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# EFFECT OF ACUTE HEAT STRESS ON CIRCULATING TESTOSTERONE LEVEL IN THE WEST AFRICAN DWARF BUCK

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Target Audience: Animal scientist, veterinarians, animal breeders

## ABSTRACT

The normal levels of circulating testosterone in the West African dwarf buck and the influence of season and thermal stress on same were studied in the humid tropics. Animals were fed a maize based concentrate ration supplemented with forage *ad libitum* and cool clean water was available always. They were housed in a standard goat barn always except when they were exposed to the tropical sun in the paddock for 1 hour for three consecutive rain-free days in special cages in the middle of each of the four seasons.

Serum testosterone levels were stable in both the barn and paddock throughout the year except in the late rainy season when there was a significant drop ($P<0.05$) in concentration in both locations. The mean values were $5.05 \pm 0.67$ ng/ml (barn) and $16.89 \pm 2.22$ ng/ml (paddock). With exposure of the bucks to heat stress serum testosterone levels highly significantly ($P<0.01$) deviated from those of the unexposed bucks by an average of 334.46% with the increase in the early rainy season being significantly lower ($P<0.05$) than the other seasons.

The study indicates that testosterone-dependent physiological processess in the buck under standard management are relatively stable in our environment with season and that undue exposure of the buck to high ambient temperatures could seriously alter the dynamics of androgen metabolism and utilization.

Key Words: Heat stress, WAD buck, Serum testosterone

## DESCRIPTION OF PROBLEM

The functions of testosterone are already known and include the promotion of the production maturation and metamorphosis of spermatids through a complex series of cytological transformations to spermatozoa (1) and the development of secondary sexual characteristics and normal male sexual behaviour (2,3) . Androgens have indeed been shown to improve growth performance in beef cattle and at the same time reduce the backfat thickness (4,5) and feed intake (6). Also, the increase in body weight of hemiorchidectomised bucks was attributed partially to an increase in biosynthesis of steroid hormones, especially testosterone (7,8) since

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testosterone level is greater in hemicastrated bulls due to increase in Leydig cel activity (9,10).

Also age-related changes in the circulating levels of testosterone in serum have been reported for bull (11) and ram (12,13,14) while seasonal fluctuations have been reported in the goat (15, 16) and the ram (17,18). Essentially, in response to gonadotropin secretion, testosterone production rises sharply at puberty (19), decrease during adult life and falls at old age (19,20).

Different evironmental factors/ conditions are known to affect mammalian reproduction in spite of the fact that within limits, animals can adjust to maintain homeostasis although performance (production, reproduction and efficiency), health and or well-being can be comprised beyond these limits (21). The results of Schahidi et al. (22) indicate that the sexual ethology of rams is highly temperature dependent. However, Minton et al. (23) obtained similarities in serum testosterone concentrations between heat stressed and non-stressed bulls. Also worthy of note is that serum LH and testosterone levels have been shown to increase with decreasing daylenght (15)

## MATERIALS AND METHODS

***Animals and management:*** The adult West African dwarf bucks used in this experiment were housed in a standard goat barn with adequate protection from the harsh ambient climatic conditions (25,26,27). A maize-based concentrate supplemented with forage and cool clean water were supplied *ad libitum,* while veterinary attention was given when necessary

***Season and exposure of animals:*** The semi-hot equatorial climate and the four three-monthly seasons of Ibadan namely early rainy season (April-June), late rainy season (July - September), early dry season (October - December) and late dry season (January - March) have already been described (28). The bucks were exposed for three consecutive rain-free days in the middle of each season to direct tropical sunlight (29) between 11.30 and 12.30h. Dry-bulb temperatures in the barn were 28 - 31°C and in the paddock 30-35°C. Exposures were done in the paddock adjacent to the barn in specially construted restraining wooden crates that exposed most of the body of the animals to the rays of the sun with a litttle space to move (27). During exposure animals were denied feed and water.

***Collection and handling of blood:*** Blood samples were collected from the Jungular vein by venipuncture after local disinfection with methylated spirit using a 21 guage 2.54 cm sterile needles and 5ml syringes at 08.00h twice weekly in the second and third weeks of the middle month of each season. During the period of exposure to direct tropical sunlight, blood sampling was done at 1000h before the exposure and immediately after the thermal stress. Blood samples were kept at 4- 5°C for 24 h and then centrifuged at 1,200g for 5 minutes and the serum separated and stored at about -20°C until analyses.

*Testosterone assay:* Serum testosterone levels were determined by radioimmonoassay according to Nduka (30) and Dada et al. (31). Inter - and

intra-assay variations were 25% and 21% respectively.

***Statistical analyses:*** Data were computed and compared using Student test and Chi square analyses (32).

## RESULTS AND DISCUSSION

Serum testosterone levels were stable in both the barn and paddock throughout the year except in the late rainy season when there was a significant drop ($P<0.05$) in concentration in both locations (Table 1.) The mean values of serum testosterone concentration were 5.05 ± 0.67

**Table 1 : Seasonal variations in the circulating serum testosterone levels (ng/ml) in the WAD buck before and after acute thermal stress (means ± sem)**

| Location | Late dry season | Early rainy season | Late rainy season | Early dry season | Mean season |
|---|---|---|---|---|---|
| Barn | $5.15 \pm 0.64^a$ | $6.95 \pm 1.07^a$ | $3.31 \pm 0.42^b$ | $4.80 \pm 0.41^a$ | $5.05 \pm 0.57$ |
| Paddock | $*22.48 \pm 2.78^a$ | $*18.42 \pm 2.66^a$ | $*10.16 \pm 0.59^b$ | $*16.53 \pm 1.06^a$ | $16.89 \pm 2.22$ |

Ab: Values bearing different superscript along the same row are significantly different ($P<0.05$).
* : Location values are significantly different ($P<0.001$).

ng/ml (barn) and 16.89 ± 2.22 ng/ml (Paddock). Location also highly significantly affected ($P<0.001$) testosterone levels all the year round as the acute exposure of the bucks to direct tropical sunlight resulted in highly significantly deviations ($P<0.01$) of 264.04% in the early rainy season to 436.50% in the late dry season over the levels of the hormone in the unexposed bucks (figure 1.) The deviation in the late dry season significantly superceded ($P<0.05$) those of the early dry and late rainy seasons which were, in turn, significantly higher ($P<0.05$) than that of the early rainy season.

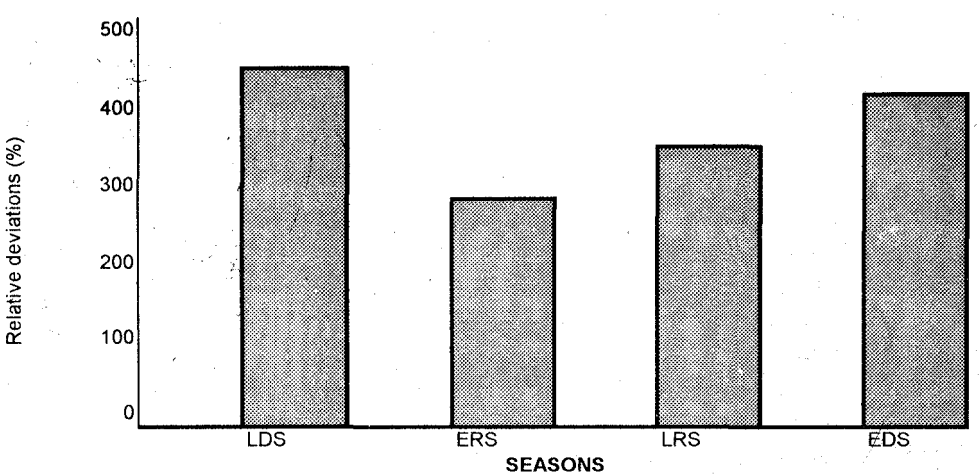


Fig. 1. Effects of acute exposure of the WAD buck to tropical sunlight on circulating testosterone levels as reflected by the relative deviations (%) from the values of non-exposed bucks in the late dry (LDS), early rainy (ERS), late rainy (LRS), and early dry (EDS) seasons.

The seasonal fluctuations in the circulating testosterone levels in the West African dwarf bucks observed in this study are in support of the reports of earlier workers on goats (15,16) and on rams (17, 18). It is also of interest to note that the lowest serum testoterone concentration in the buck in Ibadan was obtained in the late rainy season suggesting this season to be either limiting steroidogenesis in the buck or enhancing the metabolic utilization of testosterone. Considering our recent recommendations that these goats could be fattened within the late rainy and early dry seasons (27) we may assume that testosterone may be better utilised for growth promotion during this period.

Although Minton *et al.* (23) could not find differences in serum testosterone concentrations of heat-stressed and non-stressed bulls, the results of Schahidi et al. (22) indicated that the sexual behaviour of rams was highly temperatures dependent. The dramatic deviation of the serum testosterone concentration in the paddock from that in the barn was indeed at variance with the report of Minton et al. (23). Even though these animals are indigenous in the location of the study and so were adapted to the environmental conditions, it is noteworthy that the same animals showed significant elevations in some physiological variables, rectal temperatures, respiratory rate and sweating rate, during the same one hour thermal stress (27). It is known that with heat stress, animals experience a reduction in feed intake and an increase in water intake as well as respiratory rate (6). Thus it can be inferred that the witholding of water and feeds from these goats during the heats stress may have contributing to their drastic changes in testosterone concentration.

Our results are also not in agreement with those of Agiang et al. (34) who showed that Leydig cell function, as judged from testosterone concentration in response to HCG stimulation, is very much reduced ($P<0.001$) in the hot periods of the year probably by a reduction in hCG receptors in the testicular tissue.

It may be concluded from the generally high testosterone levels in the hot dry season and the elevation of same during heat stress that there is some alteration in the dynamics of androgen metabolism during this period. This may thus not be a conducive time to graze the goats for fattening.

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