SHORT COMMUNICATION

Study of Sweating Rate and Morphometry of Sweat Gland in Kangayam Cattle during Different Environmental Conditions

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Abstract

The present study was conducted to evaluate sweating rate and the morphological changes of sweat gland of Kangayam cattle during different climatic conditions of Tamilnadu (India). Six adult Kangayam cattle in the age range of 3 to 5 years were selected from farmer's house in the vicinity of Namakkal and Sathyamangalam districts of Tamil Nadu. The skin biopsy samples were collected during winter (December-February) and summer (April-June) seasons. The sweating rate was calculated using a Cobalt Chloride Disk (CCD) method during both seasons. Histological measurements like, sweat gland length, sweat gland diameter, depth of sweat gland and sweat gland density were measured with the help of trinocular microscope (Leica DM 1000) with image analyzer (Leica application suit) software. The results revealed significant ($p<0.01$) increase in sweating rate and length, diameter and number, with significant ($p<0.01$) reduction in depth, of sweat glands during summer than winter season. The observations clearly indicated the greater evaporative cooling capacity of indigenous cows to changing climatic conditions.

Key Words: Environmental conditions, Kangayam, Morphometry, Sweat gland, Sweating rate.

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Introduction

Thermoregulation is the balance between heat production and heat loss mechanism that occurs to maintain a constant body temperature. Cattle maintain their body temperature by regulating the balance of heat gain and heat loss. In recent years, the environmental temperature increases gradually due to global warming and animals are susceptible to various types of stress such as physical, chemical, nutritional, physiological and thermal stress. Exposure of cows to hot environment stimulates thermoregulatory mechanisms and produces reduction in the rates of metabolism, feed intake and productivity (Abdelatif and Alameen, 2012). During higher environmental temperature, the imbalance between heat production and heat loss makes the animal to heat stress. Thermal stress is a major concern for farm animals. Zebu cattle had a higher thermoregulatory ability by reducing metabolic heat production to minimize the heat storage and increase the heat loss capacity to the environment compared to European cattle (Pereira *et al*., 2014).

Heat loss from an animal can be categorized into sensible heat loss via conduction, convection, and radiation and evaporative heat loss through sweating and panting (Hansen, 2004). The primary way of heat loss from the animal is evaporative heat loss from the skin surface and accounting for approximately 85% of the total heat loss at high air temperatures (Maia *et al.,* 2005). The sweat gland volume was shown to differ with the breed type, where the most heat tolerant breeds had the highest sweat gland volume. The indigenous animals like Kangayam had good heat tolerance ability than other crossbred cattle. However, no information exists regarding the natural variation in skin properties including sweating rate and sweat gland morphometry in indigenous Kangayam cattle during different environmental conditions. Hence, the objective of this study was to estimate the sweating rate and changes in sweat gland morphometry to prove the heat tolerance ability of Kangayam cattle.

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Materials and Methods

For this study, six adult Kangayam cattle in the age range of 3 to 5 years were selected from farmer's house in the vicinity of Namakkal and Sathyamangalam districts of Tamilnadu (India) to record the sweating rate and morphometry of sweat gland during winter (December- February) and summer (April-June) seasons. Due consent was obtained from animal owner and the samples were collected as per recommendation by state animal husbandry practices.

Sweating Rate

The sweating rate (SR) was determined by the method described by Bertipaglia *et al*. (2007). Briefly, the time taken by paper discs impregnated with 10% cobalt chloride to change its colour from violet to bright rose was measured. The uniform size and thickness of chromatography paper was immersed in 10% cobalt chloride solution and then dried at room temperature on a glass. Further oven dried at 50°C, and discs of 0.50 cm in diameter were punched out and re-dried. Three discs were rapidly mounted on the mid-line of a cellulose adhesive tape, which was then fixed to a glass slide and stored in a desiccator. Mounted strips were prepared about 24 h before use (Schleger and Turner, 1965). The middle thoracic area, about 20 cm below the dorsal line, was chosen as a convenient site of measurement, being close clipped and brushed free of dust. Later, an adhesive strip with discs attached was removed from its slide and applied to the skin firmly. The time taken for each of the three discs to change colour was measured with a stop-watch, and the mean time calculated. Sweating rate was estimated by the equation.

SR ($g/m^2\ h^{-1}$) = (22 X 3600) / (2.06 X t) = 38446.6/t, where 't' is the time in seconds.

Morphometry of Sweat Gland

For the morphometry of sweat gland, the biopsy samples of skin from middle third of the trunk and the intercostal space between 8^{th} and 11^{th} rib, 20 cm below the mid dorsal line were collected both during winter (December - February) and summer (April- June) seasons. Skin biopsy punch with a diameter of one cm was used for skin biopsy. Initially, the skin area was cleaned with an antiseptic and 2 % lignocaine was infiltrated around the site of collection before the biopsy procedure. After sampling, the site of biopsy was sprayed with fly repellent. Then the biopsy samples were fixed in 10 % neutral buffered formalin and processed, and paraffin blocks were sectioned using Rotary Microtome (Leica RM 2145) at 5 µm thickness. The sections were mounted on a glass slide and dried at room temperature for 24 h and stained with haematoxylin and eosin stain.

Histometric measurements like sweat gland length, diameter, numbers and depth of sweat gland from the skin were recorded with the help of trinocular microscope (Leica DM 1000) with image analyzer (Leica application suit) software to reveal the sweat gland morphology. Diameter and length of the sweat gland were measured randomly from 30 skin biopsy samples. Four measurements were taken from each sweat gland under 40X magnification. One measurement from top to bottom of the gland was taken as length (L), and average of three measurements at three levels (top, mid and bottom) of the sweat gland was taken as width or the diameter (D) of the sweat gland. The depth of sweat gland in skin was recorded by measuring the length from the epidermal layer to the top of sweat gland. Totally 30 measurements were made from skin samples in both the seasons and the mean values were calculated. The density of sweat gland was determined by counting the number of sweat glands per cm^2 of the skin section under microscope with 40X magnifier.

The data collected were analysed using one-way ANOVA and independent 't' test in SPSS Version 21.0 software package. Results are presented as means with standard errors.

Results and Discussion

In response to thermal stress, the physiological changes like increased respiration rate, increased blood flow to the peripheral tissues, increased skin temperature and increased sweat rate occur to facilitate the heat loss from body of the animal. In an earlier study, about 15% of heat was eliminated through respiration and the remaining was dissipated through skin via sweating (Finch, 1986). In the present study, the heat tolerant ability was studied in Kangayam cattle during different climatic conditions.

Sweating rate

Sweating rate is considered as one of the primary autonomic nervous system responses exhibited by animals during heat stress, which leads to evaporative heat loss from the skin surface (Nursita *et al*. 2022). The time (mean) taken for each of the three discs to change colour in Kangayam breed was 105 seconds and 175 seconds in summer and winter, respectively. The evaporation ($g/m^2\ h^{-1}$) in the Kangayam in summer and winter season was 366.1± 15 and 219.6 ± 09, respectively, which differed significantly (Table 1).

Morphometry of Sweat Gland

The mean length of sweat gland in Kangayam breed of cattle was significantly ($p<0.05$) higher during summer than winter (Table 1). Jian *et al*. (2014) reported length of sweat gland in Sahiwal as 415 µm and in Holstein Friesian 381 µm. Rohankar *et al*. (2018) found that sweat gland length in Deoni, Red Kandhari, Dangi and Gaolao breeds of cattle were 203 µm, 213 µm, 198 µm and 299 µm during summer, and 168 µm, 185 µm, 159 µm and 199 µm during winter, respectively. The size of sweat gland in calves, heifer and adult cows of Nellore breed of cattle was 324.30±109.82 µm, 344.20±112.48 µm and 406.70±145.94 µm, respectively (Nascimento *et al*. 2015). Similar to present findings, higher (798 µm) sweat gland length was reported in Brahman cattle against its crossbred with Angus cattle (Mateescu *et al*., 2023). This may be due to influence of change in environmental condition of south eastern regions of the United States and heat tolerance ability of Brahman cattle by more evaporative cooling through sweating.

Table 1: Sweating rate and morphometry of sweat glands during different environmental conditions in Kangayam cattle

Parameters	Summer	Winter
Evaporation ($g/m^2 h^{-1}$)	$366.10^b \pm 15.00$	$219.60^a \pm 09.00$
Length (µm)	$323.61^b \pm 16.14$	$237.26^a \pm 15.05$
Diameter (µm)	$99.58^b \pm 5.25$	$77.93^a \pm 4.86$
Depth (µm)	$568.29^a \pm 17.28$	$672.13^b \pm 19.17$
Density/Number ($/cm^2$)	$933.33^a \pm 88.19$	$816.67^b \pm 122.25$

Means with different superscripts in a row differ significantly ($p<0.05$).

The mean diameter of sweat glands in Kangayam cattle during summer was significantly ($p<0.05$) higher than in winter season (Table 1) and concurred with the report of Rohankar *et al.* (2018) in different breeds of cattle. The sweat gland diameter was also reported to be higher in Sahiwal (69.4 µm) than HF (41.3 µm) breed of cattle (Jian *et al.,* 2014).

The mean depths of sweat gland were significantly ($p<0.05$) lower during summer than winter season in Kangayam animals (Table 1). The sweat glands in the skin of Kangayam cattle were located superficially to dissipate more heat from the body to adapt for the environmental temperature of Tamilnadu. The change in depth of sweat gland during summer and winter seasons could be related to the change in length and diameter of sweat gland as an adaptive physiological change. Rohankar *et al.* (2018) also observed that in Deoni, Red Kandhari, Dangi and Gaolao breeds of cattle, the depth of sweat gland during summer was 670 µm, 530 µm, 572 µm and 540 µm, whereas in winter it was 705 µm, 620 µm, 657 µm and 648 µm, respectively.

The mean density of sweat gland in Kangayam cattle during summer was non-significantly higher than in winter season (Table 1, Fig 1, 2). This increased number of sweat glands in Kangayam cattle during summer concurred with the observations of Jian *et al.* (2014), who reported that *Bos indicus* cattle had larger and more numerous sweat glands, and consequently greater capacity to maintain their thermal equilibrium by evaporation of sweat. Nascimento *et al.* (2015) in Gir breed of cattle observed more density of sweat gland in summer ($3359.8/cm^2$ area of skin) than in winter ($1779.38/cm^2$). The greater number of sweat glands during summer is to combat with the environmental temperature.

To conclude, the number, length and diameter of sweat glands were more with reduced depth during summer than in winter in Kangayam cattle facilitating active sweating ability during summer. The variation in sweat gland length, diameter, depth and density in Kangayam cattle during different seasons could be correlated to their breed specific adaptational response to the environmental temperature. This correlation depicts the role of sweat gland in animal adaptation to different seasons especially in indigenous cattle.

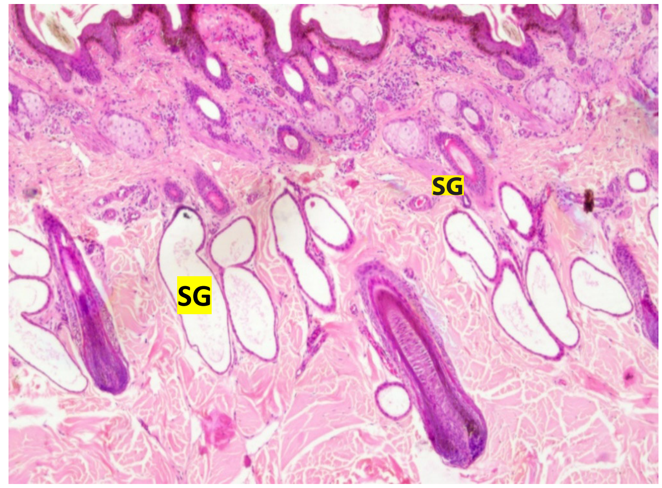

Fig 1: SG - Sweat glands in the skin of Kangayam cattle during summer season, H&E X 40.

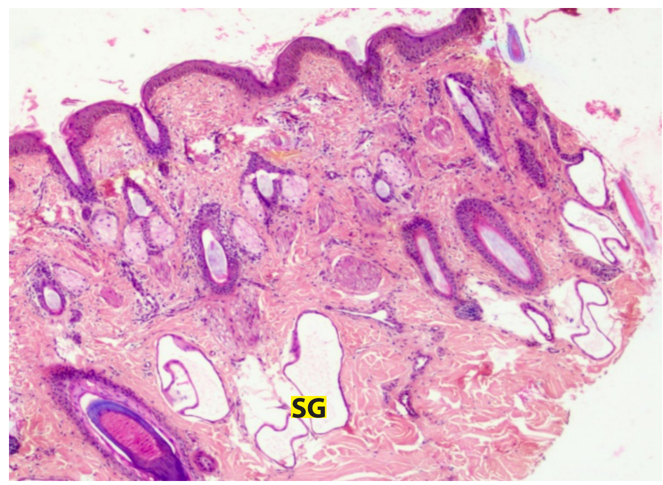

Fig 2: SG - Sweat glands in the skin of Kangayam cattle during winter season, H&E X 40.

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References

Abdelatif, A.M., & Alameen, A.O. (2012). Influence of season and pregnancy on thermoregulation and haematological profile in crossbred dairy cows in tropical environment. *Global Veterinaria, 9*(3), 334-340.

Bertipaglia, E.C.A., Da Silva, R.G., Cardoso, V., & Fries L.A. (2007). Hair coat characteristics and sweating rate of Braford cows in Brazil. *Livestock Science, 112,* 99-108.

Finch, V.A. (1986). Body temperature in beef cattle: Its control and relevance to production in the tropics. *Journal of Animal Science, 62,* 531-542.

Hansen, P.J. (2004). Physiological and cellular adaptations of zebu cattle to thermal stress. *Animal Reproduction Science, 82*(3), 349-360.

Jian, W., Duangjinda, M., & Vajrabukka, C. (2014). Differences of skin morphology in Bos indicus, Bos Taurus, and their crossbreds. *International Journal of Biometeorology, 58,* 1087-1094.

Maia, A.S.C., Da Silva, R.G., & Battiston Loureiro, M.C. (2005). Sensible and latent heat loss from the body surface of Holstein cows in a tropical environment. *International Journal of Biometeorology, 50*(1), 17-22.

Mateescu, R.G., Sarlo Davila, K.M., Hernandez, A.S., Andrade, A.N., Zayas, G.A., Rodriguez, E.E., Dikmen, S., & Oltenacu, P.A. (2023). Impact of Brahman genetics on skin histology characteristics with implications for heat tolerance in cattle. *Frontiers in Genetics, 14,* 1107468.

Nascimento, M.R.B., Dias, E.A., Santos, T.R., Ayres, G.F., Nascimento, C.C.N., & Beletti, M.E. (2015). Effects of age on histological parameters of the sweat glands of Nellore cattle, *Revista Ceres, 62*(2), 129-132.

Nursita, I.W., Trisaputra, F., Cholis, N., & Prayogi H.S. (2022). Study of sweating rate and microscopic anatomy of some breed bulls sweat glands in different body parts. *Journal Ilmu-Ilmu Peternakan, 32*(1), 139-146.

Pereira, A.M.F., Titto, E.L., Infante, P., Geraldo, A.M., Alves, A., Leme, T.M., Flávio, B., & Almeida, J.A. (2014). Evaporative heat loss in *Bos taurus*: Do different cattle breeds cope with heat stress in the same way? *Journal of Thermal Biology, 45,* 87-95.

Rohankar, R.U., Waghaye, J.Y., Kapadnis, P.J., & Thakur, P.N. (2018). Histological study of hair follicles of cattle breeds of Maharashtra in different climatic condition. *International Journal of Environmental Science and Technology, 7*(4), 1221-1230.

Schleger, A.V., & Turner, H.G. (1965). Sweating rates of cattle in the field and their reaction to diurnal and seasonal changes. *Australian Journal of Agricultural Research, 16*(1), 92-106.