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# Diurnal Fluctuations in Rectal Temperature of Sahel Goats During the Hot Dry Season of the Semi-arid Zone

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## ABSTRACT

Experiments were performed on 10 adult Sahel goats with the aim of determining their diurnal temperature fluctuations during the hot dry season. The rectal temperatures (RT) were recorded with a standard clinical thermometer every hour from 06:00 to 19:00 hours. The RT of goats rose gradually from its minimum value of 38.5 ± 0.0°C at 08:00 hours and attained its peak value of 39.2 ± 0.0°C at 16:00 hours ($p<0.001$). The RT rose concurrently with increase in ambient temperature. The overall mean RT obtained was 39.1 ± 0.0C. The diurnal fluctuation in the rectal temperature of the Sahel goats was 1.3 ± 0.1°C. There was neither positive correlation between the minimum and maximum RT values obtained from individual animals ($r = 0.4152$, $p = 0.2328$), nor for the hourly recordings ($r = 0.186$, $p = 0.5429$). The result indicated a slight diurnal rhythm in the rectal temperature of the Sahel goat. The low diurnal range of 0.4 ± 0.0°C suggests that the hot dry season is not thermally stressful to the Sahel goat.

**Key words:** Diurnal fluctuations, rectal temperature, Sahel goat, hot dry season, Sahel zone

## INTRODUCTION

Goats are highly prolific small ruminants with many economic uses, and they contribute significantly to rural household economies especially in the Savannah zones (Mukasa-Mugerwa and Tekelye, 1988).

Variations related to the time of day are designated as diurnal variations. In animals that are active during day time, temperature maxima are usually found in early afternoon and minima; early in the morning. The extent of such changes varies in different species (Swenson, 1977).

In the Sudano-Sahelian zone of Nigeria, farmers keep goats in small numbers (Ayo *et al*., 1998) under the traditional extensive management system of free-range grazing with little or no shelter against adverse environmental conditions, particularly during the day.

The environmental temperature and related humidity can cause variation in physiological responses of animals and these may differ between breeds and species. Assessment of acclimatization or adaptation of animals in the tropics therefore involves their thermal response to meteorological conditions (Ayo *et al*., 1998).

The Semi-arid zone has long dry season from October to May. The hottest months are usually March to early June, when daily maximum temperatures could get to 44° C (Wakil, 1998).

In order to survive and also maintain good production levels under unfavourable meteorological conditions, goats depend on special physiological mechanisms to maintain thermal equilibrium especially during the thermally stressful dry hot season occurring from March to early June in the Nigeria Sahel Savannah zone (Igono and Aliu, 1982). Body temperature is one of the important physiological parameters that could be altered during this season. It is the balance between heat gains and losses of the body, and is the best single criterion of heat tolerance in animals. The body responds readily and repeatably to heat stress, with variation in body temperature (Bianca, 1961).

The aim of this study is to measure rectal temperature of Sahelian goats in order to assess their thermoregulatory capacity and the adaptation of the breed to the hot dry season.

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## MATERIALS AND METHODS

### *Site and climatic conditions*

The experiment was performed at the Large Animal Clinic of the Faculty of Veterinary Medicine, University of Maiduguri, Maiduguri (11° 40' N, 13° 04' E) located in the Sudano-Sahelian zone of Nigeria. Measurements were taken in May, 2005 during the hot dry season. Meteorological data for the locality are given in Table 1.

The meteorological data during the study (Table 1) showed that the minimum ambient temperature ranged between (24 and 27)°C while the maximum ambient temperature was between 37 and 43°C. The diurnal range in the ambient temperature was thus between 13 and 16°C. The mean wet-and dry-bulb temperatures were 21.9 ± 1.5°C and 39.0 ± 1.7°C, respectively. The relative humidity was 18.9 ± 10 percent. The Sadano-Sahelian zone is characterized by long dry season from October to May, when the daily maximum temperature can get to 44°C (Wakil, 1998).

**Table 1.** Meteorological data during the study period

| Day | Ambient temperature (°C) | | | | Relative humidity (%) |
|---|---|---|---|---|---|
| | Maximum | Minimum | Wet-bulb | Dry-bulb | |
| 1 | 37 | 24 | 25.5 | 35.5 | 45.0 |
| 2 | 41 | 27 | 20.5 | 40.3 | 11.0 |
| 3 | 43 | 25 | 19.6 | 41.8 | 7.0 |
| Mean ± SEM | 40.3 ± 1.4 | 25.3 ± 0.7 | 21.9 ± 1.5 | 39.0 ± 1.7 | 18.9 ± 1.0 |

*Data collected from Nigeria Meteorological Agency Maiduguri, Borno State.

### *Animals and management*

Ten Sahel goats, including both males and females, aged between one and three years and weighing between 18 and 43 kg, were used for the experiment.

The animals were exposed to a period of pre-conditioning (one week) during which the rectal temperatures were measured to accustom them to the experimental procedures. They were grazed during the day (except on the experimental days) on a natural pasture for approximately six hours per day, and housed at night in a shed with a concrete floor. A feed supplement of groundnut hay was provided after grazing, with clean water *ad libitum*. The feed and water were withdrawn during the measurements.

### *Experimental procedure*

Measurements of rectal temperature (RT) were taken every hour from 06:00 to 19:00 hours throughout the period of the experiment. Recordings were taken for three different days, once per week, in an open shed. Each goat was tied and hence readily accessible for measurements which were completed within ten minutes. Rectal temperature was recorded with a standard clinical thermometer which was inserted about 5 cm into the rectum and kept there for two minutes.

### *Statistical analysis*

Student's *t*-test and correlation analysis were used to analyze the data obtained from the experiment. Data were expressed as mean ± standard error of the mean (mean ± SEM).

## RESULTS

The mean minimum rectal temperature (RT) of the Sahel goat (SG) was 38.5 ± 0.1°C, while the mean maximum RT was 39.7 ± 0.1°C. The t-value ($p<0.001$) shows a significant difference between the mean minimum and mean maximum RT. The mean diurnal range of individual minimum and maximum temperatures was 1.3 ± 0.1°C (Table 2).

The recorded hourly temperature (Table 3) was lowest at 06:00 hours, i.e., 38.2ºC and highest at 13:00 and

18:00 hours, i.e., 39.5ºC respectively ($p<0.001$). With an increase in ambient temperature, there was a concurrent increase in RT. The correlation coefficient between the minimum ambient temperature and rectal temperature (RT) was $r = 0.0909$, $p>0.05$. Correlation coefficient between the maximum ambient temperature and RT was $r = 0.4318$, $p>0.05$. Neither was statistically significant. The dry-bulb temperature was more related to the RT than the wet-bulb temperature, with correlation coefficients of 0.2632 ($p>0.05$) and –0.5401 ($p>0.05$), respectively, both being statistically insignificant. The relationship between relative humidity and RT was not significant ($r = 0.0589$, $p>0.05$).(Table 1 ).

The maximum diurnal variation (0.7ºC) was obtained between 06:00, 13:00 and 18:00 hours (Table 3). The correlation between the time of day and RT values was very significant ($r = 0.749$, $p<0.05$). The overall mean hourly RT obtained during the entire period of investigation was 39.1 ± 0.0. The mean RT of individual goats (Table 2) varied from the minimum value of 38.8 ± 0.1ºC in goat No. 4, to the maximum value of 39.3 ± 0.0ºC in goat No. 10. The extreme minimum and maximum individual temperatures recorded were 38.0ºC (in goat No. 4) and 40.3ºC (in goat No. 9) with an extreme diurnal range of 2.3ºC (Table 2). The maximum hourly RT (39.5ºC) was recorded at 13:00 hours. Thereafter, from 14:00 to 19:00 hours, the maximum hourly RT ranged between 39.3ºC and 39.5ºC (Table 3).

**Table 1.** Meteorological data during the study period

| Day | Ambient temperature (°C) | | | | |
|---|---|---|---|---|---|
| | Maximum | Minimum | Wet bulb | Dry bulb | Relative humidity (%) |
| 1 | 37 | 24 | 25.5 | 35.0 | 45.0 |
| 2 | 41 | 27 | 20.5 | 40.3 | 11.0 |
| 3 | 43 | 25 | 19.6 | 41.8 | 7.0 |
| Mean ± SEM | 40.3 ± 1.4 | 25.3 ± 0.7 | 21.9 ± 1.5 | 39.0 ± 1.7 | 18.9 ± 1.0 |

Data collected from Nigeria Meteorological Agency, Maiduguri, Nigeria

**Table 2.** Variation in rectal temperature between the goats (ºC)

| No | Sex | Minimum | Maximum | Range | Mean ± SEM |
|---|---|---|---|---|---|
| 1 | F | 38.7 | 39.5 | 0.8 | 39.0 ± 0.0 |
| 2 | F | 38.4 | 39.5 | 1.1 | 39.0 ± 0.0 |
| 3 | F | 38.9 | 39.7 | 0.8 | 39.2 ± 0.0 |
| 4 | M | 38.0 | 39.4 | 1.4 | 38.8 ± 0.1 |
| 5 | F | 38.6 | 39.9 | 1.3 | 39.1 ± 0.0 |
| 6 | M | 38.5 | 40.0 | 1.5 | 39.0 ± 0.0 |
| 7 | F | 38.4 | 40.2 | 1.8 | 39.2 ± 0.1 |
| 8 | F | 38.1 | 39.6 | 1.5 | 39.0 ± 0.0 |
| 9 | F | 38.4 | 40.3 | 1.9 | 39.1 ± 0.1 |
| 10 | F | 38.7 | 39.6 | 0.9 | 39.3 ± 0.0 |
| Mean ± SEM | | 38.5 ± 0.1 | 39.7 ± 0.1 | 1.3 ± 0.1 | 39.1 ± 0.0 |

The RT minima and maxima, together with the standard errors and ranges shown in Table 3, described the extent between-animal variation at each hour of observation. Table 2 shows the extent of variation recorded throughout the day in each individual animal. Although all goats showed a similar diurnal pattern, there were differences between them. Minimum values were comparatively high; on the maximum scale only three goats had an individual maximum RT range of less than 39.5ºC. There was no positive correlation between the minimum and maximum RT values obtained from individual animals ($r = 0.4152$, $p = 0.2328$, i.e., $p>0.05$), neither for the hourly recordings ($r = 0.186$, $p=0.5429$). The goats differed on the time at which they first attained their peak temperature. This varied from 15:00 to 18:00 hours.

## DISCUSSION

The result of this study indicated a diurnal rhythm in the RT of the Sahel goat. The RT increased from the 07:00 hours value of 38.9 ± 0.0°C and attained peak value of 39.2 ± 0.0°C at 13:00hours which was maintained till 18:00 hours. This finding concurs with previous investigations into the rectal temperature of filial crosses and local Awassi sheep (Abi-Saab and Suleiman, 1995), Savannah Brown goat (Igono *et al*., 1982) and the West African Dwarf sheep (Orji and Umesiobi, 1985). Similar results were found in the red Sokoto goat (Ayo *et al*., 1998), Yankasa sheep (Igono *et al*., 1982) and the desert sheep (Ahmed and Abdellatif, 1995).

**Table 3.** Hourly readings in rectal temperature of the Sahel goat (°C).

| Hour | Minimum | Maximum | Range | Mean ± SEM |
|---|---|---|---|---|
| 06:00 | 38.2 | 38.8 | 0.4 | 39.0 ± 0.1 |
| 07:00 | 38.6 | 39.1 | 0.5 | 38.9 ± 0.0 |
| 08:00 | 38.5 | 39.2 | 0.7 | 38.9 ± 0.0 |
| 09:00 | 38.6 | 39.1 | 0.5 | 38.9 ± 0.0 |
| 10:00 | 38.7 | 39.2 | 0.5 | 39.0 ± 0.0 |
| 11:00 | 38.9 | 39.3 | 0.4 | 39.0 ± 0.0 |
| 12:00 | 38.9 | 39.2 | 0.3 | 39.1 ± 0.0 |
| 13:00 | 39.0 | 39.5 | 0.5 | 39.2 ± 0.0 |
| 14:00 | 39.0 | 39.4 | 0.4 | 39.2 ± 0.0 |
| 15:00 | 39.1 | 39.3 | 0.2 | 39.2 ± 0.0 |
| 16:00 | 39.2 | 39.4 | 0.2 | 39.2 ± 0.0 |
| 17:00 | 39.0 | 39.4 | 0.4 | 39.2 ± 0.0 |
| 18:00 | 38.9 | 39.5 | 0.6 | 39.2 ± 0.0 |
| 19:00 | 38.8 | 39.3 | 0.5 | 39.0 ± 0.0 |
| Mean ± SEM | 38.9 ± 0.1 | 39.3 ± 0.00 | 0.4 ± 0.00 | 39.1 ± 0.00 |

The diurnal range of RT is an important indicator of the degree of stressfulness of the ambient temperature or weather conditions to the animals. If the diurnal range is less than 1°C, there is less stress on the animal, but ranges over 1°C are stressful (Bianca, 1961). Therefore, the narrow diurnal range of less than 1°C obtained in this study (i.e., 0.4 ± 0.0) indicated that the hot dry seasons is not thermally stressful to Sahel goats and it agrees with studies made on West African dwarf goats (Mehrotra and Mullick, 1959), since the hot dry season is also generally characterized by very low relative humidity.

In general, the RT values obtained in this study were predominantly within the normal caprine range of 38.5 to 40.5°C (Zaytsev *et al*., 1971) and they followed a pattern associated with the diurnal fluctuations in activity and ambient air temperature characteristic of most animals.

In conclusion, the rectal temperature of the Sahel goats showed slight diurnal variation, and the diurnal range of less than 1°C indicated that Sahel goats can tolerate with comfort the hot dry season of the Sudano-Sahelian zone. Hence Sahel goats possess a good thermoregulatory capacity and adaptability to the stressful hot dry season of the zone.

## REFERENCES

Abisaab, S. and Suleiman, F. T. (1995). Influence of environment on respiration, heart rate and body temperature of filial crosses compared to local Awassi sheep. *J. Intern. Goat Assoc*. 16, 49-53.

Ahmed, M. M. and Abdellatif, A. M. (1995). Effect of dietary protein level on thermoregulation, digestion and water economy of desert sheep. *Small Rumin. Res*. 18, 51-56.

Ayo, J. O., Oladele, S. B., Ngam, S., Fayomi, A. and Afolayan, S. B. (1998). Diurnal fluctuations in rectal temperature of the red Sokoto goats during the harmattan season. *Res. Vet. Sci*. 66,7-9.

Bianca, W. (1961). Heat tolerance in cattle: its concepts, measurement and dependence on modifying factors. *Intern. J. Biometeorol*. 5, 5-26.

Igono, M. O. and Aliu, Y. O. (1982). Environmental profile and milk production of Friesian-zebu crosses in Nigerian guinea savannah. *Intern. J. Biometeorol.* 26, 115-120.

Igono, M. O., Molokwu, E. C. and Aliu, Y. O. (1982). Body temperature response of savannah brown goat to the harmattan and hot-dry season. *Intern. J. Biometeorol.* 26, 225-230.

Mehrotra, P. N. and Mullick, D. N. (1959). Influence of temperature on physiological reactions of goats. *Indian J. Vet. Sci*. 29. 57-59.

Mukassa-Mugerwa, E. and Tekelye, B. (1988). The reproductive performance of Ethiopian highland sheep. *Anim.*

*Reprod. Sci*. 17, 95-102.

Orji, B. I. and Umesiobi, D. O. (1985). Behavioral and physiological responses of Nigerian dwarf sheep to change in micro-environment of humid tropics. *Proceedings of the National Conference of Small Ruminants*, Zaria, Nigeria. pp. 266-267.

Swenson, M. J. (1977). *Duke's Physiology of Domestic Animals*, 9th ed. Comstock Publishing Association, Ithaca/ London. pp. 686-695.

Wakil, M. B. (1998). Rainwater harvesting as a supplementary water supply source in a semi-arid environment. A case study of Maiduguri and environs. Unpublished M. Sc. Research Proposal. Department of Geography, University of Maiduguri, Maiduguri, Nigeria. p.39

Zaytsev, V. P., Sinev, S. V., Ionov, P. S., Vasilyev, A. V. and Sharabrin, I. G. (1971). *Clinical Diagnosis of internal Non-Infectious Diseases of Farm Animals*. Kolos, Moscow