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Research

Effect of water restriction on physiological responses and certain reproductive traits of Malpura ewes in a semiarid tropical environment

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ABSTRACT

Other than high temperature and feed shortage, water scarcity is a major problem in semiarid tropical region during summer. Water is considered as an essential nutrient and is involved in every metabolic function of the body. Considering its importance in sheep productivity, twenty-eight nonpregnant Malpura ewes were randomly and equally divided into 4 groups, viz., GI (control; *ad libitum* water), GII (20% less than *ad libitum* water intake), GIII (40% less than *ad libitum* water), and GIV (*ad libitum* water on alternated day) to see the effect of water restriction on physiological responses and certain reproductive traits of Malpura ewes in semiarid tropical environment. This study was conducted for a period of 35 days covering 2 estrous cycles. All the animals were provided with *ad libitum* feed consisted of 70% roughage and 30% concentrate. All the ewes were synchronized for estrus at the starting of the experiment and reproductive parameters were recorded. The feed intake of all the ewes was recorded individually daily during the study period. All the ewes were weighed individually every week before morning feeding. Physiological responses were recorded twice daily at 0700 h and 1400 h on weekly basis. Blood samples were collected at weekly interval. The feed intake was lower ($P < 0.05$) in GIII and GIV compared with GI. The average daily weight loss was significantly ($P < 0.05$) higher in GIV. The morning and afternoon respiration rates were lower in GIV compared with GI although it was not significant ($P > 0.05$) during afternoon. All the water-restricted groups showed a trend of lower respiration rate and pulse rate both in morning and afternoon compared with GI, although the difference was not significant. Hemoglobin, packed cell volume, glucose, cholesterol, and chloride level were significantly ($P < 0.05$) lower in GIV compared with GI. The glucose and cholesterol levels were ($P < 0.05$) lower in GIII compared with GI. Estrus percentage was lower (85.7%) in the water-restricted ewes compared with control (100%). Estrogen level was significantly ($P < 0.05$) lower in GIII and GIV compared with GI, whereas progesterone level showed a reverse trend. The present study reveals the effect of water stress on biological functions of Malpura ewes during summer. The results suggest that Malpura ewes can adjust their physiochemical response and reproduction up to 20% of water restriction during hot summer.

Introduction

In the tropics, semiarid regions cover a vast agroecological area. Rangelands are available in these regions. The small, marginal farmers of the semiarid region are mostly dependent on livestock, especially small ruminants, for their livelihood and they use these rangelands. New research plans need to be formulated in semiarid, tropical environments so that the poor are able to secure their

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livelihood from these ecosystems. Water scarcity during summer is a serious regional problem (Chedid et al., 2014). During summer, good quality drinking water is reduced for all species. Drinking water is often a limiting factor for livestock in grazing areas of the semiarid (Najed et al., 2014a; Casamassima et al., 2008). Hence, selection of adapted animal breeds is very important for sustaining animal production under this challenging environment. The breeds of this region have developed adaptive capacity to survive in these adverse conditions. Reports (Najed et al., 2014b; Chedid et al., 2014) are available that breeds of small ruminants in hot arid and semiarid regions may survive up to 1 week with little or even no water. Water shortage affects an animal's physiological homeostasis leading to loss of body weight, low reproductive performance and a decreased resistance to diseases (Barbour et al., 2005). Variation in water-deprivation tolerance is observed in different breeds; however, the indigenous small ruminants are able to thrive despite extreme temperatures and limited water through their behavioral adaptations in combination with both morphologic and physiological adaptations (Cain et al., 2005). Most small ruminants respond to water stress by decreasing their feed intake, resulting in weight reduction due to water and body mass loss (Chedid et al., 2014).

Malpura is a triple purpose (wool, meat, and milk) sheep breed, which originates from the arid and semiarid regions of the western tropical India. They are well adapted to this climate and have the ability to thrive in these stressful conditions (Naqvi et al., 2013). Despite the fact that water insufficiency is a critical problem in any semiarid region, few quantitative data exist relating water need for survival of adapted breeds. The sheep producers and farmers should be advised to adopt a sound watering regime to improve productivity and achieve high economic return. With this objective, the present study was conducted to assess the effect of water stress on physiological response and certain reproductive traits of Malpura ewes in semiarid tropical environment.

Materials and methods

Site of study

The study was conducted with the approval of Institute Animal Ethics Committee (IAEC) at ICAR-Central Sheep and Wool Research Institute, Avikanagar, which is in the semiarid tropical area of the India at 75°28′E longitude, 26°26′N latitude and at an altitude of 320 m above mean sea level. The climate of this place is typically hot with annual minimum and maximum temperature of 4°C and 46°C, respectively. The annual rainfall ranges from 200 to 500 mm with an erratic distribution throughout the year. The mean environmental temperatures, relative humidity, and temperature-humidity index during the study period (35 days) are depicted in Table 1. Temperature-humidity index was calculated using the formula as described by Marai et al. (2007).

Animals

The study was conducted with 28 adult (2-4 years old) Malpura nonpregnant ewes weighing 38.83 ± 0.75 kg (between 35 kg and 42 kg). The animals were kept in well ventilated asbestos roof shed. The sheds were open from all 4 sides, and the sheds were also maintained under proper hygienic conditions. Prophylactic measures against sheep diseases like sheep pox (live attenuated vaccine), peste des petits ruminants (live attenuated vaccine), enterotoxemia (killed toxoid), and endoparasitic (closantel and levamisole rotationally) and ectoparasitic (cypermethrin, butox, and deltamethrin) 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.

Table 1
Mean environmental temperatures, relative humidity, and temperature—humidity index (THI) during the study period

Parameters	Mean ± SE
Maximum temperature (°C)	42.40 ± 0.57
Minimum temperature (°C)	30.40 ± 0.73
Dry bulb temperature at morning (°C)	32.37 ± 0.43
Dry bulb temperature at afternoon (°C)	39.86 ± 0.61
Wet bulb temperature at morning (°C)	26.11 ± 0.12
Wet bulb temperature at afternoon (°C)	27.07 ± 0.18
Relative humidity at morning (%)	36.67 ± 5.30
Relative humidity afternoon (%)	26.03 ± 2.77
Temperature-humidity index at morning	28.28 ± 0.28
Temperature-humidity index at afternoon	33.54 ± 0.46

SE, standard error.
Morning at 0700 h and afternoon at 1400 h, the meteorologic data were recorded. Temperature-humidity index was calculated using formula given by Marai et al. (2007). According to that, THI = db °C−[(0.31−0.31 RH) (db °C−14.4)], where db °C is the dry bulb temperature (°C) and RH is the relative humidity (RH%)/100. The values obtained indicate the following: <22.2 = absence of heat stress; 22.2 to <23.3 = moderate heat stress; 23.3 to <25.6 = severe heat stress; and 25.6 and more = extreme severe heat stress (Marai et al., 2007).

Experimental procedures

The present study was conducted for a period of 35 days covering two estrous cycles during summer (June–July). The ewes were randomly divided into 4 groups of 7 animals each, viz., GI (control; *ad libitum* water), GII (20% less than *ad libitum* water), GIII (40% less than *ad libitum* water), and GIV (*ad libitum* water on alternative days). In the first week of experimental period, *ad libitum* water intake of individual animal was measured by providing individually *ad libitum* (free to access) water in a bucket to each animal during feeding time (i.e., morning 0730 h to evening 1630 h). All the ewes were provided with 5 liters of water in the morning, and in the evening, the residual water was measured with measuring cylinder. The *ad libitum* water intake was measured daily for 7 days of all experimental animals. After estimating the *ad libitum* water intake in the first week, the ewes were provided water individually according to the group requirement. The water intake of all the ewes was recorded individually daily during the study period and presented in Table 2. The animals were stall-fed with a diet consisting of 70% roughage (ME 1.4 MCal and DCP 2%) and 30% concentrate (ME 2.8 MCal and DCP 7.95%; barley, 650 g/kg; groundnut cake, 320 g/kg; minerals 30 g/kg including 10 g/kg NaCl, with crude protein = 180 g/kg, and total digestible nutrients = 650 g/kg). Ewes were synchronized for estrus using indigenously developed progesterone impregnated intravaginal sponges (Naqvi et al., 2001) to ensure all ewes were in estrus phase at the start of study. The feed intake of all the ewes was recorded individually daily during the study period. All the ewes were weighed individually every week before morning feeding and watering. The average daily gain (ADG) was calculated by dividing the initial and final body weight differences by total number of experimental days (35 days). Physiological responses were recorded twice daily at 0700 h and 1400 h on a weekly basis for the duration of the experiment. Blood samples were collected at

Table 2
Water intake (mean ± SEM) of Malpura ewes during the study period

Group	Water intake (mL/day)
GI	3581.57 ± 188.99
GII	2839.18 ± 146.44
GIII	2146.90 ± 117.85
GIV	2387.51 ± 73.19

GI, control animal with *ad libitum* watering; GII, 20% less of *ad libitum* watering; GIII, 40% less of *ad libitum* watering; GIV, alternative day *ad libitum* watering; SEM, standard error of mean.