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Comparative assessment of heat and cold stress-induced changes in clinical parameters in Boer goats

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Abstract

This study was carried out on heat- and cold-adapted boar goats kept in their natural habitat to examine the physiological parameters and their seasonal fluctuations in relation to the adaptation to heat stress in boar goats. The study was conducted in two distinct stages that corresponded with the winter and summer seasons. Under the experiment, twelve experimental boar goats of both sexes were chosen at randomly. The goats were 1.5 to 2 years old and weighed between 16 to 22 kg. The temperature-humidity index (THI) was calculated by recording the daily temperature of the surrounding air and relative humidity using a digital hygrometer and thermometer that were placed in the animal shed. In this study, Heart rate (HR), respiration rate (RR), and rectal temperature (RT) were combined to determine physiological markers for thermal stress susceptibility. The temperature-humidity index (THI) was calculated by observing the daily ambient temperature and relative humidity. The THI value of summer and winter season were 31.67 and 15.34, respectively. The findings of this study revealed that the levels of physiological responses, such as rectal temperature, respiration rate, and heart rate, were significantly (p 0.05) differed throughout seasons (summer and winter) and recording periods. It has been discovered that THI, a sensitive indicator of both heat and cold stress, is more affected by ambient temperature in boar goats than relative humidity. Therefore, in Boar goats, heat and cold stress is related to certain physiological effects.

Keywords: Summer; Winter; Heat stress; Adaptation; Boar Goats.

1. Introduction

Goats that have adapted to a resilient environment perform better than other domesticated ruminants [1]. Goats have developed adaptive mechanisms that allow their survival at very high and low temperatures. However, despite their extreme tolerance to environmental changes, the productivity of these animals often declines due to thermal stress [2,3]. Productivity is adversely affected by changes in ambient temperature. Harsh environments constitute stressful conditions for animals, and as a result, these animals developed various adaptive mechanisms that enable them to survive under these conditions of extreme heat or extreme cold [4]. Goats are considered highly suitable animals for rearing in such areas. Changes in environmental variables are recognized as a potential hazard in livestock growth and production. Goats are warm-blooded animals and as such are characterized by the ability to maintain their body temperature within narrow limits; the body temperature is controlled by internal homeostatic mechanisms [5]. Physiological parameters such as the actual response or adaptability to hot or cold climate based on testing of the animals under the hot or cold climate conditions. The breed differences evoke different responses to the various stressors in a specific environment and depend on the degree of adaptation to that environment [6]. The climatic elements that most influence the increase in physiological parameters in order of importance are environmental

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temperature, solar radiation, humidity, and air movement [7]. Animals respond differently to drastic temperature changes by altering several aspects of their physiology and behavior [8,9]. These changes include alterations in physiological parameters (rectal temperature, RT; heart rate, HR; respiratory rate, RR) [1]. In this outset, we aimed to assess and compare the physiological parameters attributing adaptable characters in hot and cold climates of the Boar goats maintained in their natural habitat.

2. Materials and methods

2.1. Experimental Location and Animals

This experimental work was conducted on Research Animal Farm (RAF) of the Department of Surgery and Obstetrics, Faculty of Veterinary Science, Bangladesh Agricultural University (BAU). Twelve experimental boar goats of either sex were randomly selected under the experiment. The goats were 1.5 to 2 years old and had an average body weight of 16 to 22 kg. At the time of the experiment, all the animals were clinically healthy and free from any physical or anatomical abnormalities. The experiment was carried out during two distinct phases coinciding with two seasons of the year viz. summer (April – July) and winter (November – February) season when the ambient temperature was highest and lowest respectively. All the animals were closely monitored and were provided with similar managemental inputs during the experimental period. Sufficient feed and clean ad libitum water were available for the experimental animals round the clock.

2.2. Climatological Measurements

During all the experimental period, values of temperature and relative humidity were recorded (maximum, mean and minimum) with the help of a digital thermo-hygrometer placed at a height of the center of mass of the animals. The environmental parameters were recorded twice daily in the morning and afternoon. The temperature- humidity index (THI) was calculated according to the formula proposed by Marai et al. [10]:

Based on ambient temperature and relative humidity, Temperature Humidity Index (THI) was calculated with the formula Marai et al. [10]:

$THI = tm^0 c - \{(0.31 - 0.31 \times RH\%) \times (tm^0 c - 14.4)\}$

Where,

$tm^0 c$ = Temperature in Celsius

RH = Relative humidity percentage/100.

The THI values are classified as follows: <27.8= absence of heat stress, 27.8 - < 28.9= moderate heat stress, 28.9 - <30.0 = severe heat stress, and 30.0 and more = very severe heat stress [10].

2.3. Clinical Examination

Clinical parameters (rectal temperature, respiratory rate, and heart rate) of the animals were recorded daily during the summer and winter season. Respiratory rate (RR) was determined by means of visual evaluation, observing the movements of the flank, and determining the movements per minute (breaths/min). Heart rate (HR) was measured by auscultation of the heart with a flexible stethoscope, directly in the left thoracic region, determining the beats per minute (beats/min).

2.4. Statistical Analysis

All the data were expressed as Mean ± SEM (Standard Error of Mean). The Statistical Package for the Social Science (SPSS) version 20.0 was used to run an independent sample t-test to compare the data between the groups. Probability $P<0.05$ was regarded statistically significant.

3. Results

The average climatic parameters recorded during the experimental periods are presented in Table 1. During the summer season, the average ambient temperature and relative humidity was recorded 32.62 ± 2.43 (°C) and 83.21± 4.15 respectively. The obtained temperature humidity index was 31.67± 0.78 which represented animals were in very

severe heat stress. Whereas during winter season, the calculated THI was 15.34 ± 1.54 based on data on ambient temperature (AT) and relative humidity (RH) which represented animals had no stress and the recorded average ambient temperature was 15.35 ±1.93 (°C) and the average relative humidity was 96.72 ±1.37 in winter season.

Table 1 Ambient temperature, relative humidity, and temperature-humidity index (THI) of the summer and winter season

Season	Ambient Temperature (AT) (◦ C)	Relative Humidity (RH)	THI
Summer	32.62 ± 2.43	83.21± 4.15	31.67± 0.78
Winter	15.35 ±1.93	96.72 ±1.37	15. 34 ± 1.54

Table 2-4 summarized the daily and seasonal changes in physiological parameters of boar goats. The results showed that the rectal temperature, were statistically (P< 0.05) different between seasons and times of recording. The recorded value of rectal temperature was significantly (P<0.05) higher in afternoon as compared to morning during summer and winter season. However, there was statistically significant (P< 0.05) variation was observed in the respiration at the time of recording of boar goats during summer and winter season. Heart rate showed the same pattern of respiration rate, as it was lower in morning in both summer and winter season as compared to afternoon and the changes were statistically significant (P< 0.05). Moreover, In the morning, there was a substantial (P<0.05) decrease in the recorded values of temperature, heart rate, and respiration rate compared to the afternoon values.

Table 2 Physiological parameters of Boar goats during summer and winter season.

Season	Time	RT (^{0}F)
Summer	Morning	101.74± 1.21^{ax}
	Afternoon	103.23± 0.81^{bx}
Winter	Morning	99.66± 0.58^{ay}
	Afternoon	101.67± 0.61^{by}

$^{a, b,x,y}$ Mean (± SE) within a column showing different superscripts are significantly different (P<0.05).

Table 3 Physiological parameters of Boar goats during summer and winter season

Season	Time	RR (breath/min)
Summer	Morning	35.54± 8.52 ^{ax}
	Afternoon	50.27± 9.49 ^{bx}
Winter	Morning	13.67±1.52 ^{ay}
	Afternoon	21.0± 6.24 ^{by}

$^{a, b,x,y}$ Mean (± SE) within a column showing different superscripts are significantly different (P<0.05).

Table 4 Physiological parameters of Boar goats during summer and winter season.

Season	Time	HR (beat/min)
Summer	Morning	89.6 ± 10.08 ^{ax}
	Afternoon	107.33 ± 9.85 ^{bx}
Winter	Morning	54.34± 4.04 ^{ay}
	Afternoon	71.67± 9.07 ^{by}

$^{a, b,x,y}$ Mean (± SE) within a column showing different superscripts are significantly different (P<0.05).

4. Discussion

Relative humidity was much higher during winter season than summer season, whereas ambient temperature was very high during summer season as compared to winter season. THI was higher during the summer season. Thus, it was considered that the higher ambient temperature causes higher THI during summer season and makes the summer more stressful as compared to winter. In this study, during the summer, each experimental animal was having severe heat stress; however, in winter, the THI values showed that each animal was comfortable. There was no heat stress during this period which is agreed with the score of Marai et al. [10].

The animals dissipate heat effectively; even at high temperatures in the dry season, rectal temperature (RT) was maintained within the limits indicated for this species. These findings are indicative of a good adaptive capacity of the animals to stressful conditions. In this study, body temperature rises more in the afternoon and the significant increase in rectal temperature is attributed to the increased ambient temperature and these results coincide with those of Al-hidary et al. [11]; Marai et al. [1].

The physiological functions of the animals, such as RT, RR and HR, can facilitate survival in a hot climate. Respiration rate and RT are useful indicators of thermal stress and can be used to assess the adversity of the environment [12], indicating an adaptation to high temperatures and natural selection in these animals caused by the alteration of the thermoregulatory point at the central level or the sensitivity of temperature receptors to a higher threshold. In the present study, RR was greater ($P< 0.05$) in the afternoon in both seasons. However, the mean RR was greater during the summer season than during the winter season. The RT is influenced by the time of day, as AT is greater during the afternoon [13,8]. In the summer season, afternoon RR was 50.27± 9.49 breath/min, indicating that the animals were subjected to considerable stress during this period. During this experiment, morning RR values were within the limit for goats which is similar to the findings of [14, 15]. However, a greater RR value does not necessarily indicate heat stress, as the animals maintained their RT at an appropriate level, indicating effective heat dissipation [16].

In this study, the HR was higher in the afternoon in both seasons, with 107.33 ± 9.85 and 71.67± 9.07 beats/min in the summer and winter season, respectively. Normally, HR increases with increasing AT levels, which are usually higher in the afternoon [8]. Heart rate during winter season was found significantly higher in Boar goats as compared to summer season at different times of recording which was contrary to the other findings [17, 18]. Higher heart rate during summer season suggests that active participation of thermoregulatory protective mechanism of goats. The adaptive capacity of the animals cannot be described solely by RT and RR. Therefore, adequate assessment of the adaptive profile requires the consideration of physiological and behavioral responses to environmental conditions.

5. Conclusions

It can be concluded that THI is a sensitive indicator of heat stress and is impacted by ambient temperature more than the relative humidity in boar goats. The physiological parameters of Boar goats were significantly altered by heat stress in both the summer and winter seasons.

Compliance with ethical standards

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Disclosure of Conflict of Interest

The authors declare no conflict of interest.

Statement of ethical approval

The study has been performed with the approval and guidelines of the Animal Welfare Experiment and Ethics Committee (AWEEC) of the Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh (permission Number: AWEEC/BAU/2022/09).

References

[1] Marai IFM, El-Darawany AA, Fadiel A, Abdel-Hafez MAM. Physiological traits as affected by heat stress in sheep—a review. Small Ruminant Research. 2007; 71(1–3):1–12.

[2] Devendra C. Comparative aspects of digestive physiology and nutrition in goats and sheep. In: Devendra C, I mazumi E, editors. Ruminant Nutrition and Physiology in Asia. 1990; 45–60.

[3] Al-Tamimi HJ. Thermoregulatory response of goat kids subjected to heat stress. Small Ruminant Research. 2007; 71: 280–285.

[4] Marai IFM, Habeeb AAM. Buffalo's biological functions as affected by heat stress – A review. Livestock Science. 2010; 127: 89–109.

[5] Nardone A, Ronchi B, Lacetera N, Ranieri MS, Bernabucci U. Effect of climate changes on animal production and sustainability of livestock systems. Livestock Science. 2010; 130: 57–69. doi:10.1016/j.livsci.2010. 02.011.

[6] Jindal SK. Effect of climate on goats: a review. Indian Journal of Dairy Science. 1980; 33: 285–292.

[7] Lee JA, Roussel JD, Beatty JF. Effect of temperature season on bovine adrenal cortical function, blood cell profile, and milk production. Journal of Dairy Science. 1974; 59:104–108

[8] Silva EMN, Souza BB, Souza OB, Silva GA, Freitas MMS. Evaluation of adaptability of goats to semiarid through physiologic parameters and structures of the tegument. Revista Caatinga. 2010; 23:142–148.

[9] Rasooli A, Nouri M, Khadjeh GH, Rasekh A. The influence of seasonal variations on thyroid activity and some biochemical parameters of cattle. Indian Journal of Veterinary Science. 2004; 5:1383.

[10] Marai IFM, Ayyat MS, Abd El-Monem UM. Growth performance and reproductive traits at first parity of New Zealand White female rabbits as affected by heat stress and its alleviation, under Egyptian conditions. Tropical Animal Health and Production. 2001; 33: 457–462.

[11] Al-Haidary AA. Physiological responses of Naimey sheep to heat stress challenge under semi-arid environments. International Journal of Agricultural Biology. 2004; 2:307–309.

[12] Daramola JO, Adeloye AA. Physiological adaptation to humid tropics with special references to the West African Dwarf (WAD) goat. Tropical Animal Health and Production. 2009; 41:1005–1016.

[13] Sejian V, Maurya VP, Naqvi SMK. Adaptability and growth of Malpura ewes subjected to thermal and nutritional stress. Tropical Animal Health and Production. 2010; 42:1763–1770.

[14] Hamzaoui SAAK, Salama AAK, Albanell E, Such X, Caja G. Physiological responses and lactational performances of late-lactation dairy goats under heat stress conditions. Journal of Dairy Science. 2013; 96(10):6355–6365.

[15] Silanikove N. The physiological basis of adaptation in goats to harsh environments. Small Ruminant Research. 2000; 35:181–193.

[16] Ribeiro NL, Furtado DA, Medeiros NA, Ribeiro MN, Silva RCB, Souza CMS. Assessment of thermal comfort indexes, physiological parameters, and thermal gradient of native sheep. Agriculture. 2008; 28:614–623.

[17] Devendra C. Goats. Ed. Johnson H.P. Bioclimatology and the Adaptation of Livestock. Elsevier Publication. 1987; 157:16-77.

[18] Sejian V, Maurya VP, Kumar K, Naqvi SMK 2012. Effect of multiple stresses (thermal, nutritional, and walking stress) on the reproductive performance of malpura ewes. Veterinary Medicine International. 2012; 5: 6.