SEASONAL EFFECTS ON OESTRUS PATTERNS AND PROGESTERONE PROFILES OF YANKASA EWES OF DIFFERENT AGE-GROUPS IN THE SUB-HUMID TROPICS

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ABSTRACT

Oestrus patterns and serum progesterone profiles of 10 adult and 10 yearling Yankasa ewes were investigated in the late hot-dry and late-wet seasons in the subhumid tropical climate of Zaria, Nigeria. The proportions of ewes which came on heat once, twice or thrice within the experimental periods in the late hot-dry and late-wet seasons were 25, 15 and 0%, and 5, 10 and 85% respectively, while mean oestrous cycle length was significantly longer (P<0.001) in the hot-dry season than in the late-wet season (30.9 *vs* 18.4 days) due to the higher incidence of anoestrus in the former. However, the mean duration of oestrus was not affected by season. Mean serum progesterone levels were significantly (P<0.05) higher in the late-wet season than in the late hot-dry season (1.57 *vs* 0.52 ng/ml). However, there was a highly significant (P<0.001) interaction between season and age group in mean serum progesterone levels due to a relatively greater depression in progesterone levels in yearling ewes during the hot-dry season compared with adult ewes. The observed disruptions in the oestrus cycle and serum progesterone levels of the ewes in the hot-dry season confirm the adverse effect of heat stress on the reproductive behaviour of ewes.

Keywords: Oestrus, Yankasa, Progesterone, Season, Subhumid, Tropics.

INTRODUCTION

It is well recognized that in the tropics, seasonality of breeding in sheep is minimal due to the limited variation in daylength. However, the high ambient temperatures characteristic of the region is a problem. Heat stress adversely affects cyclic oestrus activity (Hafez, 1968; Kajian, 1987), causing blockage of behavioural oestrus, increasing the incidence of silent ovulations and increasing the length of the oestrus cycle. The severity of such effects depends upon both the duration of exposure to high temperatures and on the stage of the oestrous cycle when ewes are exposed (Sawyer, 1979). In the sub-humid zone, the hot-dry season which lasts from February to April is characterized by high ambient temperatures with average daily temperature ranging from 33 to 39°C. It also has low relative humidity (21-33%) and high evaporation rate (226-262mm). The wet season (July-September) is characterized by lower ambient temperature (20-25°C), higher relative humidity (70-85%) and low evaporation rate (100-130mm), while cold-dry season or harmattan (November-January) is characterized by the lowest ambient temperature (16-24°C), lowest relative humidity (14-20%) and moderate evaporation rate (182-205mm) (Igbono and Aliu, 1982). Oestrus was blocked in one-third of all the ewes exposed to high temperatures for at least 6 days, whereas exposure to heat for a short period after insemination had a less serious effect on fertility.

High environmental temperature is associated with decreasing progesterone concentrations of the peripheral blood in the ewe (Adnan, 1984). Chronic exposure of sheep to heat reduces pituitary hormone output, which in turn results in lower metabolic rate and lower thyroid, adrenal and gonadotropic activity (Yousef *et al.*, 1968). Metabolic rates are lower in hot environments than in cold ones. Daily temperatures above 30°C depress thyroxine production, regardless of coat insulation. Blood thyroxine content, plasma-bound iodine and turn-over of thyroxine are all greater in winter than in summer (Premachandra *et al.*, 1960). Also the excretion of 17-hydroxysteroids by sheep is reduced in summer (Robinson *et al.*, 1970). The effects of seasonal variations in temperature, relative humidity, sunshine hours and other climatic factors on the oestrous cycle and progesterone profile of sheep in the sub-humid zone of West Africa are relatively unknown. The present study was therefore undertaken to investigate differences in oestrous activities and serum progesterone profiles of Yankasa ewes in the hot-dry and late-west seasons at a sub-humid station in Nigeria, using sheep of two different age groups.

MATERIALS AND METHODS

Animals

The study was carried out at the National Animal Production Research Institute (NAPRI), Shika, Nigeria, on latitude 11°12'N, longitude 7°33'E and an altitude of 610m. Shika is within the Northern Guinea Savanna Zone and has a sub-humid tropical climate. The long-term average weather conditions of the area are summarized in Fig. 1. The 20 ewes involved in the study were obtained from the Yankasa Sheep Breeding Project at NAPRI. The origin and management of the flock have been previously described (Osinowo, 1982; Osinowo and Ekpe, 1985). The sheep were managed under a semi-intensive system involving grazing on improved pastures for 6-8 hours daily plus 0.3-0.5 kg/head/d of a 15% crude protein concentrate supplement throughout the year. The animals were housed overnight in well-ventilated pens. The experimental animals comprised 10 yearlings (with average weight of 29kg and aged 12-13 months) and 10 adult ewes (with average weight of 37kg and aged 18-24 months) at the start of the study.

Experiment

The influence of season (late hot-dry *vs* late-wet) and age-group (yearling *vs* adult) on the frequency and duration of oestrus, length of the oestrous cycle and serum progesterone profiles of the ewes were investigated. The experimental periods were 14/3/92 to 24/4/92 in the late hot-dry season and 20/7/92 to 26/8/92 in the late-wet season. In each season, the animals were synchronized using progestagen-impregnated vaginal sponges (Veramix, Upjohn Ltd.), inserted for 12 days. Raddled, aproned rams were used for oestrus detection at 0800-0900 and 1600-1700 hours daily. Frequency of oestrus was defined as the number of times an animal was detected on heat within the 40-day experimental period in each season. The mean duration of oestrus was taken as the average number of times an animal was picked within each oestrus. The length of the oestrous cycle was taken as the interval from the beginning of one oestrus to the next.

Collection of Samples and Hormonal Assay

Blood samples (10ml) for serum progesterone were collected in the morning from the ewes by jugular venipuncture, thrice a week, on Mondays, Wednesday and Fridays, throughout the experimental periods. Sera samples were stored at –20°C until analysed. Progesterone concentrations were determined using a commercially-available progesterone kit (Diagnostic Products Corporation, California, 90045). The assay procedure was as follows: To antibody-coated tube, 100µl of standard (0.1 to 40ng/ml) or sample and 1ml buffered [^{125}I] labeled progesterone solution were

added. The mixture was incubated for 3h at room temperature, the liquid phase discarded (centrifugation is not required) and the radioactivity bound to the antibody-coated tube counted. The immunogen used to raise the antibody and radioiodinated progesterone (tyrosine methyl ester) are both 11 α-linked conjugates. The cross-reactivity, 3.8%, was with 11 α–hydroxy progesterone (Kubasik *et al.*, 1984). The method by which progesterone is displaced from its plasma-binding proteins has not been disclosed by the manufacturer. The sensitivity of the assay defined as twice the standard deviations away from the zero standard was 0.08ng/ml. The within and between assay coefficients of variation were 8.5% and 9.5% respectively. Recovery of added progesterone at three increasing levels from a low pool of sheep plasma varied from 95% to 103%. The potencies of the samples were estimated using a linear logit-log dose response curve.

Statistical analyses

Data on average daily temperature, relative humidity, wind velocity, sunshine hours and total rainfall were obtained from the Institute of Agricultural Research Meteorological Station, Samaru, Zaria. Analysis of the effects of season and age-group on the frequency of oestrus were by chi-square method. Data on oestrus duration and oestrus cycle length were analysed for the effects of age-group, season and age-group by season interaction using least squares method (Harvey, 1990). Data on serum progesterone levels were analysed also by least squares method using a model including season and age-group as fixed effects, with a season by age-group interaction and mean daily temperature, relative humidity, wind velocity and sunshine hours as covariates.

RESULTS

The summary of the long-term average weather conditions at Shika, Zaria, Nigeria is presented in Fig. 1. During the experimental periods, average daily temperatures, wind velocity and sunshine hours were significantly higher ($P<0.05$) in the hot-dry season than in the late-wet season (Table 1). By contrast, relative humidity and rainfall were higher in the latter season. Weather conditions during the experimental periods were generally in line with the long-term averages.

TABLE 1: AVERAGE WEATHER CONDITIONS DURING THE EXPERIMENTAL PERIOD (MEANS ± SEM)

Season	Temp. (°C)	RH (%)	Wind velocity (m/s)	Rainfall (mm)	Sunshine (hrs)
Hot-dry	28.9 ± 0.25	33.9 ± 4.12	177.5 ± 16.48	0	6.7 ± 0.69
Late-wet	23.9 ± 0.73	77.5 ±1.80	147.7 ± 11.26	196.5	5.6. ± 0.76

The frequency of oestrus was significantly influenced by season ($P<0.001$) but not by age-group. Sixty percent of the ewes did not exhibit oestrus in the hot-dry season while all ewes came on heat at least once in the late-wet season (Fig. 2). Eighty five percent of ewes cycled regularly in the late-wet season compared with zero percent in the hot-dry season. Oestrus cycles were significantly ($P<0.01$) longer in the hot-dry season than in the late-wet season while differences between age-groups for the same trait were not significant. Neither age-group nor season had any significant effect on the mean duration of oestrus (Table 2).

Serum progesterone levels were significantly ($P<0.05$) higher in the late-wet season than in

the hot-dry season (Table 3). The differences between age-groups in progesterone levels were not significant. However, there was a highly significant ($P<0.001$) interaction between season and age-group due to a relatively greater depression in progesterone levels in yearling ewes during the hot-dry season compared with adult ewes. Results of the covariate analysis showed that serum progesterone levels were significantly influenced by average daily temperature ($P<0.05$), sunshine hours ($P<0.05$) and wind velocity ($P<0.01$); the partial regression coefficients ($b \pm$ S.E.) were -0.104 ± 0.52, 0.041 ± 0.017 and 0.004 ± 0.001 respectively. The effect of relative humidity was not significant.

TABLE 2: EFFECTS OF AGE-GROUP AND SEASON ON OESTRUS DURATION AND OESTRUS CYCLE LENGTH (MEANS ± SEM)

Variable	No. of observations	Mean duration (days)	Mean cycle length (days)
Age-group:			
Adult	14	2.7 ± 0.31	25.3 ± 2.02
Yearling	14	2.2 ± 0.31	23.9 ± 2.02
Season:			
Hot-dry	8	2.8 ± 0.37	30.9 ± 2.43^a
Late-wet	20	2.1 ± 0.24	18.4 ± 1.53^b

Means with different superscripts differ significantly ($P<0.01$)

Figures 1 & 2

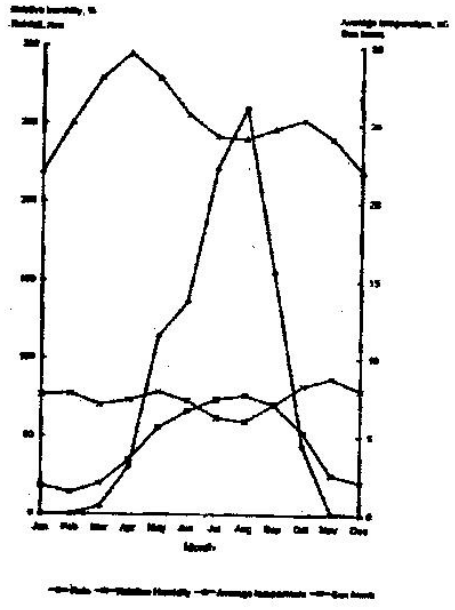

FIG.1: LONG TERM (1974-1994) WEATHER CHART

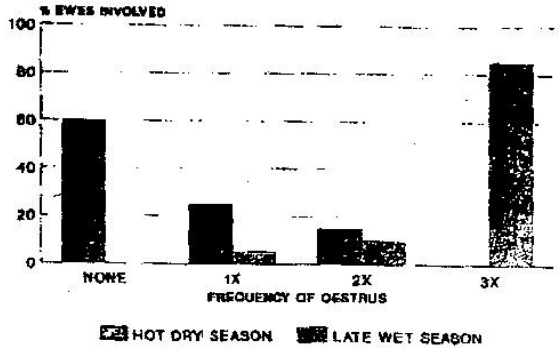

FIG 2: SEASONAL EFFECT ON OESTRUS FREQUENCY

TABLE 3: EFFECT[1] OF SEASON AND AGE-GROUP ON SERUM PROGESTERONE (NG/ML) LEVELS IN YANKASA EWES (MEANS ± SEM)

Season	Age-group Yearling	Adult	Mean
Hot-dry	0.24 ± 0.18	0.81 ± 0.18	0.52 ± 0.17
Late-wet	1.75 ± 0.19	1.39 ± 0.19	1.57 ± 0.18
Mean	1.00 ± 0.07	1.10 ± 0.07	1.05 ± 0.05

[1]Season x Age-group interaction (P<0.001)

Serum progesterone (P4) profiles showed the normal cyclic pattern in most of the ewes during the late-wet season while the profiles were depressed and non-cyclic particularly in the yearling ewes during the hot-dry season (Plate I). Comparisons between behavioural oestrus patterns and serum progesterone profiles showed that affected yearling ewes were anoestrus in the hot-dry season, with no ovulation occurring. In the affected adult ewes during the same season, although behavioural oestrus was absent, the cyclic progesterone profiles show that ovulation occurred, indicative of silent oestrus.

DISCUSSION

The present study clearly demonstrates the impact of heat stress on reproduction of Yankasa ewes in the subhumid tropics. The oestrus cycle was impaired during the hot-dry season with greater incidence of anoestrus accompanied by depression in serum progesterone levels. By contrast, in the late-wet season, the oestrus cycle was normal with typical serum progesterone profiles. The observed increases in the incidence of quiet ovulations, anoestrus and a reduction in the intensity of oestrus confirm earlier reports by Hafez (1968), and Kajian (1987).

The insignificant influences of age group and season on mean duration of oestrus in the present study agree with earlier reports by Yeates (1953) and Nandy *et al.* (1990). Although some reports claimed that the effect of season on oestrus cycle length was insignificant (Casu *et al.*, 1990), the present study indicated abnormally longer oestrus cycle length in the hot-dry season.

This study confirms the observation of lower serum progesterone levels in the hot-dry season reported by Adnan (1984). During the 40-day period of observation in the hot-dry season, the last few days coincided with the period of decreasing heat stress and so more ewes came on "heat". This indicates the adverse effect of heat stress on reproduction.

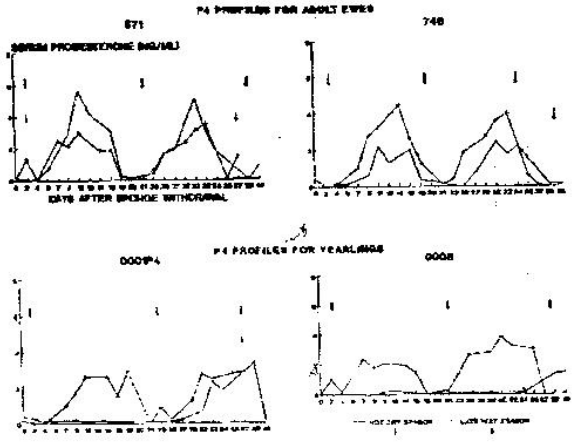

PLATE 1: SEASONAL EFFECT ON P4 PROFILES OF YANKASA EWES

Some adult ewes had normal oestrus cycles in the hot-dry season whereas none of the yearling ewes did; this could not have been due to delayed puberty in the yearling ewes because the breed has an average age at first oestrus of 240 days (Osinowo and Abubakar, 1988) and the least age of the experimental animals was 360 days (12-13 months). It therefore implies that yearling ewes are more adversely affected by heat stress than adults. High ambient temperature and solar radiation affect behavioural oestrus and cyclical oestrus activity (Barker and Wiggins, 1959), though this contrasts with reports by Thwaites (1967). The negative effect of humidity on progesterone profile (Adnan, 1984) was not confirmed in this study. However, this study indicates significant effect of sunshine hours and wind velocity on serum progesterone level. It may be deduced from the negative partial regression coefficient that an increase in temperature would be associated with a decrease in serum progesterone level, while an increase in either sunshine hours or wind velocity will be associated with an increase in serum progesterone level.

In conclusion, this study indicates that season and to a lesser extent, age group, exert significant influences on the oestrus cycle and serum progesterone level of Yankasa sheep. It is therefore recommended that in the subhumid tropics mating periods should not coincide with the hottest time of the year. However, there is need for more research to be done on the effect of heat stress on animals in the tropics and the adaptive levels of different breeds of sheep, while further basic information is also needed on the hormonal changes that occur in heat-stressed ewes.

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