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Evaluation of Indian sheep breeds of arid zone under heat stress condition

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ABSTRACT

The present study was conducted to assess the effect of the heat stress on the hematological and physio-biochemical parameters of sheep breeds thriving in hot and arid climatic conditions. Thirty animals (female) of about one and half year of age from each sheep breed (Chokla, Magra and Marwari) were used for the estimation of hematological and physio-biochemical parameters under normal (lower Temperature Humidity Index of 65) and heat stress condition (higher Temperature Humidity Index of 84). T test analysis revealed significantly higher values in the heat stressed condition for SGOT, respiratory rate and pulse rate in afternoon hours; and significantly lower values for Hb%, PCV%, Triglycerides and Cholestrol for all the three breeds. Magra breed of sheep had highest overall adaptability (83.29%) followed by Marwari (80.41%) and Chokla with the least adaptability (79.13). Higher overall adaptability in Magra sheep in this region might be due to the white and lustrous coat of Magra which reflects the sun light more as compared to other sheep breeds. However, the effect was found to be non-significant ($P > 0.05$). Therefore, it is concluded that these sheep breeds are equally adaptable to the hot and arid climatic conditions of this region.

1. Introduction

Sheep is an important livestock species of India. It contributes greatly to the agrarian economy, especially in the arid/semi-arid and mountainous areas where crop and/or dairy farming are not so economical. They play an important role in the livelihood of a large percentage of small and marginal farmers and landless labours engaged in sheep rearing. Sheep are mostly reared for wool and meat production. According to 19th livestock census 2012, the sheep population of India is 65.06 million, which contribute 12.71% of total livestock population of India. The total indigenous sheep population is 61.29 million. Among state-wise sheep population, Andhra Pradesh has highest, sharing 40.57% of total population. However, Rajasthan which has 3rd rank in population is highest in wool production. According to NBAGR, the nodal agency for the registration of livestock breeds in India, there are 40 registered sheep breeds in India. These sheep breeds have quite differences in their adaptability to the local climatic conditions in general and to heat stress in particular (Marai et al., 2007; Salces-Ortiz et al., 2015).

Heat is one of the main sources of stress which has an important impact on the production and reproduction of livestock species. Exposure of the sheep and goat to elevated temperature results in a decreased body weight, average daily gain (ADG), growth rate and body total solids, which is reflected by impaired reproduction (Marai et al., 2000a,b; Abdel-Hafez, 2002). This causes severe economic losses to sheep and goat keepers.

Heat stress (HS) can alter follicular growth (Roth et al., 2000), steroid secretion (Ozawa et al., 2005) and gene expression. It is considered to be a limiting factor for sheep production (Mc Manus et al., 2009). Animals adapted to hot/cold climatic conditions should show least variation in their physio-biochemical traits when raised under such conditions. It has been observed that the animals often differ in their tolerance and susceptibility to the thermal stress. This variability can be explored to identify superior germplasm/gene underlying such traits of adaptability. This can further be utilized for the selection of the animals tolerant to the heat stress. During HS, heat increment exceeds heat loss modifying the homeostatic functions. As per Gudev et al. (2007), HS elicits an integrative physiological and endocrinal modulation altering overall metabolism and helping the animal sustain during the stressful period. Various

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Table 1
Climatological data during the experiment period.

Month	Temperature	Relative Humidity	THI	Condition
February	68	33	65	Absence of heat stress
June	101	26	84	Severe heat stress

in-depth studies on HS in ruminants have made observations indicating severely compromised thermoregulatory functions and an overall negative effect of high temperature (Wankar et al., 2014).

Heat stress influences the hematological and physio-biochemical parameters of sheep and goat (Alam et al., 2011; Ocak and Guney, 2010; Phulia et al., 2010; Sharma and Kataria, 2011; Shivakumar et al., 2010). The present study therefore gives an account on the effect of heat stress on the hematological and physio-biochemical parameters in three important Indian sheep breeds reared under hot and arid conditions with an aim to assess their overall adaptability to heat stress.

2. Materials and methods

The experiment was carried out at the Arid Region Campus of CSWRI, Bikaner in the months of February and June. The campus is located at 28° 18′ 0″ N (28.3° N) latitude and 73° 30′ 0″ E (73.5° E) longitude at 236 m above mean sea level in the heart of Thar Desert. The average rainfall of this place is low (250 mm) and erratic. The temperature varies between sub zero (−2 °C) during winter season (December–Feb) and as high as 49 °C during summer (May to June). The animals were reared under semi intensive management system. The animals grazed for 8–10 h in a day in morning and evening. The grazing land was having different type of grasses and bushes eg. *Cenchrus ciliaris(*Dhaman) *Cenchrus setigerus* (Moda Dhaman) *Lasiurus sindicus* (sewan), *Panicum antidotale* (blue panic) *Panicum turgidum* (murath) *Cymbopogon jwarancusa* (bur) *Cynodon dactylon* (doob) *Dactyloctenium aegypticum* (Makra grass) *Dactyloctenium scindicum* (ganthia), *Aristida adscensionis* (Lapda), *Zizyphus nummularia* (Pala), *Calapagonium mucanoids* (Fog), *Capparis deciduas* (Ker), *Leptadenia pyrotechnica* (Kheep), *Salvadora oleiods* (Jaal), *Haloxylon recurvum* (Lana) etc. The water was offered ad libidum to sheep in morning and evening before and after grazing. Sheep were kept in covered shed (20 feet × 30 feet) with open corral (30 feet × 30 feet) attached to it. The area of one square meter was provided to each animal. The animals were handled by farm manager and grazier daily with all care and precautions.

The average temperature and Relative Humidity during the study period is given in the Table 1. THI index during the study period was calculated by the following formula:-

$$THI = db^{o}F\text{-}\{(0.55\text{-}0.55RH)(db^{o}F\text{-}58)\}(LPHSI, 1990).$$

Where, db^{o} F is the dry bulb temperature in ^{o} F and RH is the relative humidity (RH%)/100.

2.1. Experimental animals

The experiment was conducted on Chokla, Magra and Marwari breeds of sheep (30 animals of each breed) with different genetic background for the estimation of hematological and physio-biochemical parameters. The animals of different breeds were grouped separately according to the animal welfare rules. All the animals were females of about one and half year of age with almost similar body weight. The parameters taken for hematological study include; Hb%, PCV%, TLC, DLC and TEC whereas for the estimation of biochemical parameters; SGOT, Triglyceride, Cholestrol, Total protein, Albumin, Glucose, phosphorous and Calcium were included.

2.2. Sample collection

For haemato-biochemical estimation, blood samples were collected between 7:00–8:00 a.m. once in each extreme climatic condition *i.e.* normal and heat stressed (Feb and June month) with wide difference in their Temperature Humidity Index as given in Table 1 during the same year. The animals were identified and same animals were used for the sample collection in both the conditions for the estimation of haemato-biochemical as well as physiological parameters. Isolation of the plasma and serum was carried out immediately after blood collection. The samples were brought to the laboratory while maintaining the cold chain. Blood samples were analysed immediately, whereas the plasma and serum samples were stored at −20 °C till further analysis. For physiological parameters, recording of the rectal temperature, respiratory rate and pulse rate was carried out for three consecutive days in each condition (Table 1) in each animal and their mean values ± SE in different sheep breeds under normal (N) and heat stress (HS) condition was calculated. Rectal temperature was measured using a mercury thermometer. Respiratory rate was determined by counting the number of flank movements per minute. Pulse rate was measured by placing the fingertips on the femoral arteries of the hind limb for 1 min.

2.3. Analysis of the samples

Approximately 1.5 mL of blood sample collected with anticoagulant was analysed for hematological parameters including haemoglobin (Hb-gm/dL), packed cell volume (PCV%), total erythrocyte count (TEC × 10^6 per μL), total leukocyte count (TLC × 10^3 per μL) and differential leukocyte count (DLC) as per method described by Schalm et al. (1975). Biochemical analysis of the samples was carried out by semi-auto-analyzer (3000 Evolution, Biochemical systems International, Italy) using commercially available kits of Erba (Transasia Biomedicals Ltd. Solan, India). The physiological parameters (Rectal temperature, respiratory rate and pulse rate) were measured by standard procedures.

2.4. Statistical analysis

The mean values of all the parameters in each group were calculated and the independent *t*-test for significant was applied ($P \leq 0.05$).

3. Results

3.1. Haematological parameters

The average values of hematological parameters of different sheep breeds under normal (N) and heat stress (HS) condition are given in Table 2. These values were found to be lower in all the three breeds (Chokla, Marwari and Magra) for Hb%, PCV% and TEC under heat stressed condition. The average value for TLC was higher in Chokla and Magra and lower in Marwari under heat stressed condition as compared to normal condition (Table 2).

3.2. Biochemical parameters

The average values of biochemical parameters of different sheep breeds under normal (N) and heat stress (HS) condition are given in Table 3. For biochemical parameters the average values increased for total protein and albumin and reduced for cholesterol and triglycerides under heat stressed condition. For Glucose, the values increased for Marwari and reduced for Chokla and Magra indicating more stressful condition in Marwari sheep. For Phosphorous the values were reduced and for SGOT increased for all the three breeds.