, heart rate and rectal temperature have been considerably used as indices of physiological adaptability to heat stress in small ruminants [11]. Increased body temperature and respiratory rate are the most important signs for thermal stress in goats [12], [13], [14]. The blood system is sensitive to ambient temperature changes and is an important indicator of physiological responses to stressors [15].

AlButana is the rural area in Sudan; goat makes a very valuable contribution for most of families. Nubian goats are found as grazing animals in AlButana area where the temperature may rise to 43°C, exposing animals to high temperature and high solar radiation. This study aims to know some responses of Nubian goat when it exposed to thermal stress in the natural pasture.

II. MATERIALS AND METHODS

A. Study Area

This study was done in AlButana area, Sudan, which it lays approximately between latitude 14º-16º N and longitude 33º-36º E.

B. Experimental Animals and Duration

The study was carried out on 12 goats (Nubian goats) aged between 3 and 4 years. Animals were divided into two groups: group (A) Goats under the sun and group (B) Goats under shadow. The experiment period was 12 days preceded by 5 days as the adaptation period. All the animals were physiologically healthy and free from any physical abnormalities.

C. Metrological Data

Ambient temperature (Ta) during the study period was provided the Meteorological Unit, Wad-Medani city.

D. Physiological Parameters

The rectal temperature (Tr), Respiratory rate (Rr) and Pulse rate were measured at 3pm daily during the study period. The rectal temperature (^{0}C) of the goat was obtained by using a digital thermometer (ACON). The animals were handled gently and the probe was inserted into the rectum 7cm touching the wall of the rectum for two minutes. Respiratory rate (breath/min) was determined visually by counting the frequency of flank movement per minute using a stopwatch. Pulse rate (beat/min) was measured by feeling the jugular vein with hand per minute using a stopwatch.

E. Blood Collection

Blood samples were collected from each goat at the last day of the experiment. Five ml of blood were obtained from jugular vein using 5 ml sterile plastic disposable syringes and delivered into vials containing di-soduim ethylenediamine-

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tetraacetate (Na2 EDTA) as an anticoagulant for the hematological analyses.

F. Blood Analysis

Haemoglobin concentration (Hb) was determined by the cyano- methaemoglobin method as described by [16]. The packed cell volume (PCV) of erythrocytes was determined by the micro-haematocrit method using haematocrit centrifuge. Erythrocytic count and white blood cells count were determined according to the method described in Schalm's Veterinary Hematology [17].

G. Statistical Analysis

One way analysis of variance (ANOVA) test was used to determine the effect of the heat load on the parameters investigated using SPSS version 21 computer program. Mean separation was performed using Duncan Multiple Range Test.

III. Results

The ambient temperature during the experiment range was 23.3 – 39.6 0C.

Table I shows the effect of heat load on the physiological parameters of Nubian goat. Rectal temperature did not vary between the goats under the sun and the goats under shadow. Respiratory rate and pulse rate varied significantly ($p<0.05$) between the two group. Goats under the sun registered significantly higher values for respiratory rate and pulse rate compared with goats under shadow.

TABLE I. The effect of heat load on the physiological parameters of Nubian goat

Parameters	Goat Groups		L.S
	A (mean+SD)	B (mean+SD)	
Rectal temperature (^{0}C)	39.36+0.32	39.07+0.74	NS
Respiratory rate (breaths/min)	37.28a+8.90	26.83b+5.69	*
Pulse rate (beats/min)	84.78a+4.42	77.06b+3.67	*

A: Goats under the sun, B: Goats under shadow, SD: Standard deviation, L.S: level of significant, NS: non-significant, *: P<0.05. a and b: means values within the same row having different superscripts, differ significantly.

The effects of heat load on some hematological values are shown in Table II. Hemoglobin concentration, PCV, RBCs count and TWBCs did not vary significantly between the goats under the sun and the goats under shadow.

TABLE III. The effect of heat load on the physiological parameters of Nubian goat

Parameters	Goat Groups		L.S
	A (mean+SD)	B (mean+SD)	
Hb (g/dl)	10.17+0.64	10.55+0.83	NS
PCV (%)	17.17+3.22	15.93+2.10	NS
RBCs (X106/mm3)	4.98+0.05	5.12+0.06	NS
TWBCs (X103/mm3)	5.280+0.12	5.936+0.13	NS

A: Goats under the sun, B: Goats under shadow, SD: Standard deviation, L.S: level of significant, NS: non-significant.

IV. Discussion

In this study rectal temperature did not vary significantly between the goats under the sun and the goats under shadow. This comparable to the results of [13], [18], [19] who concluded that no rectal temperature changes were reported when goats exposed to heat treatments. In contrast, Heat exposure increased goats' rectal temperature from 37°C to 41°C [20], [21].

The results showed that goats under the sun registered significantly higher values for respiratory rate compared with goats under shadow. This agrees with the finding of [22] and [21] who reported that respiratory rate Increased following heat stress in goats. Respiratory rate is a reliable measure of heat load and an indicator of thermal stress [13], [23]. The basal reference respiratory rate is 15 – 30 breatheat stress/min in goats [24]. So, measuring respiratory rate and deciding if an animal is panting, and qualifying the severity of heat stress according to panting rate (breatheat stress/min) (low: 40 – 60, medium: 60 – 80, high: 80 – 120, and severe heat stress: >200) appears to be the most accessible and easiest method for evaluating the impact of heat stress on animals under extreme conditions [5]. As environmental temperature approaches skin temperature, the rate of heat dissipation through sensible heat loss decreases [25]. As heat stress progresses, there is recruitment of evaporative processes, primarily sweating and increased respiratory rate [26]. When heat stress becomes more severe, the depth of respiratory increases back to near normal tidal volume while the respiratory rate remains elevated above normal [27]. The increased respiratory rate is probably indicating an effort of animals to maintain their normal body temperature by increasing their heat dissipation through increasing respiratory evaporation [28]. The hyperthermia during exposure to heat stress is the result of the decreased thermal gradient between the animal and the surrounding environment, and as a result sensible heat loss (convection, conduction and radiation) becomes less effective and so under these conditions an animal must rely on evaporative cooling mechanisms from its skin and respiratory tract [12].

The present study found that goats under the sun registered significantly higher values for pulse rate compared with goats under shadow. This finding similar to that reported by [13], [21] who found that heat exposure showed a higher heart rate in goats, from 74 to 91 beats/min. Mechanisms which have developed through evolution to allow animals to adapt to high environmental temperatures and to achieve thermo-tolerance include increased blood flow to take heat from the body core to the skin and extremities to dissipate the heat [29]. The heart rate increases under heat stress conditions, and this increases blood flow from the core to the surface of the body to give a chance for more heat to be lost by sensible (conduction, convention and radiation) and insensible (diffusion water from the skin) means [30], [2].

In this work hemoglobin concentration, PCV, RBCs count and TWBCs did not vary significantly between the goats under the sun and the goats under shadow. This finding not comparable to the results of [13], [31] who reported that when exposed to heat stress, goats showed an increased amount of red blood cells, packed cell volume, hemoglobin and white blood cells. Also, the result of [21] who reported that packed cell volume, hemoglobin and red blood cells were higher under heat stress in goats. In contrast, heat stress decreases packed cell volume and hemoglobin in sheep and goats [32], [33], and white blood cells in goats [21].

The thermoneutral zone is about 12 – 24°C for goats in the hot regions of the world [34], while the ambient temperature in AlButana area during the experiment was 23-39°C and goats did not show hyperthermia. Hyperthermia represents as a failure in thermoregulation, uncontrolled heat production, poor heat dissipation or an external heat load [35]. Thus, Nubian goat in this study did not show hyperthermia and therefore hematological values, using increased respiratory rate and pulse rate to protect themselves from thermal stress and its physiological effects. Respiratory rate and pulse rate are the parameters which illustrate the mechanism of physiological adaptation [36]. The exposure of small ruminants to elevated ambient temperatures induces an increase in the dissipation of excess body heat in order to negate the excessive heat load. Dissipation of excess body heat is excluded by evaporation of water from the respiratory tract and skin surface via panting and sweating, respectively. When the physiological mechanisms of the animal fail to negate the excessive heat load, the rectal temperature increases and the evaporation becomes the most important avenue for heat dissipation [37]. When the environmental temperature rises to 36°C, the ears and legs of goats dissipate a high proportion of the heat [38].

V. CONCLUSION

From this study it can be concluded that Nubian goats adapted to AlBtana environment using heat loss methods, by increasing evaporation through the respiratory tract and skin surface without using critical physiological changes.

VI. RECOMMENDATION

Nubian goats are suitable for living in AlButana environment; we need more comprehensive studies on the adaptation of Nubian goat in this area. The adaptation of other breeds in AlButana area should also be studied.

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