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Thermoregulatory Traits of Native Sheep in Pregnancy and Supplemented in Grazing System

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Abstract

Current assay evaluates thermoregulatory characteristics of native sheep in pregnancy and supplemented in grazing system. Were used 24 multiparous lactating ewes, 12 Santa Inês and 12 Morada Nova, with an average weight of 52.6 and 31.3 kg, respectively, were randomly distributed in a completely randomized split-split plot design. Physiological parameters such as heart rate (HR), respiratory rate (RR) and rectal temperature (RT) were measured in that order during the morning and afternoon, 06-07 and 13-14 h, respectively, every seven days, totaling 10 samples. The environmental temperature was higher ($P<0.05$) in the afternoon, probably due to the higher incidence and intensity of sunlight at this time, with index globe temperature and humidity presenting values that characterize an environment of danger to animal production, characteristics of the semiarid. Effect ($P<0.05$) turn and race on the thermoregulatory characteristics of the sheep were found, showing unfavorable conditions in the afternoon with greater intensity of use of heat dissipation mechanisms by Santa Inês ewes. Assessing the effect of supplementation on the physiology of these sheep, it appears that there is an influence ($P<0.05$) on the RR and HR, with higher values for Santa Inês ewes subjected to 1.5% concentrate diet. However, RT remained within the normal range, indicating that they are adapted breeds rearing conditions and experimental diet that have efficient mechanisms in respiratory heat dissipation, indicating also that they are qualified to productive farm animals in semi-arid conditions.

Keywords: climatology, concentrated, Morada Nova, physiological parameters, Santa Inês

1. Introduction

The northeast region has much of the Brazilian herd sheep and highlights its potential production of this species, which has adaptive features that give them good production capacity in various ecosystems of the region. However, attempting to maximize the efficiency of the production systems, it is necessary to use techniques that allow these animals to express their potential leading to economic efficiency of operation (Lima et al., 2013).

Among the technologies that promote increased production in the tropical region, Façanha et al. (2013) highlight the use of more specialized genotypes inserted into a compatible with their requirements and/or use of adapted animals, of which we must select the most productive environment. Thus, a successful production depends on the choice of genotypes better adapted to the climatic conditions of a particular region plus the ability to gain weight, heavier carcasses, and have adaptive aspects such as prolificacy and survival.

In the ongoing search for the efficiency of the production system, the use of concentrates in the diet of animals raised on pasture supplementation has been widely disseminated. However, high levels of this food may impair the ability of thermoregulation of ruminants in warm regions; this food should be used sparingly in the diet of these animals.

It is known that sheep breeds Morada Nova and Santa Ines are characterized by a high degree of adaptability towards semi-arid northeastern region. However, information on the adaptive capacity of these animals gestating fetuses resulting from crossing with animals specialized for high performance and receiving different levels of

concentrate supplementation in the diet is still scarce.

Current assay evaluates thermoregulatory characteristics of native sheep in pregnancy and supplemented in grazing system.

2. Material and Methods

The experiment was conducted at the Research Unit in Small Ruminants of Campus Cinobelina Elvas of the Federal University of Piauí, Bom Jesus - PI (09º04'28" South Latitude and 44º21'31" West Longitude), at an altitude of 277 m and 635 km distant from the capital Teresina, with a semiarid climate or Bsh, according to Köppen (Brasil, 1992), and annual average rainfall 900 mm, with maximum and minimum temperatures 36 and 18 °C, and humidity relative at 55 and 75% respectively. The rainy season extends from November to May (Aguiar & Gomes, 2004). The duration of the study was 85 days, with 15 days for the adaptation of the animals to the experimental diet and the rest for data collection.

Were used 24 sheep, pregnancy pluriparous being 12 Santa Inês and 12 Morada Nova, with an average weight of 52.6 and 31.3 kg, respectively. During the experimental period, the sheep remained from 07:00 to 16:30 in paddocks formed by Andropogon pasture grass (*Andropogon gayanus*), being collected in the late afternoon and allocated to individual pens where they received concentrate supplementation (Table 1) according to the weight of ewes (0.5% of body weight (BW) and 1.5% of body weight (BW), being adjusted weekly.

Table 1. Chemical composition of experimental ingredients, concentrate supplement and Andropogon (*Andropogon gayanus*)

Ingredients	Chemical composition (% DM)							
	DM	CP	EE	TDN	NDF	ADF	Ca	P
Corn meal	87.19	9.98	5.19	67.50	24.55	5.87	0.05	0.49
Soybean meal	88.48	48.76	1.75	80.73	15.37	9.64	0.33	0.57
[1]Mineral mixture	97.91	-	-	-	-	-	18.00	13.00
Supplement	88.04	19.17	4.06	67.43	21,02	6,51	0.90	1.13
Andropogon	27.45	7.50	2.02	53.56	74.70	41.97	0.33	0.11

DM = Dry matter; CP = Crude protein; EE = Ether extract; TDN = Total digestible nutrients; NDF = Neutral detergent fiber; ADF = Acid detergent fiber; Ca = Calcium; P = Phosphorus. [1]Mineral mixture: 1,600 mg zinc, 600 mg copper, 1,500 mg manganese, 1,100 mg iron, 10 mg cobalt, 27 mg iodine and 22 mg selenium. q.s.p. 1,000 g.

The treatments were formed based on the percentage of concentrate supplementation, according to the recommendations by the NRC (2007) for animals in pregnancy.

Physiological parameters respiratory rate (RR), heart rate (HR) and rectal temperature (RT) were measured in that order with the animals at rest in the morning and afternoon, 06-07 and 13-14 h, respectively, every seven days, totaling 10 samples. For the case of animals on pasture, they were ushered into a smaller paddock to facilitate the collection of data, thus performing the least-jerky movements that could leave them stressed by changing these parameters.

Respiratory rate was measured in breaths per minute through direct observation of the movements of the left flank, HR was measured in beats per minute using a stethoscope placed between the third and fourth left intercostal space; and the RT was registered using a clinical thermometer inserted directly into the rectum of the animals until the firing of the sounder.

Environmental variables, temperature (T) and relative humidity (RH), were measured with the aid of thermo-hygrometer and temperature of the globe-thermometer (thermometer Iconterm® 0-100 °C inserted into a black globe with 150 mm diameter), at 55 cm deep into the soil close to the animals. BGTH was used for the equation proposed by Buffington et al. (1977), in which BGTH = 0.72 (WBT + BGT) + 40.6 (where: WBT- Wet bulb temperature in °C; BGT- black globe temperature in °C).

The experimental design was completely randomized split-split-plot (two breeds, MN and SI, two levels of supplementation, 0.5 and 1.5% of body weight and two turns, morning and afternoon), with ten repetitions,

repeated in time. The data were evaluated by an analysis of variance, and the means were compared by Tukey's test at a 5% probability. The experimental data were analyzed using the computer program SAS - Statistical Analysis System (2003), according to the statistical model:

$Y_{ijk} = \mu + B_i + S_j + (BS)_{(ij)} + T_k + (BT)_{(ik)} + (BST)_{(ijk)} + e_{(ijk)}$, where:

Y_{ijk} = value observed for characteristic analyzed;

μ = overall average;

B_i = effect of breed I = 1, 2;

S_j = effect of level of concentrate supplementation j = 1, 2;

T_k = effect of turn k = 1, 2;

$BS_{(ij)}$ = effect of the interaction between breed i and level of concentrate supplementation j;

$BT_{(ik)}$ = effect of the interaction between breed i and turn k;

$BST_{(ijk)}$ = effect of the interaction between breed i, level of concentrate supplementation j and turn k;

$e_{(ijk)}$ = aleatory error associated with the observation Y_{ijk}.

3. Results and Discussion

The averages of climate variables are presented in Table 2. A significant effect (P<0.05) for all factors evaluated.

Table 2. Averages of environmental variables in different turns (morning and afternoon) during the experimental period

Turns	Climatic variables				
	T (ºC)	RH (%)	BGT (ºC)	WBT (ºC)	BGTH
Morning (06-07 h)	23.5±1.8[b]	88.9±5.7[a]	24.6±2.5[b]	21.1±1.4[b]	73.5±3.4[b]
Afternoon (13-14 h)	31.3±3.8[a]	82.2±12.2[b]	32.3±4.7[a]	23.9±1.2[a]	81.1±3.1[a]

*Means followed by the same letter in columns are not significantly different by Tukey test at 5% probability.

The enviromental temperature in semi-arid conditions, as expected and reported by several authors (Santos et al., 2005, 2007; Silva et al., 2012, 2013b), was higher (P<0.05) in the afternoon, probably due to the higher incidence and intensity of sunlight at this time, showing a temperature range of 7.8 °C. These values, when compared to the established as thermal comfort zone for adult sheep, where according to Baêta and Souza (2010), is in the range 15-30 °C, and the critical temperature above 35 °C, which characterizes a situation of thermal stress to the driving conditions of the experiment, as is confirm by Oliveira et al. (2011).

The relative humidity variation was significant (P<0.05) between shifts, and in the afternoon there was a decrease in its value, data that show similarity to results obtained by Silva et al. (2013a) who evaluated hair sheep subjected to the same experiment. Thus, we notice the existence of direct and inverse behavior between RH and TA throughout the day, and that according to Baêta and Sousa (2010) should be between 50 and 70%.

Observing the values of BGTH, there is a (P<0.05) effect between the shifts of the day, and in the afternoon the environmental conditions become stressful. According to Baêta (1985), BGTH values up to 74 are define as comfortable situation, values ranging from 74-78 express a state of alert, 79-84 danger, and above 84 are defined as an emergency, and the environment in question is presented as a danger to the physiology of these sheep.

To minimize the environmental impact on the physiology and reproductive performance of these sheep, which are the most critical period of pregnancy, characterized by greater fetal development, it is of paramount importance to use strategies that allow greater protection of animals against exposure to solar radiation through appropriate environmental management, such as natural shade in pastures and access to artificial shade structures, favoring the homeostasis of these sheep, especially in the most critical time of the year, thus making less use of energy from productive functions for thermoregulation, as it was reported by Silva et al. (2013a).

Analyzing the measured physiological parameters, we found differences (P<0.05) for the factors evaluated (Table 3), ie, the effect of race and turn.

Table 3. Comparison between physiological parameters of sheep Morada Nova and Santa Ines in different shifts (morning and afternoon) in the semiarid northeast

Breed/Treatment	Physiological parameters					
	Respiratory rate (breaths/minute)		Heart rate (beats/minute)		Rectal temperature (°C)	
	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon
MN	30.1 ± 3.1^{Aa}	45.0 ± 3.1^{Ab}	83.3 ± 1.8^{Aa}	95.3 ± 1.8^{Ab}	37.6 ± 0.0^{Aa}	38.6 ± 0.0^{Ab}
SI	43.6 ± 2.5^{Ba}	62.1 ± 2.5^{Bb}	88.6 ± 1.4^{Ba}	98.9 ± 1.4^{Ab}	38.1 ± 0.0^{Ba}	38.7 ± 0.0^{Ab}

*Means followed by the same uppercase and lowercase letters in columns in rows do not differ statistically by Tukey test at 5% probability;

** MN – Morada Nova; SI – Santa Inês.

The mean respiratory rate showed significant differences ($P<0.05$), differing between races and surveyed zones (Table 3). Between the races, it was noted that the highest values were observed for the RR Santa Inês ewes, and these averages in both rounds for Santa Inês ewes and afternoon to Morada Nova sheep were above the ideal for sheep according to Silanikove (2000), which quantifies the severity of heat stress, wherein a frequency of 40-60, 60-80, 80-120 breaths / min features a low, medium-high and high stress for ruminants, respectively, and above 200 mov / min for sheep, stress is classified as severe. However, these values are likely to be influenced by food intake, pregnancy, age and size of animals (Oliveira & Costa, 2013).

The heart rate of these ewes supplemented in late-stage and established on pasture gestation behaved similarly to Respiratory rate, differing ($P<0.05$) within race between shifts and between breeds was significant ($P<0.05$) in the morning shift with superiority for Santa Inês ewes.

Thus, we verified through the results, the behavior related to the mean RT whose analysis revealed a significant effect ($P<0.05$) for the shift factor for the two races and race factor in the morning.

This fact should be considered in a production system, because even when it comes from animals that are highly adapted to semiarid conditions and that are worked mainly in extensive of production under the experimental conditions, ie, sheep in the last third of gestation, created to pasture receiving and concentrated food supplement, one must consider, since such behavior may be associated with genetic animals and that even having gone through similar processes of selection, may use different mechanisms of heat loss and, according to Silva et al. (2010) that significant variation may occur because of power, temperature, age and race.

When evaluating the values of RR between races and level of supplementation (Table 4) , we had values above the range as normal (Silanikove, 2000), except for the mean values observed for Morada Nova sheep subjected to 0.5% concentrate diet based on live weight.

There is sheep indicating that these may be in thermal stress situations and that this parameter is influenced by dietary supplementation, where sheep that undergo a high level of concentrate, probably had a larger energy increase, and this increased production of heat can promote reproductive consequences of production and order of these sheep. During periods of heat stress, dry matter intake (DMI) decreases and maintenance requirements increase as cattle attempt to dissipate excess heat load (West, 1999). In addition, changes in blood flow and the production of various hormones ultimately result in decreased reproductive performance, conception rates can decline 20-30% (Rensis & Scaramuzzi, 2003) and milk production, affecting the performance of lambs with consequent losses to the productive system.

McManus et al. (2009) in studies with sheep, detected that the increase in respiratory rate observed may be considered as the primary control mechanism of homeothermy under imposed environmental conditions. Hence the importance of working with animals adapted and under proper management conditions.

Table 4. Comparison between physiological parameters of the Santa Inês ewes and Morada Nova subjected to concentrate supplementation in semiarid northeast

Breed/Treatment	Physiological parameters					
	Respiratory rate (breaths/minute)		Heart rate (beats/minute)		Rectal temperature (°C)	
	0.5%	1.5%	0.5%	1.5%	0.5%	1.5%
MN	34.9 ± 3.8^{Ab}	40.2 ± 3.4^{Aa}	86.1 ± 2.3^{Ab}	92.5 ± 2.9^{Aa}	38.0 ± 0.0^{Aa}	38.2 ± 0.0^{Aa}
SI	47.9 ± 3.0^{Bb}	57.8 ± 2.9^{Ba}	92.4 ± 1.9^{Ba}	92.1 ± 1.8^{Aa}	38.3 ± 0.0^{Aa}	38.6 ± 0.0^{Aa}

*Mean followed by the same uppercase and lowercase letters in columns in rows do not differ statistically by Tukey test at 5% probability;

** MN – Morada Nova; SI – Santa Inês.

When evaluating the animals that were supplemented with high levels of supplementation (1.5% BW) these expressed higher values on all Physiological parameters principally the Santa Inês sheep. This result supports the statement that sheep of the Morada Nova breed has high adaptability receiving supplementary feeding combined with the production of the pasture system concentrated, this difference ($P<0.05$) between breed for FR, can be produced resulting from greater heat increment of the association of environmental factors with the highest consumption (Silva Sobrinho, 2006; Facó et al., 2008) and, consequently, greater heat production, necessitating greater use of mechanisms thermolysis.

As for the heart rate, it was significant ($P<0.05$) among genotypes for the low level of concentrate supplementation with Morada Nova sheep showing greater adaptability to the environment, characterized as hazardous situation according to Baêta (1985), and lower heat increment that Santa Inês ewes. Evaluating the effect of treatment within race, RR differed ($P<0.05$) between Morada Nova sheep, as expected, animals receiving 1.5% supplementation showed higher values as a result of endogenous increased heat production.

Overall, regardless of race and level of concentrate supplementation, the pregnant ewes showed a RT viewed as normal according to Furtado et al. (2008) and Reece (1996) should be between 38.5 and 39.7 ºC, verifying that other mechanisms of heat dissipation evaluated in this study were efficient dissipating heat stress. This feature causes the animal breeds Morada Nova and Santa Inês to become genetic material of choice for small and large producers of semi-arid northeastern region, being widely used in crosses with exotic breeds and specialized for high productivity, seeking F1 lambs with broad features of interest, early maturity and adaptability.

4. Conclusions

Sheep from breeds Morada Nova and Santa Ines in pregnancy have good adaptability to environmental conditions. However, the concentrate supplementation influences their thermoregulatory characteristics, mainly in sheep subjected to 1.5% supplementation, and the Santa Inês ewes used in most intensity of heat loss mechanisms.

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