Journal of Cell and Animal Biology Vol. 5(15), pp. 316-319, 15 December, 2011
Available online at http://www.academicjournals.org/JCAB
ISSN 1996-0867 ©2011 Academic Journals
DOI: 10.5897/JCAB11.062

Full Length Research Paper

Effects of feed and water deprivation on diurnal variations in rectal temperature, respiration and heart rate of Yankasa sheep during the rainy season

J. O. Ayo, L. S. Yaqub* and T. Dzenda

Department of Veterinary Physiology and Pharmacology, Ahmadu Bello University, Zaria, Nigeria.

Accepted 24 November, 2011

Experiments were performed with the aim of determining diurnal fluctuations in rectal temperature (RT), respiratory rate (RR) and heart rate (HR) of Yankasa sheep, and the effect of feed and water deprivation on the physiological parameters. On the experimental day, seven experimental sheep were deprived of feed and water for 12 h, while four control sheep were given access to feed and water *ad libitum*. The RT, RR and HR of all the sheep were measured using standard procedures. The RT rose gradually from its minimum values of 39.0 ± 0.3 and 39.1 ± 0.2 ^{0}C at 07:00 h in experimental and control sheep, respectively, and attained peak values of 39.5 ± 0.3 and 39.7 ± 0.2 ^{0}C at 18:00 hours in the experimental and control animals, respectively. There was a significant ($P < 0.05$) and positive correlation between hour of the day and RT values in experimental and control sheep ($r = 0.640$ and 0.769, respectively). The RR and HR values of experimental sheep (30.1 ± 0.5 breaths/min and 88.6 ± 1.3 beats/min, respectively) were not significantly different from those of control sheep; 30.5 ± 0.8 breaths/min and 89.2 ± 1.6 beats/min, respectively. In conclusion, meteorological parameters, feed and water deprivation exerted significant influence on RT, RR and HR in Yankasa sheep, and they should be considered whenever the physiological parameters are measured in the breed, even during the rainy season.

Key words: Diurnal fluctuations, rectal temperature, heart rate and respiratory rate.

INTRODUCTION

Efforts to increase the efficiency of sheep production in the tropics and other warm, harsh environments are hampered by adverse environmental factors, including high ambient temperature, low forage quality, inadequate and irregular supply of feeds and water, and exposure to diseases and parasites (Hammond and Olson, 1994; Ayo et al., 1996). In the Northern Guinea Savannah zone of Nigeria, sheep have to adopt physiological and behavioural mechanisms in order to maintain thermal equilibrium during the hot-dry, hot-humid and harmattan seasons of the year (Igono et al., 1982). Physiological parameters are influenced by the environmental, including nutritional, stress factors (Hargreaves and Matthews, 1995; Ayo et al., 2002). They are reliable indices of thermal balance used in assessing the effects of climatic stress factors on livestock (Bianca, 1976; Mittal and Ghosh, 1978; Ayo et al., 1998, 2008).

Thus, any breed capable of maintaining the parameters within the normal range is considered to have successfully adapted to the environment. The rectal temperature (RT), respiratory rate (RR) and heart rate (HR) are of importance in evaluating the health status of animals (Mittal and Ghosh, 1979; Ayo et al., 1998, 2008), and especially their immediate responses to meteorological and nutritional stress. Data on the variation in RT, RR and HR values may be useful in estimating the thermoregulatory capacity and adaptation of sheep during the various seasons. Such information may be of value in further selection and development of the local sheep in Nigeria. There is a dearth of information in the available literature on fluctuations in the physiological parameters during the rainy season. The aims of the experiment were to describe variations in RT, RR and HR values of the Yankasa sheep, reared in the Guinea Savannah zone of Nigeria, and to find out if short-term feed and water deprivations constitute a major

*Corresponding author. E-mail: suravet9@yahoo.com.

threat to the health and productivity of the animals during the rainy season.

MATERIALS AND METHODS

Experimental animals and management

The experiment was performed at a Sheep Farm in Samaru-Zaria (11° 10′N, 07° 38′E), located in the Northern Guinea Savannah zone of Nigeria. Measurements were taken once per week during the late rainy season from late September to early October. Meteorological parameters of dry- and wet-bulb temperature were recorded using the dry and wet-bulb temperature, and relative humidity (RH) values were calculated from the DBT values obtained using the manufacturer's instruction. Other meteorological parameters were collated from the Institute for Agricultural Research, Samaru-Zaria, Nigeria. Eleven healthy Yankasa sheep, including both males and non-pregnant females of about 2 to 3 years' old and weighing 24 to 30 kg, served as subjects of the experiment. A pre-conditioning period of one week was allowed during which the RT, RR and HR of sheep were measured to get the animals accustomed to the experimental procedure.

The sheep were not subjected to any special therapy prior to commencement of the experiment. They were grazed during the day on a natural pasture for approximately eight hours per day and housed at night in a shed with a concrete floor. A feed supplement of rice bran mixed with guinea corn and hay was provided after grazing. The sheep were given access to clean water *ad libitum.* The feed and water were withdrawn during the period of measurements for seven experimental sheep, while the four sheep that served as control animals were given feed and water *ad libitum*.

Measurements of physiological and meteorological parameters

Measurements of RT were taken hourly from 07:00 h to 19:00 h once per week throughout the experimental period that lasted four weeks. Each sheep was restrained in a non-stressful way for measurements, which were completed within five minutes. The RT was recorded as an indicator of body temperature using a standard digital thermometer, inserted about 3.5 cm into the rectum until alarm sound was heard indicating the stability of the reading, usually lasting about 1 to 2 min. The RR was taken by counting the number of respiratory flank movements for one minute and HR was recorded using a stethoscope, placed in the fourth or fifth intercostal space at the costo-chondral junction. The DBT and WBT values were taken hourly and concurrently with the RT, RR and HR measurements at the experimental site.

Statistical analysis

All data obtained were subjected to Student's *t*-test and correlation analysis. Data were expressed as mean ± standard error of the mean (± S. E. M.). Values of $P < 0.05$ were considered significant.

RESULTS

During the study period, the minimum and maximum ambient temperatures (ATs) ranged between 22 to 24°C and 30 to 32°C, respectively. The mean RH was 84.3 ± 2.4%. The mean amount of rainfall was 17.0 ± 8.9 mm, while the minimum, maximum and dry-bulb temperatures were 23.3 ± 0.7, 31.0 ± 0.6 and 27.6 ± 0.1°C, respectively. The mean RT of the experimental sheep was 39.4 ± 0.02°C, while that of the control was 39.2 ± 0.05°C (Table 1), but the difference in the values was not significant ($P>0.05$). There was no difference between the minimum RT of experimental and control sheep (38.4 ± 0.1 and 38.4 ± 0.1°C, respectively). The maximum RT of experimental sheep was 40.0 ± 0.01°C, and the value was significantly ($P < 0.01$) higher than that of the control sheep, 38.4 ± 0.1°C. Also the range between the minimum and maximum temperatures in the experimental sheep was not significantly higher than that of the control sheep; 1.6 ± 0.1 and 1.4 ± 0.1°C, respectively. The difference between the extreme minimum and maximum RT values was significant ($P < 0.05$) both in the experimental and control sheep.

The RT of experimental sheep rose gradually from its lowest value of 39.0 ± 0.3°C at 07:00 h and attained the maximum value of 39.5 ± 0.3^{0}C at 18:00 h; the mean maximum RT of 40.0 ± 0.01°C obtained in experimental sheep was significantly higher than the corresponding value of 38.4 ± 0.01°C recorded in control sheep. The RR and HR values of the experimental sheep were 30.1 ± 0.5 breaths/minute and 88.6 ± 1.3 beats/minute, while those of the control sheep were 30.5 ± 0.8 breaths/minute and 89.2 ±1.6 beats/minute, respectively. The minimum RR values for both experimental and control sheep were 27.2 ± 0.4 breaths/minute and 28.5 ± 0.5 breaths/minute, respectively ($P > 0.05$). The maximum RR values in experimental and control sheep were 36.0 ± 0.9 cycles/minute and 33.0 ± 1.1 cycles/minute, respectively (Tables 1). The difference in the values was not statistically significant. The mean RR and HR values recorded in experimental sheep were slightly lower than the corresponding values recorded in the control sheep, but again the difference was not statistically significant. The maximum HR values in experimental and control sheep were 104.3 ± 4.1 beats/minute and 98.8 ± 10.8 beats/minute, respectively. The difference in the values was also not statistically significant. The minimum HR value of 74.6 ± 2.3 beats/minute obtained in experimental sheep was significantly ($P < 0.01$) lower than the value of 80.9 ± 1.8 beats/minute recorded

In control sheep, the range values for HR in experimental and control sheep were 29.6 ± 5.4 beats/minute and 17.9 ± 2.8 beats/minute, respectively. The difference in the values was statistically ($P < 0.05$) significant (Table 1). The correlation coefficients between meteorological and physiological parameters were predominantly higher in the experimental than control sheep during the rainy season (Table 2).

DISCUSSION

The meteorological data obtained during the study period indicated that the rainy season was characterized by high

Table 1. Diurnal variations in rectal temperature (RT,°C), respiratory rate (RR, cycles/min) and heart rate (HR, beats/min) of experimental (deprived of feed and water) and control sheep during the rainy season (Mean ± S.E.M.).

Hour	Rectal Temperatue		Respiratory Rate		Heart Rate		RT Range		RR Range		HR Range	
	Exp	Cont	Exp	Cont	Exp	Cont	Exp	Cont	Exp	Cont	Exp	Cont
07.00	39.0 ± 0.3	39.1 ± 0.2	29.5 ± 1.0	29.7 ± 0.7	86.8 ± 2.2	85.3 ± 3.6	2.1	1.2	12.0	4.0	16.0	18.0
08.00	39.1 ± 0.3	39.1 ± 0.2	30.0 ± 1.0	29.0 ± 0.5	84.0 ± 1.3	88.3 ± 3.7	2.1	1.0	12.0	2.0	10.0	16.0
09.00	39.2 ± 0.3	39.0 ± 0.2	30.2 ± 1.0	29.3 ± 0.5	87.5 ± 3.2	84.0 ± 4.1	2.1	1.5	12.0	2.0	32.0	22.0
10.00	39.3 ± 0.3	38.9 ± 0.2	30.9 ± 1.0	32.3 ± 0.9	89.7 ± 3.5	92.0 ± 1.9	2.1	1.2	12.0	6.0	30.0	12.0
11.00	39.6 ± 0.1	39.1 ± 0.2	30.8 ± 1.3	31.4 ± 1.0	91.2 ± 4.9	92.1 ± 2.7	1.3	1.4	12.0	6.0	47.0	19.0
12.00	39.5 ± 0.1	39.0 ± 0.2	30.6 ± 1.1	30.9 ± 0.9	92.3 ± 5.9	92.9 ± 2.6	1.3	1.0	10.0	6.0	64.0	19.0
13.00	39.5 ± 0.2	39.1 ± 0.3	29.6 ± 0.6	31.5 ± 0.9	94.4 ± 3.7	87.7 ± 4.3	1.8	1.7	4.0	4.0	32.0	20.0
14.00	39.4 ± 0.2	39.1 ± 0.3	29.4 ± 0.5	31.3 ± 1.0	90.7 ± 2.9	88.0 ± 4.7	1.8	2.0	6.0	6.0	29.0	28.0
15.00	39.5 ± 0.2	39.1 ± 0.3	30.1 ± 0.8	29.2 ± 0.5	91.4 ± 2.7	92.0 ± 3.1	1.6	1.8	8.0	2.0	28.0	22.0
16.00	39.3 ± 0.1	39.5 ± 0.3	30.7 ± 0.6	30.0 ± 0.9	84.3 ± 2.5	93.1 ± 0.9	1.0	1.2	6.0	4.0	22.0	5.0
17.00	39.4 ± 0.2	39.6 ± 0.3	30.0 ± 0.6	30.5 ± 0.8	85.7 ± 2.5	86.8 ± 3.4	1.2	1.3	6.0	6.0	24.0	16.0
18.00	39.5 ± 0.3	39.7 ± 0.2	29.8 ± 0.7	31.0 ± 0.8	85.2 ± 2.5	87.5 ± 3.6	1.2	1.0	6.0	6.0	22.0	18.0
Mea ± S.E.M	39.4 ± 0.02	39.2 ± 0.1	30.1 ± 0.5	30.5 ± 0.8	88.6 ± 1.3	89.2 ±1.6	1.6 ± 0.01[a]	1.4 ± 0.1[b]	8.8 ± 1.2	4.5 ± 0.9	29.6 ± 5.4	17.9 ± 2.8

Exp = Experimental sheep, n = 7; Cont = Control sheep, n = 4; For each parameter, values with different superscript alphabets are significantly (P<0.05) different.

RH and high AT. The results demonstrated that concomitant water and feed deprivation during the rainy season, characterized by hot-humid environment, may be thermally stressful to the sheep and that they could increase the values of the physiologic parameters above the normal range, especially if the deprivation is prolonged. The fact that the range values of RT in experimental and control sheep were 1.6 and 1.4°C, respectively showed that the values fell between 1.0 to 2.0°C and that the RT diurnal fluctuations were within a narrow range. The finding is in agreement with the results of previous studies, that the rainy season is the least thermally stressful season in the Northern Guinea Savannah Zone of Nigeria (Igono et al., 1982; Oladele et al., 2001, 2003). The results of diurnal fluctuations in RT obtained during the harmattan season in the Red Sokoto goat indicated a wider range value of 1.9 ± 0.1°C (Ayo et al., 1998, 2008). Higher values of RT were obtained earlier at 11:00 to 13:00 h in the experimental than control sheep, (16:00 to 18:00 h) due to the effect of feed and water deprivation on the sheep. In the control sheep, the pattern of fluctuations was in agreement with the finding of Ayo et al. (1996), who obtained the peak mean RT in goats during the harmattan season at 18:00 h.

The higher positive correlation coefficients obtained between the meteorological parameters and physiological values is more in experimental than control sheep due to water and feed deprivation. Such fluctuations had been shown to be due partly to variations in AT values with increase in hour of the day, especially during the afternoon hours, and also to a biological clock driven in the hypothalamus (Piccione and Caola, 2002). The maximum RR value rose significantly as compared to that of the control sheep, indicating that feed and water deprivation in the Yankasa sheep significantly increased the maximum RR. Similarly, the range value of RR significantly rose in sheep deprived of water and feed as compared to the control. Therefore, fluctuations in the maximum and range values of RR may better indicate the degree of availability of water and feed to the sheep during the season rather than the mean RR value. The results obtained in the present study suggested that the regularity of supply of feed and water to the sheep may be reflected in the diurnal fluctuation in the physiological parameters of RT, RR and HR. Often; the parameters are measured during the diagnosis of diseases in the sheep, and the

Table 2. Correlation coefficients between meteorological and some physiological parameters in experimental (water and feed deprived) and control sheep.

Meteorological data	Rectal temperature		Respiratory rate		Heart rate	
	Exp	Control	Exp	Control	Exp	Control
Minimum temperature	-0.756**	-0.500*	0.410^{NS}	0.500*	-0.688**	-0.419
Maximum temperature	-0.327	-0.189	0.101^{NS}	0.040^{NS}	-0.234^{NS}	-0.016^{NS}
Dry-bulb temperature	-0.655**	-0.866***	0.912***	0.885***	-0.725***	0.908***
Relative humidity	-0.839***	-0.971***	0.990***	0.980***	-0.980***	0.756**
Rainfall amount	-0.268^{NS}	-0.568*	0.649**	0.601**	-0.360^{NS}	0.999***

Exp = Experimental sheep ; Control = Control sheep ; ^{NS} = Non-significant (P>0.05) correlation ; ***** = Significant correlation (P<0.05); ****** = Very significant (P<0.01) correlation; ******* = Very highly significant (P < 0.001) correlation.

evaluation of their therapeutic and prophylactic responses. Therefore, in order to evaluate correctly the parameters in the sheep, water and feed should be made available to them. The findings of the present study further support the report of Mormede et al. (2007) that environmental factors, including ambient temperature and humidity influence diurnal rhythm of basic physiological processes. In view of the fact that the values of RT, RR and HR obtained in the present study were within the established normal ranges for the sheep (38.5 to 40.0°C, 16 to 30 breaths/minute, and 70 to 80 beats/minute, respectively) (Zaytsev et al., 1971), the Yankasa breed of sheep has successfully adapted to meteorological factors prevailing in the zone during the rainy season, characterized by high AT and high RH. Therefore, indiscriminate crossing of the sheep should be avoided in order to preserve this good adaptive trait.

Conclusion

In conclusion, the effect of feed and water deprivation on the RT, RR and HR of the Yankasa sheep should be considered whenever the parameters are measured, in order to ensure adequate and correct interpretation of the values obtained, even during the rainy season.

REFERENCES

Ayo JO, Dzenda T, Zakari FO (2008). Individual and diurnal variations in rectal temperature, respiration, and heart rate of pack donkeys during the early rainy season. J. Equine Vet. Sci., 28(5): 281-288.

Ayo JO, Oladele SB, Fayomi A (2002). Behavioural reactions of cattle to stress situations: A review. J. Agric. Technol., 8: 15-20.

Ayo JO, Fayomi A, Jumbo SD, Hambolu JO, Oladele SB (1996). Diurnal variations in rectal temperature of Red Sokoto goats during the harmattan season. Paper presented at the Annual Congress of the Nigerian Veterinary Medical Association, October 21 - 25, 1996, Enugu.

Ayo JO, Oladele SB, Ngam S, Fayomi A, Afolayan SB (1998). Diurnal fluctuations in rectal temperature of the Red Sokoto goat during the harmattan season. Res. Vet. Sci., 66: 7-9.

Bianca W (1976). The significance of meteorology in animal production. Int. J. Biometeorol., 2: 139-156.

Hammond AC, Olson TA (1994). Rectal temperature and grazing time in selected beef cattle breeds under tropical summer conditions in subtropics Florida. Trop. Agricult., (Trinidad), 2: 128-134.

Hargreaves AL, Matthews LR (1995). The effect of water deprivation and subsequent access to water on plasma electrolytes, haematocrit and behaviour in red deer. Livest. Prod. Sci., 42: 73-79.

Igono MO, Molokwu ECI, Aliyu YO (1982). Body temperature response of Savanna Brown goat to the harmattan and hot-dry season. Int. J. Biometerol., 26: 225-230.

Mittal JP, Ghosh PK (1979). Body temperature, respiration and pulse rate in Corriedale, Marwari, Magra sheep in Rajasthan desert. J. Agric. Sci., 93: 587-591.

Mormède P, Andanson S, Aupérin B, Beerda B, Guémené D, Malmkvist J, Manteca X, Manteuffel G, Prunet P, van Reenen C, Richard S, Veissier I (2007). Exploration of the hypothalamic-pituitary-adrenal function as a tool to evaluate animal welfare. Physiol. Behav., 92(3): 317-339.

Oladele SB, Ayo JO, Ogundipe SO, Esievo KAN (2003). Seasonal and species variations in erythrocyte osmotic fragility of indigenous poultry species in Zaria, Northern Guinea Savanna Zone of Nigeria. Bull. Anim. Health Prod. Afr., 51: 204-214.

Oladele SB, Ogundipe S, Ayo JO, Esievo KA (2001). Effects of season and sex on packed cell volume, haemoglobin and total proteins of indigenous pigeons in Zaria, Northern Nigeria. Vet. Arhiv., 71(5): 277-2886.

Piccione G, Caola G (2002). Biological rhythm in livestock. J. Vet. Sci., 3: 145-157.

Zaytsev VI, Sinev AV, Ionov PS, Vasilyev AV, Sharabrin IG (1971). Clinical Diagnostics of Internal Diseases of Farm Animals. Kolos Publishing House, Moscow (in Russian), p. 336.