ETHOLOGICAL BEHAVIOR OF CREATED SHEEP IN THE SUN AND SHADE IN THE SEMI-ARID REGION OF PARAIBA STATE

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ABSTRACT: The objective of the present study was to evaluate the interference of two distinct environments in the ethological responses of Santa Inês and Dorper sheep during the dry period in the semi-arid region of Paraíba State. The study was carried out in the municipality of Caturité, Paraíba, Brazil, with 20 male sheep, 10 Santa Inês breed and 10 Dorper breed. The animals were placed in two different environments, in the sun and in the shade. The dietary behavior was determined by the quantification of the parameters by 10 hours / day, with an interval of five minutes. The experimental design was completely randomized, in a 2 x 2 factorial scheme, with two breeds and two environments and three replicates. The data were analyzed through Statistical Analysis Systemby, applying the chi-square test. Even with temperatures, relative humidity and BGHTI above the comfort zone for the sheep at certain times of the day, the animals did not present thermal discomfort. The animals of the Dorper breed, although exotic, exhibited behaviors similar to those of the Santa Inês breed, a naturalized breed, demonstrating a high adaptive potential for the semi-arid region.

KEYWORDS: Coverage, Dorper, environments, Santa Inês, welfare.

COMPORTAMENTO ETOLÓGICO DAS OVELHAS CRIADAS NO SOL E NA SOMBRA NA REGIÃO SEMIÁRIDA DO ESTADO DE PARAIBA

RESUMO: O objetivo do presente estudo foi avaliar a interferência de dois ambientes distintos nas respostas etológicas de ovinos da raça Santa Inês e Dorper durante o período de seca na região semiárida do Estado da Paraíba. O estudo foi realizado no município de Caturité, Paraíba, Brasil, com 20 ovinos machos, 10 da raça Santa Inês e 10 da raça Dorper. Os animais foram colocados em dois ambientes diferentes, ao sol e à sombra. O comportamento dietético foi determinado pela quantificação dos parâmetros por 10 horas / dia, com intervalo de cinco minutos. O delineamento experimental foi inteiramente casualizado, em esquema fatorial 2 x 2, com duas raças e dois ambientes e três repetições. Os dados foram analisados por meio do Statistical Analysis Systemby, aplicando o teste do qui-quadrado. Mesmo com temperaturas, umidade relativa do ar e BGHTI acima da zona de conforto para as ovelhas em determinados momentos do dia, os animais não apresentavam desconforto térmico. Os animais da raça Dorper, embora exóticos, exibiram comportamentos semelhantes aos da raça Santa Inês, raça naturalizada, demonstrando um alto potencial adaptativo para a região semiárida.

PALAVRAS CHAVE: Cobertura, Dorper, Ambientes, Santa Inês, Bem estar.

1 INTRODUCTION

Brazil comprises a total of 18,443,810 million sheep heads, 57.5% of which are distributed in the Northeastern region (IBGE, 2016). Sheep breeding exhibits a high potential in Brazilian livestock development process, mainly due to the great genetic variability of the animals in the country, considering that sheep species adapt to the most diverse environments, including semiarid regions, which exhibits high radiant loads (LIMA et al., 2014).

In semi-arid region, herds are mainly composed of animals with no defined racial pattern. These animals display remarkable rusticity but low productivity, with

live weight at 100 days of around 8 kg and average carcass weight of one-year-old males around 10 kg. However, it is necessary to understand which factors directly affect animal productivity, in order to maximize agricultural exploitation in the tropics (ROBERTO; SOUZA, 2011).

With the intention of maximize sheep productivity, is necessary to exploit their genetic potential alongside correct management practices, as well as maintain a balanced diet aiming to meet their nutritional requirements. Knowledge on sheep ingestive behavior displays have fundamental importance in dietary evaluations, since it allows the adjustment of the feeding management regime to obtain superior productive performance, guaranteeing desirable results (FIGUEIREDO et al., 2013).

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In this context, the aim of the present study was to evaluate the interference of two distinct environments, sun and shade, in the ethological responses of sheep during the dry period in the semi-arid region of Paraíba State.

2 MATERIAL AND METHODOS

The study was carried out in Brazil, in the micro region of Cariri in Paraiba State, at Umarí Farm, located in the city of Caturité at 7º 24'47 "S and 36º1'49"W. The region comprises a semi-arid climate, according to the Koppen classification (BSh). The maximum mean temperature in the region is of 37ºC, the minimum is of 16 ºC. The annual rainfall average is of 500 mm.

Environmental data, named as environmental temperature (ET), relative humidity (RH) and wind velocity (WS), were collected. ET and RH were obtained through HT500-type sensors, while WS was obtained through a thermohigroanemometer.

Black Globe Temperature (BGT) data was obtained by sensors installed inside black globes positioned in and outside the study facilities, at a corresponding to the center of animals. Data readings were carried every 60 min.

The Black Globe and Humidity Temperature Index (BGHTI) were calculated using the equation proposed by Buffington et al. (1981).

$$BGHTI = Tbg + 0.36Tdp + 41.5 \qquad (Equation\ 1)$$

Where:
BGHTI: Black Globe and Humidity Temperature Index;
Tbg: Black globe temperature and
Tdp: the dew point temperature.

The research period comprised the months of April to May of 2012, with a seven day experimental adaptation period to the experimental environment to management, followed by 46 days of data collection.

Twenty male sheep, 10 Santa Inês breeds and 10 Dorper breeds, 24 months old and weighing approximately 40 kg, were evaluated. The animals were subdivided into four lots, each containing five animals, allocated in two different environments of 24 m² and three meters of height. The first covered with fiber cement tiles and the second uncovered.

The forage was composed of Tifton hay (*Cynodon dactylon* (L) Pers), sorghum silage and palm forage and the concentrate, composed of soybean meal and corn, supplied twice daily at 7:00 AM and 4:00 PM. Water was supplied *ad libitum*.

Feeding behavior was determined for 10:00 h per day, with observations from 7:00 AM to 5:00 PM, with five minutes of intervals. The analyses were performed by observers positioned in a way to not disturb the animals (Table 1).

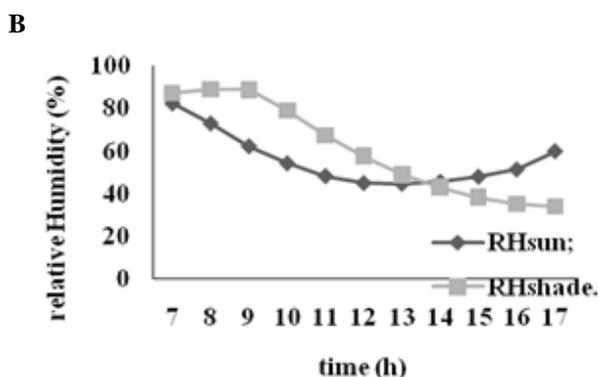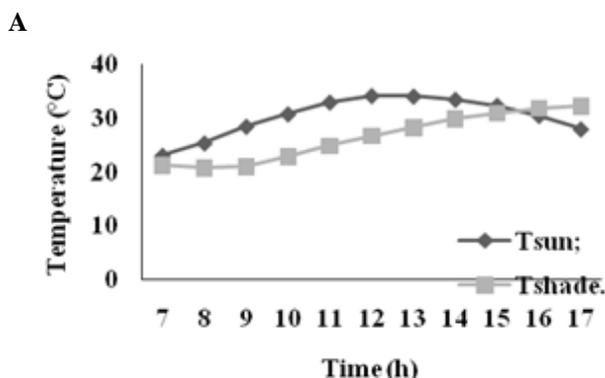**Table 1 -** *Animal behavior categories used in the present study for Santa Inês and Dorper sheep.*

Code	Category	Description
1	Water	Animals observed drinking water from the drinking trough
2	Feeding	Animals observed feeding from the feeder
3	Bipedal	Animals observed on only two paws
4	Standing	Animals observed on all fours paws
5	Walking	Animals observed walking inside the picket
6	Laying down	Animals observed laying down
7	Interaction	Animals observed in peaceful interactions with other animals
8	Exploring	Animals observed exploring the environment
9	Bleatinf	Animals observed vocalizing
10	Cleaning	Animals observed cleaning or scratching themselves
11	Idleness	Animals observed with no apparent activity
12	Feces	Animals observed defecating
13	Ruminating	Animals observed ruminating
14	Other	Animals observed performing other activities

Four treatments were carried out, first with Santa Inês sheeps in the shade, second with Santa Inês sheeps in the sun, third with Dorper sheep in shade and the forth with Dorper sheep in the sun.

The experimental planning comprised a completely randomized design (CRD) in a 2 x 2 factorial scheme, with two breeds (Santa Inês and Dorper) and two environments (in the sun and in the shade), with three replicates. The data were analyzed using Statistical Analysis System (SAS, 2004), by applying the chi-square test.

3 RESULTS AND DISCUSSION

Temperature averages from 7:00 AM to 3:00 PM in the sun (Tsun) were higher than the temperatures in the shade (Tshade), but from 4:00 to 5:00 PM temperatures below the sun were observed compared to the shade (Figure 1A).

A

B

Temperatures in the sun (Tsun), increased throughout the first hours of the day, reaching a maximum of 34.2 ºC at 12:00 PM, with subsequent declines until reaching a minimum temperature of 28.0 ºC, at 5:00 PM (Figure 1A). On the other hand, temperatures in the shade (Tshade) increased throughout the day, with higher values at the end of the afternoon, at 4:00 and 5:00 PM, with 32.0 and 32.4 ° C, respectively (Figure 1A), probably due to the type of cover applied to the environment (fiber cement roofing), which absorbs more

heat during higher temperature hours and frees heat faster in milder temperatures (COELHO et al., 2017).

Variations in climatic elements during the day, especially temperature and relative humidity, directly influence sheep ingestive behavior and physiology (ROBERTO et al., 2014).

The thermal comfort zone, according to Baêta and Souza (2010) and Souza et al., (2011), should vary between 20 and 30 ºC. Taking this into account, the observed temperatures were within the comfort zone for the animals only from 7:00 to 10:00 AM in the sun and from 7:00 AM to 2:00 PM in the shade. Thus, temperatures, both in the sun or in the shade, did not exceed the effective critical temperature to sheep, of 35ºC (BAÊTA; SOUZA, 2010).

The temperatures observed in this study, minimum of 23.1 and maximum of 34.2 °C, were higher than those reported by Leitão et al. (2013), which ranged from 22.9 and 33.9 °C, in a study on the comfort and thermal stress of Santa Inês and Dorper sheep in Juazeiro do Norte, State of Ceará, indicating a higher temperature, which the animals evaluated in this study were submitted, presenting greater risk of thermal discomfort.

The highest value of relative humidity recorded in the sun (RHsun) was 82.4% at 7:00 AM and the lowest was 44.7% at 1:00 PM. In shadow (RHshade), the highest value was 89.2% at 8:00 AM and the lowest value for RHshade, at 34%, observed at 5:00 PM.

The highest value for Tshade (32.4%) can be explained by the inverse correlation between temperature and relative humidity, the temperatures increase leads to a humidity decrease.

The ideal values of relative humidity for sheep, according to Matos Jr. et al. (2016), should range between 60 and 70%. This was not obtained from 7:00 to 9:00 AM for RHsun and from 7:00 to 11:00 AM for RHshade.

An inverse correlation between temperature and relative humidity was observed, since as Tsun increased, with highest values at 12:00 PM, RHsun decreased, with the lowest values observed at the same time. In turn to, increasing Tshade throughout the day was accompanied by declining RHshade values, corroborating with Matos Jr. et al. (2016).

The BGHTI in both the sun and shade increased throughout the day and decreased at the end of the afternoon (Figure 2).
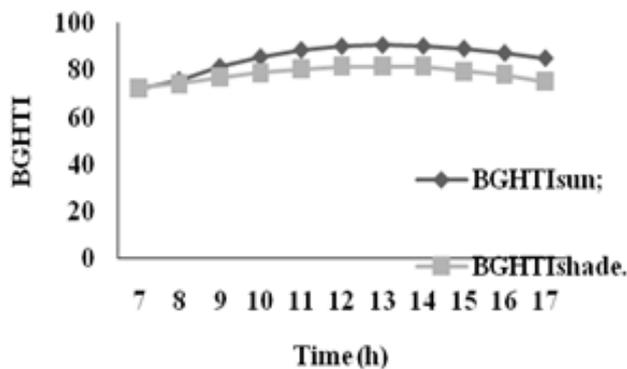
Figure 2 *- Mean Black Globe Temperature and Humidity Index in the sun (BGHTIsun) and shade (BGHTIshade) at throughout the evaluated time points.*

The highest BGHTI values in the sun were observed from 12:00 to 2:00 PM, (81.7), while in the shade recorded values were 90.3 and 90.8 at 12:00 and 1:00 PM, respectively (Figure 2).

Bezerra et al. (2011) in studies of heat adaptability of different ovine genetic groups in the semi-arid region of the Paraiba State, observed higher values in the hottest period of the day, corroborating with this study.

According to Matos Jr. et al. (2016), BGHTI values up to 74 define a comfortable situation; from 74 to 79, an alert situation; from 79 to 84, danger; and, above 84, emergency. Values for BGHTIsun and BGHTIshade were above 84 for most of the day in the present study, but did not necessarily indicate that the animals were in thermal discomfort, due to the adaptability and rusticity of the animals evaluated to the semi-arid.

The maximum values obtained for BGHTI in this study were similar to those observed by Santos et al. (2011), when evaluating Santa Inês sheep in rural Pernambuco State, but lower than those observed by Leitão et al. (2013) when evaluating the Santa Inês and Dorper ewes, who observed averages of BGHTI of 94, showing greater adaptation of the experimental animals.

Regarding animal behavior results obtained by the chi-square test, the animals spent most of the day standing; Santa Inês sheep presented this behavior during 44.39% of the day, with values of 20.89% and 23.50% in the shade and in the sun, respectively. Dorper sheep presented this behavior during 55.61% of the day, 26.62 and 28.99% in the shade and in the sun, respectively, higher in the sun (Table 2).

Table 2 - *Santa Inês and Dorper sheep Behavior at different times measured in sun and shaded environments*

Behavior	Genotype	Environment (%)		Total	Pr>X²
		Shade	Sun		
WATER	Santa Inês	76 (21.29)	92 (25.77)	168 (47.06)	0.0648
	Dorper	104 (29.13)	85 (23.81)	189 (52.94)	
FEEDING	Santa Inês	539 (26.06)	508 (24.56)	1047 (50.62)	0.6684
	Dorper	516 (24.95)	505 (24.42)	1021 (49.37)	
BIPEDAL	Santa Inês	27 (24.55)	28 (25.45)	55 (50)	0.1793
	Dorper	61 (30.91)	49 (19.09)	55 (50)	
STANDING	Santa Inês	783 (20.89)	881 (23.50)	1664 (44.39)	0.6215
	Dorper	998 (26.62)	1087 (28.99)	2085 (55.61)	
WALKING	Santa Inês	176 (22.48)	176 (22.48)	352 (44.96)	0.8211
	Dorper	212 (27.08)	219 (27.97)	431 (55.04)	
LAYING DOWN	Santa Inês	875 (31.90)	749 (27.31)	1624 (59.21)	0.8208
	Dorper	598 (21.80)	521 (18.99)	1119 (40.79)	
INTERACTION	Santa Inês	62 (19.75)	84 (26.75)	146 (46.50)	0.1499
	Dorper	85 (27.07)	83 (26.43)	168 (53.50)	
SOCIALIZATION	Santa Inês	170 (22.64)	181 (24.10)	351 (46.74)	0.8232
	Dorper	197 (26.23)	203 (27.03)	400 (53.26)	
BLEATING	Santa Inês	37 (22.98)	38 (23.60)	75 (46.58)	0.9327
	Dorper	43 (26.71)	43 (26.71)	86 (53.42)	
CLEANING	Santa Inês	19 (23.17)	17 (20.73)	36 (43.90)	0.7353
	Dorper	26 (31.71)	20 (24.39)	46 (56.10)	
IDLENESS	Santa Inês	448 (33.71)	372 (27.99)	820 (61.70)	0.1624
	Dorper	298 (22.42)	211 (15.88)	509 (38.30)	
FECES	Santa Inês	102 (31.58)	87 (26.93)	189 (58.51)	0.5336
	Dorper	77 (23.84)	57 (17.65)	134 (41.49)	
RUMINATING	Santa Inês	336 (29.68)	300 (26.50)	636 (56.18)	0.5013
	Dorper	272 (24.03)	224 (19.79)	496 (43.82)	
OTHER	Santa Inês	82 (21.58)	83 (21.84)	165 (43.42)	0.5378
	Dorper	100 (26.32)	115 (30.26)	215 (56.58)	

Chi-square test

Sheep alternate daily behaviors such as feeding, rumination and idleness (FIGUEIREDO et al., 2013). The monitoring of the ingestive behavior of the animals is an important tool, since it allows for the adjustment of food management to obtain better productive performances (AZEVEDO et al., 2013).

Feed intake can be influenced by food distribution, since this practice encourages animals to begin a meal, however, the intake occurs in a more concentrated manner during the day, and meal duration is more variable than rumination and idleness (AZEVEDO et al., 2013; FIGUEIREDO et al., 2013). However, in the present study, feeding was higher in the morning, at 50.62% for Santa Inês sheep, compared to Dorper sheep (49.37%).

From 7:00 AM to 5:00 PM, sheep presented standing feeding behaviors, subsequent lying down and chewing, followed by idleness (Table 2). Food intake was lower in the sun, with values of 24.56 and 24.42% for Santa Inês and Dorper animals respectively. This can be explained due to the inverse correlation between feeding activities and temperature, since these animals use this mechanism to lose heat to the environment and maintain themselves in homeothermia (ABIOJA et al., 2010).

In a study carried out by Cirne et al. (2014) evaluating the ingestive behavior of lambs, values ranging from 21.73 to 23.50% for feeding, lower than the values reported found herein.

On the other hand, water consumption was higher in the sun for both Santa Inês (25.77%) and Dorper (23.81%) sheep, mainly due to the fact that water aids in regulating internal body temperature.

In subsequent activities, the animals were observed lying down and ruminating. Resting animals accounted for 59.21 and 40.79% for the Santa Inês and Dorper animals, respectively.

Both breeds were longer in the shaded environment, indicating that the animals show a preference for the shaded environment, even with increasing temperatures in this environment throughout the day.

The animals Santa Inês and Dorper presented daily rumination activity of 56.18 and 43.82%, respectively, being the highest proportion for this behavior in the shade.

The objective of animal rumination is to reduce the size of food particles and facilitate the degradation process (ALVES et al., 2010). In the present study, when feeding decreased, rumination increased, corroborating a study developed by Santos et al. (2011).

While Cirne et al. (2014) reported rumination values ranging from 23.50 to 27.87%, being lower than the values observed in the present study. Idleness behavior comprised 61.70 and 38.30% for Santa Inês and Dorper sheep, respectively. The longest idleness periods were also observed in the shaded environment (33.71 and 22.42%), where the animals preferred resting.

Cirne et al. (2014) reported values higher than those detected herein for idleness, ranging from 41.33 to 42.37%, demonstrating that the animals evaluated by those authors found the environment more adequate for food rest compared to the animals of the present study.

Other behaviors were also observed, such as walking, which was the same for both the shaded and sun environments for Santa Inês animals (22.48%), while for Dorper sheep this behavior was higher in the sun (27.97%) compared to the shade (27.08%), representing 44.96% and 55.04% for Santa Inês and Dorper sheep, respectively. Animal socialization behaviors, as well as interactions, were higher in the uncovered environment, representing 24.10% and 27.03% for Santa Inês and Dorper animals, respectively. In the shade, this behavior comprised 26.75 and 26.43% for Santa Inês and Dorper, respectively.

The animals defecated more in the shade compared to the sun, with values of 31.58% and 23.84% for Santa Inês and Dorper, respectively. The higher defecation value observed in the Santa Inês animals is justified by the fact that these animals consumed more food during the day. The least observed behavior during the study was vocalization, higher in Dorper sheep (53.42%) compared to Santa Inês animals (46.58%).

4 CONCLUSIONS

- Temperatures in the sun and shade exceeded the comfort zone for sheep at certain times of the day, as the relative humidity and BGHTI were not ideal, but the animals did not present thermal discomfort.

- Sheep alternate daily behaviors, so the monitoring of ingestive behavior is an important tool that allows for adjustments in feeding management, leading to better productive performance.

- Animals of the Santa Inês breed exhibited better adaptability to the climatic conditions of the semi-arid region compared to the Dorper breed, demonstrating the maintenance of natural behaviors even at high temperatures.

- Even the Dorper breed being exotic, exhibited behaviors similar to those of the naturalized Santa Inês breed, demonstrating a high adaptive potential for the semi-arid region.

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