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Alteration in surface body temperature and physiological responses in Sirohi goats during day time in summer season

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Goats are well adapted to tropical and subtropical conditions (Finch *et al.* 1980, Goyal and Ghosh 1987), due to their ability to withstand high ambient temperatures (Finch *et al.* 1980). Goats maintain homoeothermy through a balance in heat loss and heat production through behavioural mechanisms and physiological changes (Ogebe *et al.* 1996, Al-Tamimi 2007). Singh *et al.* (2004) reported on adaptability of goats mainly based on rectal temperature, respiration rate and pulse rate, without considering surface body temperature. Particularly, there is lack of information on summer surface body temperature in Indian breed of Sirohi goats, which could be helpful in improving production through proper management during hot period. The present study was carried out to investigate physiological responses and surface body temperature during day time in semi-arid conditions.

Six adults (24–30 months weighing 25–30 kg) and 6 kids (5–6 months weighing 8–12 kg) were selected from institute herd. All these animals were maintained under standard management practice followed at the animal farm. The experiment was conducted during summer and all the animals were exposed to the solar radiations in open goat pen during day time. Ten points (forehead, ear, neck, back, rump, abdomen, shoulder, hip, fore leg and hind leg) were earmarked on the body of animal to record surface body temperature using an Infra-red tela-temp thermometer at 3 h interval during day time (9.00AM to 6.00 PM) in summer. The temperature recorded from ear, fore legs and hind legs was grouped under extremities and rest was grouped under body proper. Rectal temperature was recorded using a clinical thermometer. Respiration rate was recorded on the basis of the flank movement. The average relative humidity, wind speed and minimum temperature were 62±8.3%, 69.3±26.8 m/min and 27.5ºC, respectively. The environmental temperature (37.0, 38.0, 41.0, 39.0 ºC) and the soil temperature (41.8, 46.0, 48.9, 38.0 ºC) in the experimental pen fluctuated at different hours of observations (9.00 AM, 12.00 Noon, 3.00 PM and 6.00 PM). Data were analysed by one way analysis of variance and the differences were tested using Duncan's multiple range test (SPSS 11.5 Version, 2002).

Surface body temperature at different sites differed significantly ($P<0.01$) between adults and kids during day time. The skin surface temperature in adult goats increased significantly ($P<0.01$) with increase in the intensity of solar radiation at noon (Table 1). Changes in body surface temperature at different sites were low ($P<0.01$) in the morning (9.00 AM) and about 5–10 ºC higher in the afternoon (3.00 PM). Fore head, back and rump showed significantly ($P<0.01$) higher temperature than other sites, but these differences were more pronounced in the adults as compared to kids (Table 1). The kids have higher body surface area per unit of body weight and therefore heat dissipation is faster. As a consequence, small animals require a greater heat production per unit of weight than large animals, if the same body temperature is to be maintained. With declining body size, the increase in metabolic rate will eventually reach a limit because the requirements for 'Fuel' became prohibitively high (Bianca 1968). The mean rectal temperature of kids (Table 1) was similar as reported by Singh *et al.* (2004). The changes in rectal temperature were minimum, but it differed significantly ($P<0.05$) between day time and again significantly ($P<0.05$) declined in the evening at 6.00 PM in both kids and adult goats.

Surface body temperature of forehead, back and rump increased significantly ($P<0.01$) with increase in the intensity of solar radiation in both the groups. However, it was more pronounced ($P<0.01$) in adults, probably due to larger body surface area exposed to solar radiation. The surface temperature of extremities was significantly ($P<0.01$) lower than other body parts; the extremities were cooler by 4–10ºC as compared to body trunk. The ear and legs have more

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Table 1. Surface body temperature (°C) and physiological responses (rectal temperature and respiration rate) of Sirohi adult goats and kids during summer condition (mean±SE)

Hours Sites	Adults				Kids			
	9.00 AM	12.00 Noon	3.00 PM	6.00 PM	9.00 AM	12.00 Noon	3.00 PM	6.00 PM
Surface body temperature								
Forehead**	42.4±0.94^{b}	46.80±0.83^{c}	46.36±1.30^{c}	35.93±0.22^{a}	40.15±0.84^{b}	35.33±0.12^{a}	36.45±1.10^{a}	35.85±0.15^{a}
Ear**	37.30±0.45^{a}	40.25±0.30^{b}	46.00±1.60^{b}	36.63±0.85^{a}	37.53±0.14^{c}	36.55±0.11^{b}	35.2± 0.49^{a}	36.93±0.49^{bc}
Neck**	38.45±0.47^{a}	42.2±0.73^{b}	42.55±0.55^{b}	36.10±0.56^{a}	38.65±0.44^{a}	36.0±0.11^{b}	36.50±1.00^{b}	36.08±0.95^{b}
Back**	48.06±1.10^{b}	51.5±1.10^{b}	48.26±2.10^{b}	36.10±0.33^{a}	46.23±1.63^{c}	35.5±0.26^{a}	40.45±1.00^{b}	35.85±0.33^{a}
Rump**	42.35±0.71^{b}	46.28±0.66^{c}	46.30±1.30^{c}	36.25±0.12^{a}	44.36±1.20^{c}	35.32±0.32^{a}	40.30±0.42^{b}	35.73±0.26^{a}
Abdomen**	38.08±0.27^{a}	40.75±0.40^{b}	40.35±0.98^{b}	36.70±0.08^{a}	37.70±0.37^{b}	35.8±0.18^{a}	35.85±0.95^{a}	36.33±0.28^{a}
Shoulder**	38.11±0.38^{a}	40.28±0.24^{b}	41.80±1.10^{b}	36.80±0.15^{a}	37.26±0.37	35.04±.26	35.65±1.17	36.41±0.67
Hip**	39.1±0.97^{ab}	41.60±0.31^{bc}	42.36±1.60^{bc}	36.43±0.11^{a}	37.05±0.63^{bc}	34.83±0.15^{a}	38.60±0.28^{c}	35.41±0.59^{ab}
Fore leg**	37.86±0.60^{a}	39.50±3.80^{b}	40.20±0.71^{b}	36.31±0.13^{a}	36.48±0.48^{bc}	34.51±0.20^{a}	37.50±0.92^{c}	34.98±0.39^{ab}
Hindleg**	37.08±0.53^{a}	39.78±0.39^{b}	39.96±0.84^{b}	36.00±0.19^{a}	36.20±043^{bc}	34.26±0.35^{a}	37.55±0.3^{c}	34.86±0.43^{ab}
Physiological responses								
Rectal temp.* (ºC)	38.97±0.15^{ab}	38.90±0.17^{ab}	39.35±0.08^{b}	38.76±0.14^{a}	39.4±0.04^{b}	38.95±0.09^{a}	39.70±0.06^{c}	39.15±0.09^{ab}
Resp. rate/min.	43.66±5.0^{a}	57.00±5.80^{a}	77.33±8.10^{b}	45.60±02.33^{a}	51.00±4.10^{a}	48.00±1.60^{a}	56.00±1.84^{b}	41.30±3.12^{a}

** Significant difference (P<0.001) between adults and kids; * Significant difference (P<0.005) between adults and kids;^{abc} Values with a different superscript in the row under adults and kids column differ significantly (P<0.005).

surface area to weight and the volume ratio, hence ear and legs permit greater evaporative cooling. The extremities like ears and legs being highly vascularised result in circulation of larger volume of blood per unit area. In fact long and thin legs and long ears are an adaptation character in the hot environment breeds of the tropics, which facilitate their survival in hot environment.

The respiration rate of both adults and kids at 3.00 PM was significantly (P<0.01) higher as compared to those in morning and evening. Present study also showed as increase in respiration rate with increase in environmental/soil temperature (Phulia *et al.* 2000, Ogebe *et al.* 1996). The rise in respiration rate probably demonstrated that goats used heat regulating mechanisms by increasing respiratory exchange.

Rectal temperature is an important indicator of thermal balance and might be used to evaluate the impact of heat stress (Spiers *et al*. 2004). Rectal temperature was significantly (P<0.05) different between kids and adults (Table 1). The rectal temperature was highest at 3.00 PM, that declined significantly (P<0.05) during evening (6.00 PM) in both groups. Avendano-Rayes *et al.* (2006) reported that increased body temperature is a normal mechanism by which animals diffuse heat from their bodies to maintain thermoregulation in hot ambient conditions. In the present experiment, the rectal temperatures of both groups exceed over 39°C. However, Devendra (1987) reported that goats maintain their rectal temperatures below 38.5°C, which is considered normal. Darcan *et al.* (2008) also reported that there was a diurnal fluctuation in body temperature, that was lowest in early morning and highest in late afternoon. In the present study, with the rise in surface body temperature goats started panting. Thermoregulatory responses of panting may result from both central stimuli such as blood temperature supplied to hypothalamus or from peripheral stimuli to the skin (Terill 1968). This was due to commissioning of physiological and behavioral process for maintaining homeothermy in both adults and kids. In adult animals, evaporation through respiratory passage is more than the kids.

Rise in surface body temperature, rectal temperature and respiration rate was observed in relation to rise in solar intensity and orientation. At higher environmental temperature and increase solar radiations intensity, goats start panting. Hence under extreme environmental conditions goats must be protected from direct solar radiations.

SUMMARY

The study was undertaken to evaluate physiological responses and surface body temperature during summer. Adult goats and kids of Sirohi breed were exposed to solar radiations. Body sites, viz fore head, back/middle and rump, which were facing sun radiation directly, showed significantly higher skin surface temperature than the other parts of body. Extremities showed significantly lower surface temperatures than the other parts. In adults, respiration rate was significantly higher at 3.00 PM when ambient temperature was high. Body temperature of adults and kids differed significantly among different hours of the observations. The finding suggests that under extreme environmental conditions goat must be protected from direct solar radiations.

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