Seasonal pattern of the physical and physiological traits of Brazilian naturalized goats in a semiarid climate

Wallace Sostene Tavares da Silva[1]; Luis Alberto Bermejo Asensio[2]; Wilma Emanuela de Silva[3], Jacinara Hody Gurgel Morais Leite[3], Josiel Borges Ferreira[3], Débora Andréa Evangelista Façanha[4]

[1]Msc. Animal Production - Universidade Federal Rural do Semiárido/Universidade Federal do Rio Grande do Norte- RN, Brazil email: wstdsharm@gmail.com;
[2]Departmento de Ciencias de la Navegacion, Ingeniería Marítima, Agrária e Hidráulica. Escuela Técnica Superior de Ingeniería Agraria. Universidad de La Laguna – Tenerife - Canary Island, Spain.
[3]Doutorandos do Programa de Pós-Graduação em Ciência Animal – Núcleo Pró-Criar: Pesquisa e Conservação da Genética Adaptada ao Semiárido, Campus de Mossoró, RN.
[4]Department of Animal Science – Universidade Federal Rural do Semiárido-RN, Brazil

Abstract: The aim of this work was to assess seasonal changes of the physical and physiological traits of Naturalized Brazilian goats in semiarid climate using the Canonical Analysis of Principal Coordinates (CAP) statistical technique. It was evaluated 30 adult Canindé and 30 Moxotó goats in the rainy and dry periods. The air temperature (ºC), relative humidity (%) and black globe temperature (ºC) were assessed thus, Radiant Heat Load (W m^{-2}) and Black Globe Humidity Index (BGHI) was calculated. The physiological variable as rectal temperature (R_T, ºC), respiratory rate (R_R, breaths min^{-1}), surface temperature (S_T, ºC) were recorded from 09:00 to 11:00 am. Furthermore, investigation on hair coat traits (thickness, length, diameter and density) and thyroid hormones (T3 and T4) were performed. Exploratory analysis (Canonic Analysis of Principal Coordinates – CAP) were performed using morphophysiological traits. The results showed that Moxotó and Canindé were separated in two different groups. Levels of T3 and T4 were inversely correlated and responsible for this separation. Canindé goats presented lower concentration of T4 and presented morphological hair coat thickness that tends to present difficulties in the elimination of heat.

Keywords: genetic resources, adaptability, heat stress

DOI: 10.6084/m9.figshare.5195134

Introduction

The brazilian semiarid is characterized by high levels of solar radiation, water deficit and low forage potential, being the main stress factors to the animals living in this environment. Adapted animals have morphological and physiological traits that allow to cope better with these challenges in comparison to exotic breeds. Goats are mostly found in arid and semiarid lands, as in Brazil northeastern. Physical and physiological traits as hair coat and skin, respiratory and sweating rate, and endocrine response are important bioindicators to understand process of thermoregulation and animal homeostasis (SALAMA et al., 2014). Few surveys reported about adaptative characteristics of brazilian naturalized goats as Moxoto and Caninde breeds. Thus, the aim of this investigation is to assess seasonal pattern of physical and physiological traits of naturalized brazilian goats in a semiarid environment.

Material and Methods

The study was conducted in a commercial farm located in the city of Lajes-RN, with geographical coordinates 5º41'42" South, 36º22'37" West, in the Brazilian semiarid region. The climate in the semi-arid tropical region, with two seasons, a rainy season from January to May and a dry season from June to December, period of study. The annual median of temperature and humidity of 27.2 °C and 70% respectively, with mean annual precipitation of 414.7 mm . The experiment was carried out for one year in the two corresponding seasons, the animals always being exposed to direct solar radiation in the morning between the hour intervals of 9:00 and 11:00 am, so that there were no peaks of the thyroid hormones, which usually arose at sunrise. At the end of the day, the animals received a concentrated mixture composed of corn, soybean meal, mineral complex and vitamins; the bulk was acquired through native vegetation, caatinga, in an extensive production system of xerophilic plants.

A total of 60 adult non-pregnant goats, 30 of the Canindé breed and 30 of the Moxotó breed, were used in this study. All goats had previously been wormed and received health examinations. The maintenance of reproductive activity was confirmed by monthly monitoring of the signs of estrus. The goats were managed under an extensive system that included feeding in native pastures and commercial mineral supplementation.

The rectal temperature (R_T, ºC) of each goats was measured after an initial five-minute habituation interval. A digital thermometer was inserted into the rectum of the animal. The thermometer was guided to the roof of the rectal cavity to detect the temperature of the anal mucosa. The thermometer remained at a depth of approximately five centimeters for approximately two minutes. The respiratory rate (R_R, breaths min^{-1}) was measured with a clinical stethoscope on an area on the right side of the ewe. The animal's breaths were counted over a measured period of 30 seconds. The result was multiplied by two to calculate the number of breaths per minute (breaths min^{-1}). The surface temperature (S_T, °C) of each animal was carried out with the aid of an infrared thermometer, exposed to radiation, always in the same place of hair removal.

The coat thickness (C_T, mm) was measured in situ in the croup area with a digital caliper. The caliper was inserted into the coat, perpendicular to the body of the animal, until it touched the skin. The cursor was then moved to touch the outer surface of the coat and obtain the reading. To estimate the hair density (H_N, hair cm^{-2}), the number of hairs per cm^2 was calculated. The hair length (H_L, mm) and the hair diameter (H_D, mm) were measured on the hair collected from a known area of the coat with the aid of duckbill pliers. A Petri dish was placed on a flat. The hairs collected from each animal were placed individually in the dish to determine the H_D. The H_N was estimated by counting the number of hairs collected in each sample. The sample represented 0.2077 cm^2 of skin, the area of the free end of the pliers when opened. Finally, the estimated number was converted to an estimate of the number of hairs per square centimeter of skin based on a conversion factor of 0.20 to 1.

The estimated hair length (H_L) was determined by the same technician who determined the HDE because "hand calibration" is essential to obtain reliable results. A digital caliper was used to perform this measurement. The longest ten hairs from each sample were visually selected, and the arithmetic mean of the HL of these hairs was then calculated. This methodology follows Udo (1978). The hairs used for the determination of H_L were used to measure the hair diameter (H_D). The same precautions (i.e., determination by the same technician) were followed to minimize error. A digital micrometer was used to measure the diameter of the ten largest hairs. The arithmetic mean of the H_D of these hairs was obtained.

The blood was collected from the jugular vein (10ml) into the vaccum tubes. The plasma total triiodothyronine (T3) and thyroxine (T4) concentrations were determined as the mean of duplicate determinations using the Human In Vitro® commercial kits for an automatic Elisa device (Elysis Uno®, Human®).

A basic meteorological station was used to obtain climatic data on each day of collection. The station included maximum and minimum thermometers, an anemometer positioned at the height of the dorsum of the animals, a black globe positioned in sunlight at the height of the dorsum and a hygrometer. The air temperature (AirT, °C), relative humidity (R_H, %) and wind speed (U, m s^{-1}) were recorded every three minutes. The radiant thermal load (RHL) and the Black Globe Humidity and Temperature Index (BGHI) were calculated according to the methodology of Silva (2008) and Buffington et al. (1981), respectively.

Statistical analysis was performed using PRIME 6 and PERMANOVA + (PRIMA-E Ltd. Plymouth, UK), in order to test the fixed effects as time of year (two) and breeds (two) by means of permutation based on Euclidean distance PERMANOVA on the variables studied. Test T was also performed when analyzing the differences between means of significant effects. A Canonic Analysis of Principal Coordinates (CAP) was performed to characterize the global physiological responses of both races in the periods of the year studied.

Results and Discussion

It can be observed that the environment presented stressful meteorological characteristics during the dry and rainy seasons, Table 1, show air temperatures, above the thermal comfort zone for the goat species (35.0 and 34.3 °C, respectively), especially in the rainy season, which the high Tar associated with high levels of radiation (624.1 W m^{-2}), low (39.1%) in the presence of low air movement (0.83 m s^{-2}), possibly hampered convection energy changes causing greater thermal discomfort to the animals studied. Gomes et al. (2008) mentioned that it is common for temperatures in the Brazilian semiarid zone to be near thermal comfort zone or even higher for the caprine species (35 to 39 ºC), however, it is desirable to select animals that have morphological characteristics of the pelage that facilitate heat exchanges since the environment presented a high incidence of solar radiation throughout the year, the main limiting factor in animal production (SILVA et al., 2010).

Table 1 Environmental conditions of rainy and dry season during experimental days

Season	Air T (°C)	R_U (%)	U (m s^{-2})	RHL (W m^{-2})	BGHI	RF (mm)*
Rainy	34.3^b±0.13	39.1^a±0,37	0.83^a±0,24	624.1^a±5.07	89.7^a±0.35	101.2^a
Dry	35.0^a±0.20	37.5^b±0,43	0.73^b±0,16	608.8^b±6.72	88.2^b±0.39	40.4^b

Air T – air temperature; R_U – ralative humidity; U – wind speed; RHL – radiant heat load; BGHI – black globe humidity index; RF – rainfall. Means the same superscript do not differ statistically P>0.05.* Data obtained from the Empresa de Pesquisa Agropecuária do Rio Grande do Norte – EMPARN

Therefore, Canindé animals breeds, which had totally black fur and pigmented epidermis, presented higher hair coat thickness (C_T - 5.28 mm), longer (H_L - 28.08 mm), thicker (H_D - 0.062 μm) and higher number (N_H - 690.03 hair cm^{-2}), however, the animals of the Moxotó breed, with totally white coat and pigmented epidermis, had lower values for C_T (4.27 mm), lower H_L (23.85 mm), (0.052 μm) and lower N_H (342.29 hair.cm^{-2}), Table 2. When presenting differences in their characteristics of the fur, Canindé animals tended to trigger much more their thermoregulatory characteristics than the animals of the Moxotó breed, Table 3, such behavior possibly resulted in a greater resistance in the internal heat flow to the environment and a greater air entrapment betw een the fibers (MAIA et al., 2005), thus, being able to attribute a greater adaptive advantage to the animals of the race Moxotó to the environment Semiarid.

Table 2 Mean (µ), standard error (S.E) of the hair coat characteristics in brazilian goats in two seasons

Variable	Breed	Seanson of the year		Mean µ ± S.E
		Rainy	Dry	
		µ ± S.E	µ ± S.E	
Hair coat thickness (C_T, mm)	Canindé	5.90^{aA}±0.85	5.13^{aB}± 0,80	5.28^a±0.83
	Moxotó	4.73^{bA}± 0.85	2.90^{bB}±0,81	4.27^b±0.95
	Mean	5.36^A	4.03^B	4.70
Hair length (H_L, mm)	Canindé	30.14^{aA}± 5.40	23.43^{aB}±4.89	28.08^a±1.96
	Moxotó	30.25^{aA}± 5.97	17.86^{bB}±3.46	23.85^b±2.40
	Mean	30.42^A	20.65^B	25.52
Number of hair per cm^2 (N_H, hair cm^{-2})	Canindé	542.53^{aA}±148.11	354.23^{aB}±168,47	448.38^a±249,21
	Moxotó	360.92^{bA}±167,32	325.36^{bB}±83,49	342.29^b±146,06
	Mean	451.73^A	340.08^B	396.91
Hair diameter (H_D, µm)	Canindé	0.053^{aB}±8.15	0.080^{aA}±6.07	0.062^a±0.024
	Moxotó	0.052^{aA}±2.85	0.051^{bA}±16.33	0.050^b±0.034
	Mean	0.054^A	0.055^B	0.056

Table 3 Mean (µ) ± standard error (S.E) of the coats traits the Canindé and Moxotó breed and Rho Spearman coefficient between CAP axis and each variable

Variable	Breed	Season of the year		Mean	CAP I	CAP II
		Rainy	Dry			
		µ±S.E	µ±S.E	µ±S.E		
T3 (ng mL^{-1})	Canindé	1.55^{bB}±0.21	1.94^{bA}±0.80	1.75^{b}±0.36	**-0.85**	-0.20
	Moxotó	2.71^{aB}±0.39	3.13^{aA}±0.39	2.92^{a}±0.45		
	Mean	2.13^{A}	2.56^{B}	2.33		
T4 (µg dL^{-1})	Canindé	5.37^{aA}±0.66	4.92^{aB}±0.56	5.15^{a}±1.42	**0.84**	0.23
	Moxotó	1.63^{bA}±0.19	1.62^{bA}±0.20	1.63^{b}±0.38		
	Média	3.51^{A}	3.02^{B}	3.39		
R_T (ºC)	Canindé	39.2^{aB}±0.76	39.6^{aA}±0.61	39.4^{a}±0.78	-0.10	0.37
	Moxotó	39.4^{aA}±0.83	39.5^{aA}±0.48	39.5^{a}±0.67		
	Média	$39{,}30^{A}$	$39{,}55^{A}$	39.45		
R_R (breaths min-1)	Canindé	36.0^{aB}±19.21	49.0^{aA}±14.89	42.50^{a}±21.17	0.28	0.29
	Moxotó	31.0^{bB}±25.41	48.0^{bA}±8.76	39.50^{b}±19.20		
	Média	33.5^{B}	48.5^{A}	41.0		
S_T (ºC)	Canindé	35.2^{bB}±2.83	39.1^{aA}±4.15	37.15^{a}±3.57	-0.23	**0.64**
	Moxotó	34.9^{bB}±2.00	37.2^{aA}±3.57	36.05^{b}±3.77		
	Média	$37{,}10^{B}$	38.12^{A}	37.58		

R_T – rectal temperature; S_T – surface temperature; R_R – respiratory rate; T3 – total triiodothyronine; T4 – total thyroxine. *Means in rows followed by the same letters are statistically different by t test ($p < 0.01$).

The Figure 1 is a graphic representation of the Canonical Analysis of Principal (CAP) for the evaluated variables, in which the two eigenvectors explained more than 80% of the total variation between the characteristics evaluated, evidencing that the main characteristic that segregates the two breeds of goats Was the total thyroxine hormone (T4), in which the Canindé breed tended to present higher concentrations of this hormone in both the dry season and the rainy season, unlike the Moxotó breed, which presented a low concentration of T4, presenting higher concentrations of triiodothyronine (T3) in the rainy season, thus there were differences in the thermoregulatory responses of the animals according to the seasons. Therefore, Canindé animals tended to present higher respiratory rate (R_R), rectal temperature (R_T) and surface temperature (S_T) in the dry period of the year. However, it was observed that there were no differences in the activation of the thermoregulatory characteristics in relation to the time of the year for the Moxotó breed, with a homogeneity of their responses to the meteorological conditions studied.

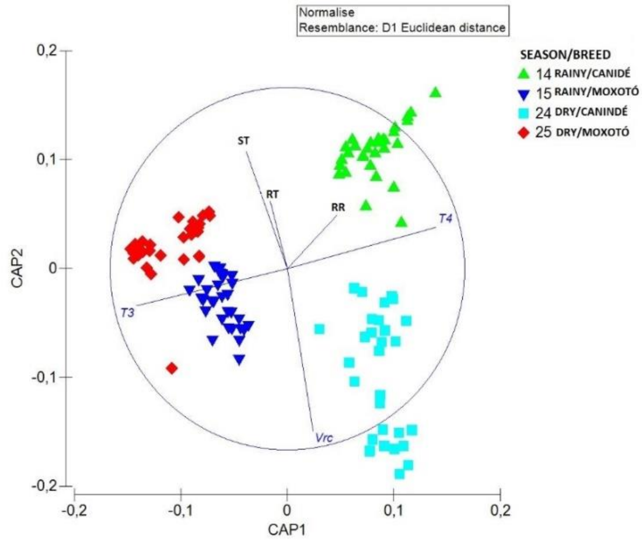

Figure 1 Plot based on coat surface temperature, respiratory rate, rectal temperature and thyroid hormones. Lines show the Spearman correlation among variable and CAP axis.

It is also observed that there was a strong correlation of S_T in the CAP II, in which both races tended to present high values for this characteristic, Figure 1, being able to conclude that due to the high levels of AirT and RHL the Canindé breed animals possibly absorbed Greater radiation than the animals of the Moxotó race, leading them to an immediate activation of RR and increase of T4. It was suggested that, because the animals showed differences in their morphological characteristics, the environment directly influenced the activity of the thyroid gland, especially for the Canindé breed, which, even though it was difficult to dissipate the absorbed heat, The normal functionality of the thyroid gland in order to maintain its characteristics related to reproduction, growth and performance of which aid this hormone (BERNABUCCI et al., 2010).

Conclusions

The Canindé and Moxotó goats could maintain the homeostasis presenting different adaptive profiles in which the characteristics of the pelt observed in the Moxotó breed as: thinning of the coat, short, thick and less dense, accompanied by a light pigmented coloration and epidermis, Influenced directly the reduction of T4 concentrations, being considered decisive in the thermal equilibrium of these animals in semi-arid environment.

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