



Effect of multiple stress factors (thermal, nutritional and pregnancy type) on adaptive capability of native ewes under semi-arid environment



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ABSTRACT

This study was conducted to evaluate the effect of multiple stress factors (thermal, nutritional and pregnancy type) on two different native track breeds of ewes as reflected by their adaptive capability under semi-arid environment. The multiple stressor experiment was conducted in twenty-four ewes (12 Santa Inês and 12 Morada Nova ewes). Both heat stress and pregnancy stress was common to all four groups. However, the animals were divided into further two groups within each breed on the basis of nutrition regimen. According the groupings were: Group 1 (Six Santa Inês ewes; heat stress; nutrition at 0.5% of BW; single pregnancy); Group 2 (Six Santa Inês ewes; heat stress; nutrition at 1.5% BW; twin pregnancy); groups Group 3 (Six Morada Nova ewes; heat stress; nutrition at 0.5% of BW; single pregnancy); Group 4 (Six Morada Nova ewes; heat stress; nutrition at 1.5% BW; twin pregnancy). All the animals in the experiment were pregnant. Heat stress was induced by exposing all animals to summer heat stress in outside environment while the nutritional regimen followed was at 0.5% and 1.5% level of body weight (BW) respectively in each breed. The experiment was conducted in a completely randomized design with two breeds, two nutritional treatments and two pregnancy types, 10 repetitions for physiological parameters and six for blood parameters, with repeated measures over time. Physiological parameters (respiratory rate, pulse rate and rectal temperature) were measured with the animals at rest in the morning and afternoon, 0600–0700 and 1300–1400 h, respectively, every seven days. Blood samples were collected every 14 d for determination of serum glucose, triglycerides, cholesterol, urea and creatinine. We found interaction effect between breed and pregnancy type on respiratory rate and rectal temperature with greater values in Santa Inês ewes than Morada Nova ewes. However, there was no significant fixed effect of pregnancy type and supplementation level on physiological responses of breeds. Environmental factor (period of the day) had influenced the physiological responses of ewes during all gestational period. Santa Inês ewes had greater serum glucose concentration at 105 d and 120 d of gestation compared to the Morada Nova ewes. Morada Nova ewes had greater concentrations of triglycerides, urea at 120 d, 150 d and also greater cholesterol at 105 d, 135 d and 150 d of gestation compared with Santa Inês ewes. The present result indicates that thermal condition was most important factor that modified the physiological responses of ewes in a semi-arid tropical environment.

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1. Introduction

Global demand for livestock products is expected to double during

the first half of this century as a result of the growing human population and its growing affluence by increasing their purchasing capability. Over the same period, we expect big changes in the global climate. Today climate change is one of the most serious long-term challenges facing farmers and livestock owners around the globe. In arid and semi-arid areas, livestock are often considered to be one of the most important means of food and economic security for poor and marginal farmers. In addition, climate changes can affect the

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pasture availability, grazing time causing inefficiency of the production system by reducing the nutrient intake (Silva et al., 2016).

Semi-arid environment is one of the major agro-ecological zones of the tropics in Brazil, over 50% of the sheep population is concentrated in this region. Semi-arid environment is one of the major agroecological zones of the tropics. There is, in general, a strong relationship between agro-climatic conditions, population density, cropping systems, and livestock production (Maurya et al., 2010). The development of sheep production may have a direct influence on the income and quality of life for part of this population (Renaudeau et al., 2012; Shiotsuki et al., 2014). Semi-arid regions are characterized by ambient temperature, high incidence of solar radiation, low humidity and high skin evaporation rates. The interaction of these factors can cause intense physiological alterations in animals raised on pasture (Sejian et al., 2010a; Silva et al., 2013b). Further, inadequate and low quality feed is a major factor leading to under-production of animals in arid and semi-arid tropical regions. Under-nutrition in sheep production in semi-arid conditions can occur in late spring and summer due to increased energy output for thermoregulation and concurrent reduction in energy intake. Thereby, information regarding nutritional requirements of native breeds for optimum production and fertility is limited, mostly extrapolated from developed countries and does not consider additional requirements from environmental stress (Sejian et al., 2014). The biological changes as a result of thermoregulation include a decrease in feed and water intake and utilization, the body fluid balance, the acid-base equilibrium, blood biochemical (Braun et al., 2010; Fadare et al., 2012).

In the present changing climate scenario, there are numerous stresses other than the heat stress, which constrain the livestock and have severe consequences on their production (Sejian et al., 2010a, 2011, 2013). The projected climate change seriously hampers the pasture availability, especially during the period of frequent drought in summer. Thus, livestock suffer from drastic nutrition deficiency. Both the quantity and the quality of the available pastures are affected during extreme environmental conditions. Hence, from the climate change perspectives its not only the heat stress that is very important apart from this nutritional stress also plays an important influential role in deteriorating their production (Sejian et al., 2010a, 2010b).

In small ruminants the most important productive parameter is their efficient reproductive activities. To improve the economy of sheep farms, farmers have to ensure regular lambing. Hence, proper reproductive management of sheep is very crucial from economic perspectives. The energy demands during pregnancy period for sheep are huge. Further, in the changing climate scenario, the multiple stresses that arise and in particular heat and nutritional stress can have detrimental effects during pregnancy period. When exposed to one stress at a time, animals can effectively counter it based on their stored body reserves and without altering the productive functions. However, if they are exposed to more than one stress at a time, the summated effects of the different stressors might prove detrimental to these animals. Such a response is attributed to animal's inability to cope with the combined effects of different stressors simultaneously. In addition, studies pertaining to thermoregulation involving the effects of multiple types of stresses on pregnant ewes are limited. This study is one such attempt to establish the cumulative impact of heat and nutritional stress in pregnant sheep as these stresses do not occur in isolation rather they impact sheep production simultaneously (Sejian et al., 2010a, 2013). Studies pertaining to establishing the impact of heat and nutritional stress during pregnancy in sheep are very negligible. This is very important to study as in small ruminants especially in sheep getting lambs at regular interval is of paramount importance. Hence concerted research efforts are needed to provide the base line information related to establishing

the impact of heat and nutritional stress simultaneously in pregnant sheep. This may pave way for development of suitable amelioration strategies to counter the heat and nutritional stress during pregnancy period in sheep.

Our hypothesis is that thermal, nutritional and pregnancy type factors can affect adaptive physiology of native ewes in a semi-arid environment. Therefore, this study was conducted to evaluate the effect of multiple stress factors (thermal, nutritional and pregnancy type) on adaptation physiology of native ewes under semi-arid environment.

2. Materials and methods

2.1. Site of study

The experiment was carried out at Professor Cinobelina Elvas Research Unit in Small Ruminants Campus (CPCE), Federal University of Piauí (FUPI), Bom Jesus - PI (09° 04'28" south latitude and 44° 21'31" west longitude) at an altitude of 277 m above sea level with a semi-arid climate (Bsh), according to Köppen (Brasil, 1992). The experiment was conducted between November 2011 to February 2012 when the environmental temperature was generally hot.

2.2. Animals

A total of 51 multiparous ewes (3 years), 27 Santa Inês (SI) breed and 24 Morada Nova (MN) were artificially inseminated at fixed time (AIFT) in the study. Both these breeds were indigenous breeds. The animals were housed in well-ventilated sheds made up of asbestos roofing at the height 2.4 m, open sides and maintained under proper hygienic conditions. The animals had *ad libitum* access to good quality drinking water. Prophylactic measures against sheep diseases like sheep pox, peste des petits ruminants, enterotoxaemia, endo and ectoparasitic infestations were carried out as prescribed by the health calendar of the institute to ensure that the animals were in healthy condition throughout the study.

2.3. Estrus synchronization and pregnancy diagnosis

All 51 ewes were subjected for estrus synchronization protocol. The protocol involved in the application of intravaginal sponge containing 60 mg of medroxyprogesterone acetate (Progespon[®] Syntex S. A, Argentina) for 9 d. After sponge removal, beginning of the FSH treatment, 200UI of eCG (Folligon 5000[®], Intervet, Holanda) and 0.1 mg of cloprostenol sodium (Ciosin[®], Intervet, Holanda) were given intra muscular (IM) to synchronize the follicular wave and stimulate ovulations. After oestrous synchronization, ewes were artificially inseminated at fixed time with semen of Dorper Breed ram. On day 60, post-artificial insemination, trans-abdominal ultrasonography (50S Tringa Vet, Pi Medical, Maastricht, The Netherlands; transducer of 3.5/5.0 MHz) was used to detect pregnancy and fetal quantification.

2.4. Technical details

The study was conducted for a period of 173 d. First 75 d, all animals were maintained with the concentrate supplementation at the rate of 1.0% body weight (BW) along with grazing on *Andropogon grasses* (*Andropogon gayanus*). After this period new experiment on multiple stressors were carried out. This experiment was conducted for a period of 84 d. Twenty-four ewes, 12 Santa Inês and 12 Morada Nova with an average initial body weight (weight \pm SD) of (52.6 \pm 6.54) and (31.3 \pm 3.74 kg) were selected respectively. All these ewes were subjected to three stresses viz., heat stress, nutritional stress and pregnancy stress. The multiple stressor experiment was

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