Physiological Response of Local and Saanen x Local Cross Goats during the Late Rainy Season in North-eastern Brazil

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Summary

In order to compare in vivo *performance and environmental adaptation of two genetic types of goats raised in north-eastern Brazil, 20 females (10 local and 10 Saanen x local) were used in this experiment. During the late rainy season the goats were monitored for the following parameters: body weight, body (BT) and skin temperature (ST), respiratory (RR) and heart rate (HR) as well as the air temperature (AT) and humidity (HU) in the pens in the morning (MR) and afternoon (AR). From May to June the crossbred goats showed a significant gain (P< 0.05); the live weight of F1 was superior to the local goats (P< 0.05) at the end of the experiment. The physiological response during the AR was significantly superior to MR (P< 0.05) for all parameters. The local goats achieved the highest values of BT and ST during the experiment. On average, the physiological rhythms (RR and HR) were higher in crossbred than local goats. In conclusion, crossbred goats showed to be less at risk to environmental stress condition in north-eastern Brazil.*

Résumé

Réponse physiologique chez les caprins de race locale et croisés Saanen x race locale pendant la saison pluvieuse tardive au nord-est du Brésil

Vingt femelles (10 locales et 10 Saanen x locale) ont été utilisées dans cette expérimentation afin de comparer les performances in vivo *et l'adaptation environnementale de deux différents génotypes de caprins. Pendant la saison pluvieuse tardive, les chèvres ont été soumises à l'enregistrement des paramètres suivants: poids corporel, température corporelle (BT) et cutanée (ST), rythmes respiratoires (RR) et cardiaques (HR) tandis que la température (AT) et humidité (HU) dans les installations étaient relevées au matin (MR) et à l'après-midi (AR). A partir du mois de mai jusqu'au mois de juin, les chèvres croisées ont montré un gain significatif (P< 0,05) ; le poids corporel chez les chèvres F1 était supérieur à celui des chèvres locales (P< 0,05) à la fin de l'expérimentation. La réponse physiologique pendant l'AR a été supérieure au MR (P< 0,05) pour tous les paramètres. Les chèvres locales ont montré les valeurs de températures (BT et ST) les plus élevés au cours de l'expérimentation. Les rythmes (RR et HR) observés chez les chèvres croisées ont été plus élevés que ceux des chèvres locales. En conclusion, les chèvres croisées semblent présenter moins de risque dans les conditions environnementales du Nord Est du Brésil.*

Introduction

Brazil and especially the north-eastern region have important role in goat production in the world (7). In this region, the herd is mainly composed of local breed animals without breed type 13, which are characterized by good adaptation to environmental conditions but lower productivity rates when compared to the breeds coming from the temperate regions (17). Some developing countries as well as Brazil, with the strategies to meet the increasing demand for animal products, introduced exotic genotypes with a high degree of specialization such as Saanen, Anglo-Nubian and Alpine breeds, for example. For milk production the most used breed in north-eastern Brazil is the Saanen. In this region the farms whose rearing system was mainly based on pasture, breed extensively the F1 cross between Saanen and local with the objective to exploit the greater productivity in well adapted animals (17). Although the use of Saanen goats in the North-eastern was pronounced in the last

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decades, it has little studies concerning their ability to tolerate the high temperatures in tropical areas.

Lopes Junior *et al.* (11) reported a substantial alteration in the sexual behavior and estrous activity in Saanen reared in intensive system during the rainy season of north-eastern Brazil. It is well known that the stress from environmental conditions can produce a reduction in reproductive performance as well as the meat and milk production (15). Nevertheless the study of environmental response may be suitable to obtain good productive index in these areas, in respect of the animal welfare.

The aim of this study was to compare *in vivo* performance and environmental adaptation of Local breed and Saanen x Local adult goats, raised in the tropical area of north-eastern Brazil.

Material and methods

Experimental conditions

The experiment was carried out on the farm of "Centro Educacional da Juventude Padre João Piamarta" (Itaitinga-CE-Brazil, 3º 43'47'' S and 38º 30'37'' W), during the late rainy season (April, May and June) (10). This period characterizes the transition from the rainy (January - June) to the dry season (July - December) and allowed us to evaluate the animal response in different environmental conditions.

Animals and management

In one herd composed of two genetic types (local and F1 crossbred Saanen x local), each one with one hundred female goats, 20 multiparous adult, non pregnant and non lactating goats were chosen randomly: ten local (group 1) and ten F1 crossbred (group 2). The experimental groups were similar in age (mean ± SEM): 2.5 ± 0.17 vs 2.6 ± 0.16 years (P> 0.05) and body weight: 28.76 ± 5.60 vs 29.99 ± 5.72 kg (P> 0.05). These animals were weighed monthly and kept in the flock. The herd was reared in a semi-extensive system with the follow management: daily, from 07:00 AM to 14:00 PM, the goats grazing on pasture and later they were housed in the pens. Herein at 16:00 PM animals received 500 g/head of concentrate with 20% of crude protein. Water and salt were supplied *ad libitum*. Pens (two) were separated by a central feed alley. Each pen measured 40 x 50 m and contained a 40 x 3 m open front shelter. The feed alley and the front shelter was clay with concrete and faced in east-west direction.

Physiological parameters

Monthly, for four days consecutively, at 06:00 AM (morning reading: MR) and at 14:00 PM (afternoon reading: AR), body and skin temperature and the respiratory and heart rate were recorded. The body temperature (BT) was taken with a rectal digital thermometer. Skin temperature (ST) was measured by a digital thermometer (HI 9063, Hanna Instruments Inc., Woonsocket, USA). Each reading was made at a constant depth by compression in the muscular areas of the rack and leg on the right side of the animal. The ST was obtained by mean of the two measurements. Respiratory (RR) and heart rates (HR) were measured using a stethoscope (Littmann, 3M Health Care, Oakdale, USA). The air temperature (AT) and the humidity (HU) were recorded using a digital thermohygrometer (Ziel WS 9015, Lichtenfels, Germany) before and after each daily measurement of the physiological parameters. The data are given with an accuracy of 0.1° C. All parameters were taken in the pen.

Statistical analyses

All descriptive data was analyzed using the GLM procedures for repeated measures analysis of variance (ANOVA) of SAS program software. The factors used in the model for analysis of physiological parameters included genetic type (local, Saanen x local), months (April, May and June), daily reading (MR and AR) and interactions. Day of record (1, 2, 3, 4) was the repeated measure. Difference among months in the same breed was performed by Duncan test. For the comparison between breeds within each daily reading the t test was used, while the difference between the daily readings for each breed was performed by paired t test. Results were expressed as mean ± SEM and differences were taken as statistically significant from P< 0.05.

Results

Environmental parameters and live weight
(Tables 1 and 2)

The percentage of days with rainfall was 90% (27/30), 32% (10/31) and 43% (13/30) in April, May and June, respectively. At MR the AT was higher in May and at AR in June, (P< 0.05).

During June, AT was superior at AR when compared to MR (P< 0.05). Concerning the HU, the highest values (P< 0.05) were always recorded during April while the records for HU were always higher in MR (P< 0.05). However the AT and HU values recorded inside the pen during the experiment were in agreement to the seasonal averages of the region. From May to June the crossbred goats showed a significant gain (P< 0.05); the live weight of F1 was superior to the local (P< 0.05) at the end of the experiment.

Physiological parameters: daily reading response

A significant effect of daily reading was observed. The readings during the afternoon were significantly superior to the morning (P< 0.05) for all parameters.

Table 1

Mean (± SEM) of air temperature (AT) (ºC) and humidity (HU) (%) recorded in the pen during the experiment

Month	Morning		Afternoon	
	AT	HU	AT	HU
April	24.75^{a} ± 0.17	86.50^{aA} ± 0.68	26.50^{a} ± 0.33	80.50^{aB} ± 1.16
May	25.88^{b} ± 0.17	71.00^{bA} ± 0.57	26.38^{a} ± 0.22	65.00^{bB} ± 0.95
June	22.50^{cA} ± 0.17	81.75^{cA} ± 0.55	29.63^{bB} ± 0.22	72.25^{cB} ± 1.15

^{A,B} Comparison between daily readings (P< 0.05);

^{a,b,c} Comparison among months (P< 0.05).

Table 2

Live weight (mean ± SEM) of F1 and local goats recorded during the experiment

Month	Body weight (kg)	
	F1	Local
April	29.99a ± 0.64	28.76 ± 0.62
May	28.62a ± 0.54	28.58 ± 0.51
June	31.83bA ± 0.65	28.93B ± 0.69

^{A,B} Comparison between genetic types (P< 0.05);

^{a,b} Comparison among months (P< 0.05).

Physiological parameters: monthly and genetic response

Figures 1, 2, 3 and 4 presented the results of comparison among months in each genetic type and between genetic type in the same daily readings (MR or AR).

Skin and body temperature (Figures 1 and 2)

In the afternoon both temperatures presented a significant increase from April to May (P< 0.05).

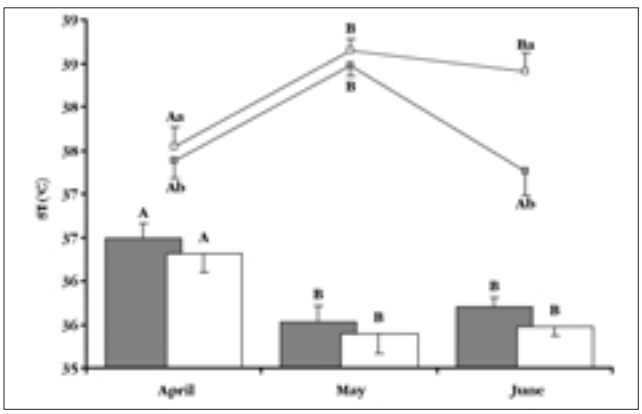

Figure 1: Mean (± SEM) of skin temperature (ºC) of F1 (grey) and local (white) goats, recorded in the morning (bars) and in the afternoon (lines), during the late rainy season in north-eastern of Brazil. Each value represents the mean of four consecutive days.
^{a,b} Comparison between breeds in the same daily reading (P< 0.05);
^{A,B} Comparison among months in the same breed (P< 0.05).

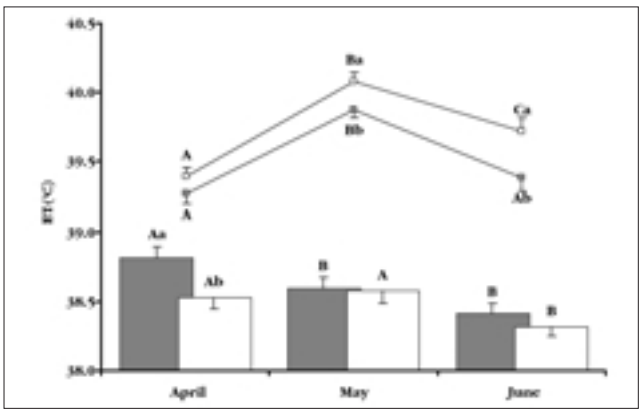

Figure 2: Mean (± SEM) of body temperature (ºC) of F1 (grey) and local (white) goats, recorded in the morning (bars) and in the afternoon (lines), during the late rainy season in north-eastern of Brazil. Each value represents the mean of four consecutive days.
^{a,b} Comparison between breeds in the same daily reading (P< 0.05);
^{A,B} Comparison among months in the same breed (P< 0.05).

Thus in May the highest values (ST: 38.66 ± 0.12 °C and BT: 40.09 ± 0.06 °C) of the experiment were detected in local goats. From May to June the AR showed again a decrease in temperatures (P< 0.05), except for the ST in local animals. In the morning, the greatest mean temperatures were observed in April (P< 0.05). In this month the BT of local breed was significantly lower than the F1. Also in both breed the temperatures showed a decrease from April to May - June period (P< 0.05).

Respiratory and heart rate (Figure 3 and 4)

Concerning AR, the RR recorded during May (P< 0.05) was superior when compared to the other months. F1 goats showed the highest values of RR in this month (74.10 ± 4.54 bpm).

For this genotype the RR reading in the morning showed a slow increase from April to June (P< 0.05). Also the RR recorded in June was different between genotypes (P< 0.05). The HR data in the afternoon showed a significant increase from April to May in local breed and for F1 from May to June. The highest

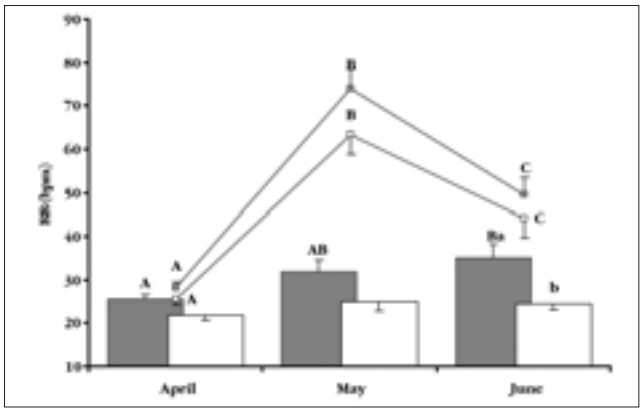

Figure 3: Mean (± SEM) of respiratory rate (bpm) of F1 (grey) and local (white) goats, recorded in the morning (bars) and in the afternoon (lines), during the late rainy season in north-eastern of Brazil. Each value represents the mean of four consecutive days.
[a,b] Comparison between breeds in the same daily reading (P< 0.05);
[A,B] Comparison among months in the same breed (P< 0.05).

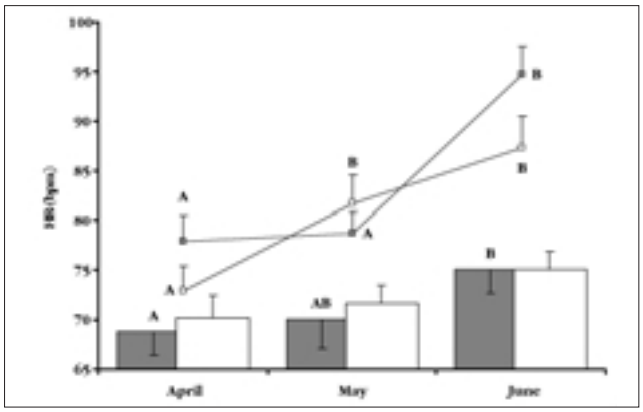

Figure 4: Mean (± SEM) of heart rate (bpm) of F1 (grey) and local (white) goats, recorded in the morning (bars) and in the afternoon (lines), during the late rainy season in north-eastern of Brazil. Each value represents the mean of four consecutive days.
[a,b] Comparison between breeds in the same daily reading (P< 0.05);
[A,B] Comparison among months in the same breed (P< 0.05).

value was recorded in June (F1: 94.70 ± 2.92 bpm). During MR the HR and RR of the crossbreds became progressively greater during the experiment (P< 0.05).

Discussion

Live weight recorded during the experiment did not show a reduction in body mass in either genetic type. Literature on goats reported a marked depression of food intake and weights when animals were exposed to high temperatures of tropical areas (12, 18). Goats living in harsh environments represent a climax in the capacity of domestic ruminants to adjust to such areas, where water sources are widely distributed and food sources are limited by their quantity and quality (19).

However the air temperatures registered in the pens throughout the experiment demonstrated that the upper critical temperature (up to 30 °C) of goats was not raised (12). Also in this period the effect of rainfall provide the greatest food offer of pasture in the region (10). These facts interpreted the performances *in vivo* reported in the study.

The increases in physiological response showed during AR in both genetic types were expected (1, 2). It can be considered as a protective mechanism of homeostasis against stress due to exercise and heat increment of digestive process. Such factors associated with an increment of solar radiation justified the highest values recorded in the afternoon from May to June (4). Ogebe *et al*., (16) showed a negative correlation between rainfall and physiological parameters in Nigerian dwarf goats. These authors observed an increase in physiological response from rainy to dry season and suggested that rainfall is associated with high atmospheric moisture, which could reduce the amount of heat stress.

In spite of the greater values in the afternoon previously mentioned, the experimental BT means recorded in both genetic types were in accordance with the standard values proposed for goats (39 – 40 °C) in neutral thermal condition (3). Some authors (3, 5, 9, 12, 14), demonstrated in several stress conditions that BT exhibited minimal variations.

During the last part of the experiment the goats showed clinical signs of stress in the afternoon. Both pulses (RR and HR) surpassed the mean values of goats (HR: 75 - 85 bpm and RR: 25 - 40 bpm, 3). In the same daily reading the ST means were quite close to BT, showing a less efficiency to dissipate the increase of temperature observed in this period.

Concerning genetic comparison, the local goats achieved the highest values of temperature parameters throughout the experimental period. The lower thermal stress in the F1 cross can be interpreted by the presence of white coat and skin pigmented in these animals (1). It is known that the effect of penetration of solar radiation is a function not only of the color but also of the structure of the coat (1, 8). Thus short haired animals, such as the F1 cross goat showed in this research, were susceptible to higher increase of RR and HR (1). Berbigier (6), reviewing results of some experiences conducted in Guadalupe with Local and F1 Alpine x local kids, reported that the greater productivity of crossbreds did not affect their tolerance of diurnal temperatures. However in F1, weight of heart and lungs were higher than local goats probably consequence of intense thermoregulation activity.

Data of readings conducted in the morning permitted description of the animal response after the nocturnal inactivity phase. It is important to point out that in all animals the physiological observations did not show sign of stress and means values of parameters were within the limits of tolerance (3). In both groups, body and skin temperatures displayed a slight decrease (0.5 - 1.0 °C) from May to June. This loss of heat was probably the residual effect of animal reaction to a progressively fall of temperature during the night. The increase of solar radiation and of clear days is usually associated to a cooling effect in the nocturnal period.

Apparently crossbred goats exhibited higher responsiveness to exposure to morning environmental conditions. During transition from rainy to dry season rates values raised. The cause of these results is difficult to explain. However the presence of the response only in F1 would seem to indicate that their traits were involved. Moreover in the morning readings recorded in April appear to be more affected by the highest humidity shown during this month. Especially in F1, the BT and ST registered in this period were superior to the other months and quite close to the afternoon values. These results are not in agreement with other authors (16), who concluded that at the onset of rain animals became more comfortable environmentally. Nevertheless the literature had little information about the crossbreds used in this work. Publications are focused mainly on temperate breeds or native breeds submitted to tropical conditions. It is possible that the moisture elevation influenced the ability for thermal dissipation in F1 characterized with a greater demand by the local breed.

Conclusion

It was concluded that the local goats are more susceptible to climatic stress than Saanen crossbreds. The greater ability of crossbred goats to tolerate the tropical environment in North-eastern Brazil may be due to their white coat and skin pigmented.

Acknowledgements

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