



Scrotum bipartite in sheep as a parameter indicative of adaptation to semi-arid climates: A thermographic and reproductive study

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ARTICLE INFO

Article history:

Received 24 January 2018

Received in revised form

20 July 2018

Accepted 26 July 2018

Available online 29 July 2018

Keywords:

Reproduction

Morphology

Temperature

Ruminants

Semi-arid

ABSTRACT

With the objective of assessing the influence of scrotum bipartition on scrotum-testicular thermoregulation and semen quality in sheep native to a semiarid region, 14 adult crossbred rams were placed into groups, GI (7 with bipartition in the scrotum) and GII (7 without bipartition). Images were taken of the caudal scrotum surface using a Fluke (Ti25[®]) thermographic camera, for temperature analysis. Two semen collections were made, at an eight-day interval, by electroejaculation, to analyze macroscopic and microscopic parameters. It was observed that the surface temperatures of the proximal, medial and distal regions of the testicle and the epididymis tail did not present significant statistical difference ($p > 0.05$) between the groups. The GI showed a great ability to regulate the temperature in the tail region of the epididymis ($p = 0.062$), location of the bipartition, and the difference in temperature between the body surface and the epididymis tail was 0.54°C much lower than the G2. Although no significant statistical difference ($p > 0.05$) was observed, the animals with bipartition presented higher means for body surface temperature, showing greater efficiency in heat dissipation and indicating that these animals used peripheral vasodilation on a larger scale to eliminate excess heat and thus had a lower energy expenditure. The semen parameters studied in both groups were within the desirable values for the species, with no differences between the groups ($p > 0.05$). Higher scrotum testicular values were observed (scrotum circumference GI = 30.40 ± 0.53 and GII = 28.42 ± 1.13 cm, testicle length, right and left, respectively GI = 8.14 ± 0.90 cm, 8.00 ± 0.00 cm and GII = 7.28 ± 0.04 cm, 7.28 ± 0.48 cm) and bodyweight (GI = 44.57 ± 5.25 Kg and GII = 39.85 ± 1.57 Kg) in rams with scrotum bipartition ($p > 0.05$). It is concluded that scrotum bipartite in rams was shown to be an evolutionary indicator showing that animals with this characteristic dissipate heat more efficiently, have bigger scrotum-testicle biometrical parameters and heavier body weight. However, as the rams with scrotum bipartite presented division of less than 50% of the scrotum length, this degree did not influence the scrotum surface temperature and semen quality, as has been observed in goats with the same characteristic.

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1. Introduction

Goat and sheep rearings of major social and economic

importance in many countries because these animals are highly adaptable to adverse conditions in different regions, especially semi-arid regions, with irregular rainy seasons and periodic droughts. However, these factors can limit the animals reproduction process. When management practices cannot in part correct these imbalances, natural selection processes will favor those animals better adapted to the adverse conditions of the environment.

Goats from the arid and semi-arid regions of East Africa present morphological alterations in the reproductive organs, such as the

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appearance of scrotum bipartite [1]. This characteristic has been observed frequently in goats reared in the Northeast of Brazil, and is known as “bipartite scrotal sack” [2]. Studies have shown that this anatomy considerably amplifies the surface of each testicle exposed to environmental temperature, providing better heat dissipation, with consequent increase in the testicle biometrical parameters, sperm quality and reproductive efficiency of these animals compared to those that have a simple scrotum [2–4].

To analyze the effect of morphological alterations in the reproductive organs on reproductive efficiency, it is important to correlate them with other factors that affect animal reproduction, especially those regarding environmental temperature and relative humidity [5].

Scrotal conformation and environment temperature exercise considerable influence on the testicle temperature. When the environmental temperature increases, the thermoregulation mechanism is damaged and testicular degeneration is more likely. This increase in temperature has serious consequences for semen quality and subsequently for embryo fertilization and survival and it interferes directly in the fertility results at birth [6–10].

To meet the demands of semen production and quality, the scrotum temperature should be 2 to 6 °C lower than that of the abdomen, so that verifying the scrotum/testicular temperature contributes to a better understanding and assessment of the reproductive function of the animal [11].

With advances in technology, new equipment is always available that facilitates in loco analysis and provides more significant and precise data. Infrared thermography is important because it is a non-invasive method to assess skin surface temperature, that captures charges of infrared radiation and expresses the heat gradient in a pattern of colors [12].

Variation in skin temperature results from changes in the tissue perfusion and blood flow [13] and the use of a thermographic camera that detects, with high sensitivity, radiation emitted by the bodies so that minimal changes in temperature on the surface can be monitored rigorously.

In this context, the objective of the present research was to assess the influence of scrotum bipartite on thermoregulation and semen quality in rams native to a semi-arid region.

2. Material and methods

2.1. Ethics committee

The methodology protocols of the present study followed the ethical concepts in animal experimentation, approved by the Ethics Committee for Animal Use-CEUA, protocol No 277–2015, of the Committee for Ethics in Research at the Federal University of

Campina Grande- UFCG, Patos-PB, Brazil.

2.2. Animals, research location and formation of experimental groups

The study was carried out in June and July on the farm Fazenda Águas da Tamanduá, (6°47'46.95"S and 38° 8'51.78"W), located in the irrigated perimeter of Várzeas de Sousa, municipality of Sousa, Paraíba, Brazil. The climate in the region is the Aw' type by the Köppen classification [14], with 780 mm mean annual rainfall [15], concentrated from January to May and 27 °C mean annual temperature.

Fourteen rams of no specific defined breeding (with predominance of Santa Inês breed) were used, 12–18 months old, identified by inspecting the dental arch [16], with homogeneous body score (44.57 kg mean weight). They were divided into two groups considering the scrotal conformation, as proposed by Almeida [17] for goats, making an analogy to the classification by Nunes et al. [2]. Group I (GI) contained animals that had scrotum bipartite, on average, up to 16% of the scrotum length, and group II (GII) consisted of seven animals with simple scrotum (Fig. 1).

The animals were kept under semi-intensive management, released in the morning to graze in a 60 m × 362 m paddock with native pasture and were corralled at the end of the afternoon, where they had access to corn and soybean-based concentrate (80:20) and mineral salt.

2.3. Environmental variables

The environmental variables air temperature (T°Ar) and relative air humidity (UR%) and black globe temperature (TGN) were obtained using a HOBO (Temp/RH/2-U12-013) type datalogger, the external cable was attached to the black globe and installed in the animals shelter.

The datalogger was programmed, using its software, to record the data set every hour, for 24 h before and after collecting the thermographic data and during the experiment days, in order to obtain the means of all the variables for each day of the experiment.

The environmental data obtained was used to calculate the indices of black globe temperature and humidity (ITGU), according to the formula: $Tgn + 0.36 \cdot Tpo + 41.5$ [18], where Tgn is the temperature of the black globe and Tpo: Temperature of the dew point.

2.4. Physiological parameters

Rectal temperature (TR) and respiratory frequency (FR) were recorded at two times, 8 a.m. and 3 p.m. The TR was determined



Fig. 1. Photographs of ram scrotum. A) Animal with scrotum bipartite (GI), B) animal without scrotum bipartite (GII).

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