

Thermoregulatory responses of adapted hair sheep breed in a semiarid environment

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Abstract: The aim of this study was to evaluate the thermoregulatory responses of Morada Nova sheep managed in a semiarid region. This study was carried out in four farms, characterized by extensive managed system. Meteorological variables air temperature (Air T°, C), relative humidity (RH, %), and black globe temperature (BGT, °C) were recorded. Furthermore, radiant heat load (RHL, W m⁻²) was calculated. Physiological traits as rectal temperature (RT, °C), respiratory rate (RR, breath/min.) and surface temperature (ST, °C; neck, flank, and croup) were recorded at morning (9:00 a.m.) and afternoon (2:00 a.m.) on approximately 160 Morada Nova ewes in the farms at months of March, June, September, and December. The data were analyzed using month effect (March, June, September and December) and time of day (morning and afternoon). It was observed that the RHL, which March and September presented higher average values. The results shows the relation of RR with RHL, there is a direct relationship of these variables over the months in the morning, that is, in the months of higher RHL, higher RR were recorded. In the afternoon RT was higher in all months studied. The same pattern of behavior was observed in these variables in the two periods of the day, but with different intensities. A direct relationship between ST and RHL was not observed, but in the morning ST values were lower when compared to afternoon values this can be explain by effect of heat accumulated in the body, except in June that ST was higher in the morning, coinciding with lower values of RT and RR during the June at the same time. Animals triggered more intense the thermoregulatory mechanisms in the afternoon period, despite higher RHL values are recorded in the morning period, as the effect of heat accumulated in the body of the animal during the day. However, in March, the animals used more effectively the thermoregulation mechanisms, such as RR, RT and ST simultaneous, as a way to maintain homeothermia in the two periods studied. So it is important to provide environmental protection or shade during critical periods of the day, especially in March in this region, even for locally adapted breeds.

Keywords: adaptation, environmental conditions, heat stress, rectal temperature

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Introduction

The development and progress of the breed Morada Nova, counted on the unplanned crossing of sheep races of almost all the continent. Classified as a locally adapted breed of Brazil, it is associated with extensive production, and with this, exposed chronically to high levels of solar radiation, in the environmental conditions in the Brazilian Northeast. These animals are usually outside the zone of thermoneutrality mentioned in the literature, and possibly for that reason, they morphophysiologicaly adapted to the thermal stress regions that are created (Costa et al., 2015).

With the current scenario of climate change, mainly in tropical regions, the environment is characterized by high temperatures, high radiation throughout the year associated with variations of relative humidity. In this context, animals need to make thermoregulatory mechanisms active as a strategy to maintain homeostasis; however, some animals may find it difficult to adapt to these conditions, demonstrating reductions in productive and reproductive indexes due to health disturbances (Marai et al., 2007).

Because there is a strong relationship between the environmental conditions and the animal response, it is important to know the mechanisms used to achieve thermal equilibrium under the real combination of climatic factors. Therefore, the aim of this study was to assess the thermoregulatory responses of Morada Nova sheep exposed to solar radiation in a semiarid environment.

Material and Methods

The study was carried out at farms of the Morada Nova Breeding Program (6° S, 39° W). Physiological traits as rectal temperature (RT, °C), respiratory rate (RR, breaths min⁻¹), and surface temperature (ST, °C; neck, flank, and croup were recorded at morning (9:00 a.m.) and afternoon (2:00 a.m.) which are considered the most stressful times for animals, on approximately 160 Morada Nova ewes in the farms at months of March, June, September, and December.

As well as, the meteorological variables like (RH %), (Tar, °C) and black globe temperature (T_{bg} °C) were recorded, relative humidity and air temperature through a digital thermohygrometer, and the black globe temperature that was placed in the sun, it was recorded at the same moment of the taking of the physiological data, so for each animal will have a reading of the corresponding meteorological variables. Furthermore, radiant heat load (RHL, W m⁻²) was calculated according to Silva (2008):

$$RHL = 1,053 hc (T_{bg} - T_{air}) + \delta T_g^4, W/m^2$$

Where,

Hc = Convection coefficient of the black globe (W/m²),

T_g = Black globe temperature in the sun (°C),

T_{air} = Air temperature (°K),

δ = Constant of Stephan-Boltzman (5.66697 x 10⁻⁸ W/m²/K⁴).

The animals remained in the corral in the sun to perform the data collection, with the minimum of interference to not change the results. Respiratory rate was obtained by direct counting of the flank movements for one minute with caution and a safety distance so as not to alter the behavior of the animal, the rectal temperature was recorded using a digital clinical thermometer, with scale up to 44 °C, inserted directly into the rectum of the animal at a depth of approximately 5 cm, taking care to keep the sensor of the thermometer in contact with the mucosa until the beep sounds, and the reading is carried out in °C. The surface temperature was obtained through an infrared thermometer obtaining the temperature of the animal in three different regions of the body (neck, flank and croup) in °C. The physiological and environmental variables will be collected twice a day every three months for a year. The evaluation was performed with the animals in the sun.

The statistical model used was the following:

$$Y_{ijk} = \mu + M_i + T_j + E_{ijk}$$

Where: Y_{ijk} is the n-th observation of the physiological response to environmental conditions throughout the year, M_i represent the fixed effect of the month (i = March, June, September and December),

T_j represent the fixed effect of the j-th time of the day (j = morning and afternoon) and E_{ijk} is random error.

Results and Discussion

The analyzes of the relationship between rectal temperature, respiratory rate and surface temperature with the radiant thermal load are shown in Figure 1. It was observed that the RHL found in all months was greater in the morning, and the months of March and September had larger averages, followed by June and December, this behavior also observed in the afternoon but with lower values than those found in the morning.

In Figure 1.A1 (morning) and 1.A2 (afternoon) shows the relation of RR with RHL, there is a direct relationship of these variables over the months in the morning, that is, in the months of higher RHL, higher RR were recorded. RR is considered an almost immediate response to thermal stress and according to (Silanikove, 2000) the breathing rate can quantify the severity of heat stress, in which a frequency of 40-60, 60-80 breaths / min features a low and medium-high stress, only values in these two classes previously mentioned were found in the present study. In the afternoon the months that the animals used less intense RR were the months of September and December. The months of March and June are characterized by months that are concentrated rainfall in the region where the study was conducted, so the environment will have higher relative humidity and the animals will have greater difficulties in performing the changes with the environment by means of evaporative. In September and December for not having rains the relative humidity is lower and the evaporative losses are facilitated.

In Figure 1.B1 (morning) and 1.B2 (afternoon) shows the relationship of RT with RHL, the afternoon RT was higher in all months studied. The same pattern of behavior was observed in these variables in the two periods of the day, but with different intensities.

In Figure 1.C1 (morning) and 1.C2 (afternoon) shows the relationship of ST with RHL. A direct relationship between ST and RHL was not observed, but in the morning ST values were lower when compared to afternoon values this can be explain by effect of heat accumulated in the body though the day, except in June that ST was higher in the morning, coinciding with lower values of RT and RR during the June at the same time, in this way the animals warmed their body surface more than they increased their internal temperature, and used the loss of heat through the increase of the rate respiratory to be thermoregulated. Already in the afternoon probably due to the effect of accumulation of heat on the body with the passing of the hours of the day, the RR and ST averages increased and the ST decreased when compared to the average values of the morning period.

It is also observed that the behavior of RT in the Fig. 1. (B 1,2) and ST (C 1,2) in the two periods studied express the same pattern of behavior with respect to RHL with small variations. Thus, an increase in ST leads to an increase in RT, these results corroborate with those found by (Silva et al., 2017)

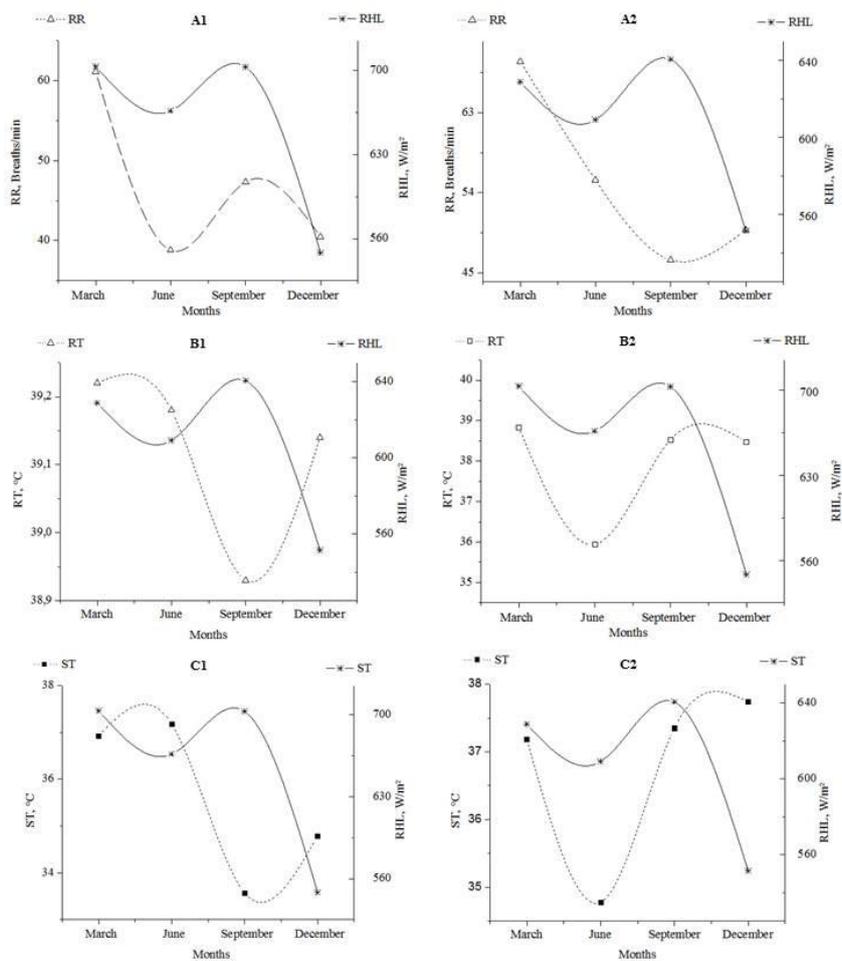


Figure 1. Relationship between Radiant Heat Load (RHL) and thermoregulatory characteristics of Morada Nova ewes during months of years, under environmental conditions in a semiarid region. A (RR, respiratory rate; B (RT, rectal temperature); C (ST, skin temperature). 1 (morning) and 2 (afternoon)

Conclusions

Animals triggered more intense the thermoregulatory mechanisms in the afternoon period, despite higher RHL values are recorded in the morning period, as the effect of heat accumulated in the body of the animal during the day.

However, in March, the animals used more effectively the thermoregulation mechanisms, such as RR, RT and ST simultaneous, as a way to maintain homeothermia in the two periods studied.

So it is important to provide environmental protection or shade during critical periods of the day, especially in March in this region, even for locally adapted breeds.

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