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GONADAL AND EXTRA-GONADAL SPERM RESERVES OF KANO BROWN BUCKS AS AFFECTED BY SEASON AND FEEDING REGIME

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ABSTRACT

This study investigated the influence of season and feeding regimes on the reproductive parameters of Kano Brown bucks. Forty-eight (48) bucks were utilized, with sixteen (16) bucks allocated to each of the three distinct seasons. The Kano Brown Bucks, a breed integral to Nigeria's meat production industry, hold significant agricultural value, necessitating a deeper understanding of their reproductive physiology to optimize breeding strategies. Central to this is the concept of gonadal reserves, which pertain to sperm stored within the testes and serve as a critical indicator of fertility potential. These reserves, influenced by environmental and nutritional conditions, directly affect the breed's reproductive capacity. Similarly, extra-gonadal reserves sperm stored in the epididymis and associated structures play a pivotal role in successful mating, underscoring the need to evaluate both reserves holistically. Seasonal variations, such as fluctuations between wet and dry seasons, introduce stressors that may disrupt hormonal balance and sperm production, while feeding regimes further modulate reproductive health, as balanced nutrition is essential for maintaining sperm quality and quantity. At the conclusion of the experimental period, twelve (12) bucks (three per treatment group) were orchidectomised. A total of twenty-four (24) testes (right and left) were harvested, and their weights (g) and lengths (cm) were recorded. Subsequently, the epididymis was meticulously dissected from each testis using a scalpel blade and further divided into its three anatomical regions: caput, corpus, and cauda epididymides. The weight (g) and length (cm) of each epididymal segment were also measured. Both testicular and epididymal tissues were processed in the laboratory to determine gonadal and extra-gonadal sperm reserves, expressed as (x 10^6)/g/testis. The results revealed a significant difference in gonadal sperm reserves (x 10^6)/g/testis across the seasons, with the dry season exhibiting the highest mean value (2896.83 x 10^6)/g/testis and the rainy season the lowest (2350.15 x 10^6)/g/testis. Similarly, the dry season showed the highest values for extra-gonadal sperm reserves, followed by the harmattan season. Based on these findings, it can be concluded that both season and feeding regime significantly affect the gonadal and extra-gonadal sperm/spermatid reserves of Kano Brown bucks. This suggests that breeding bucks may benefit from being raised during the rainy and harmattan seasons. The aim of the study was to evaluate the impact of seasonal variations and different feeding regimes on the gonadal and extra-gonadal sperm reserves in Kano Brown bucks. The research sought to understand how these factors influenced reproductive parameters, ultimately management practices to enhance breeding efficiency and livestock productivity in semi-arid regions of Nigeria.

Keywords: Extra-Gonadal, Feeding, Gonadal, Kano Brown Bucks, Season, Sperm Reserves

INTRODUCTION

In tropical and subtropical environments, both small and large ruminants are frequently susceptible to heat stress. When ambient temperatures surpass the upper critical threshold, reported around 48°C depending on the species, a noticeable decline in production or a reduced rate of weight gain typically occurs. Furthermore, when environmental temperatures deviate from the thermoneutral zone, other climatic factors gain prominence. Humidity becomes increasingly critical, alongside solar radiation and wind velocity. In arid, hot climates, evaporative cooling is efficient, whereas in humid, hot climates, the air's limited capacity to absorb additional moisture can impede effective cooling, potentially leading to heat stress. Conversely, excessively low humidity can irritate mucous membranes, while high humidity can foster the proliferation of fungal infections and contribute to structural decay. These environmental factors exert substantial influences on livestock production, particularly affecting small ruminants.

In Sub-Saharan Africa, small ruminants play a pivotal role in the livelihoods of smallholder farmers, forming an integral component of crop-livestock mixed farming systems (Bianca, 1955; Malami et al., 2006). Small ruminants, encompassing sheep and goats, are numerically significant domesticated animals due to their contributions of meat, milk, skin, fiber, and manure. Moreover, they serve as a primary or supplementary source of income for a considerable number of subsistence farmers and landless laborers (Amann, 1970). Consequently, they contribute significantly to the subsistence and socio-economic well-being of a large human population within low-input, smallholder production systems in developing countries. Goats represent the most populous livestock species in Nigeria, with an estimated population of 57.8 million, compared to 38.5 million sheep (FAO, 2012). Among the diverse goat breeds in Nigeria, the Red Sokoto goat is the predominant and most widely distributed breed across the Northern Savannah belts of the country (Ngere et al., 1984; Lombin, 2007). This breed is characterized by a uniform dark red coat, short hair, and the presence of horns in both sexes. They possess short ears and legs, and their skin is particularly valuable compared to other goat breeds.

This study was designed to evaluate the effects of seasonal variations and different feeding regimes on the reproductive parameters of Kano Brown bucks, specifically focusing on their gonadal and extra-gonadal sperm reserves.

MATERIALS AND METHODS

Study Area

The study was conducted at the University Teaching and Research Farm and the Laboratory of the Department of Animal Science, Bayero University, Kano, Nigeria. Kano is geographically located between longitude 9°30' and 12°30' East and latitude 9°30' and 8°42' North, within the Sudan Savannah region of Nigeria. The annual temperature in this region ranges from 38°C to 43°C, while the relative humidity fluctuates between 40% and 51.3% (Olofin, 2007). The climate is characterized as tropical wet and dry, with a wet season spanning from May to September and a dry season from October to April. The annual rainfall in the area typically ranges between 787 and 960 mm (KNARDA, 2001).

Experimental Animals and Their Management

Forty-eight (48) Kano Brown bucks, approximately 12 months old with an average initial body weight of 10 ± 2 kg, were procured from the Wudil market. Prior to selection, the scrotum and testes of each buck were visually examined, palpated, and carefully inspected to exclude any apparent abnormalities. The general health status of the selected experimental animals was assessed, and they were quarantined before the commencement of the study. As a prophylactic measure, the animals received a long-acting 20% Oxytetracycline injection at a dosage of 10 mg per kg body weight. They were also dewormed using Albendazole suspension at a dosage of 7.5 mg per kg body weight and vaccinated against peste des petits ruminants (PPR) with PPR Vaccine administered subcutaneously at a dose of 0.5 ml per animal. The animals were housed in groups of four bucks per treatment, and a two-week adaptation period was allowed before the initiation of the experiment. The experimental pens were thoroughly cleaned and disinfected prior to the arrival of the animals, and regular pen sanitation was maintained throughout the experimental period.

Experimental Design and Treatments

The study was conducted over a period of 12 weeks (84 days) for each of the three seasonal experiments. Sixteen (16) Kano Brown bucks were randomly assigned to four dietary treatments within each season, following a 3 x 4 factorial randomized complete block design. This design incorporated three seasons and four dietary treatments, with four bucks allocated to each treatment group within each season. The treatments evaluated were:

Treatments	Feeding regime
Treatment I:	Browsing only (No supplementation)
Treatment II:	Supplementation in the morning with browsing
Treatment III:	Supplementation in the morning and in the evening with browsing
Treatment IV:	Zero browsing (Supplementation only)

Experimental Feeds

The treatment diets were formulated using cottonseed cake, cowpea husk, maize offal, wheat offal, and salt. Clean drinking water and mineral salt licks were provided ad libitum. Supplementation was offered at a rate of 1.5% of each animal's body weight, and the quantity provided was adjusted weekly following individual weight measurements. Hay was offered ad libitum to the animals in treatment four throughout the experimental period. All feed ingredients were purchased from markets within the Kano metropolis. The concentrate feed composition included 19% maize offal, 30% cottonseed cake, 30% wheat offal, 20% cowpea husk, and 1% salt, resulting in a diet with approximately 16% crude protein and 2381 kcal/kg of energy.

Determination of Gonadal and Extra-gonadal Sperm/Spermatid Reserves (x 106)/g/testis

At the conclusion of the experiment, twelve (12) bucks, three from each treatment group, were orchidectomized. The harvested testis were utilized to determine the gonadal and extra-gonadal sperm/spermatid reserves, following the methodologies described by Rekwot et al. (1987, 1994) and Igboeli and Rekwot (1987). Twelve (12) testes were processed to assess gonadal sperm reserves. The right and left testes were labelled and used appropriately for the determination of gonadal and epididymal sperm reserves. The weight (g), length (cm), and volume of each testis (right and left) were recorded. The epididymis, visceral vaginal tunic, and tunica albuginea were carefully dissected from each testis using a scalpel blade.

Gonadal Sperm Reserves (x 10^6)/g/testis

The left and right testes were homogenized separately using a high-speed blender for 2 minutes in 50 ml of normal saline containing 100 IU/ml of Sodium Penicillin G and 1 mg/ml of Streptomycin. The volume of the homogenate was measured after rinsing the blender with an additional 20 ml of normal saline. A 5 ml aliquot of the homogenate was then transferred to a conical flask and further diluted with 80 ml of normal saline. The diluted homogenate was stored overnight at 5°C. Sperm concentration was determined using a hemocytometer, as described by Rekwot et al. (1987).

Extra-gonadal (Epididymal) Sperm Reserves (x 10^6)/g/testis

The epididymis was carefully dissected from each testis using a scalpel blade, and the total length and weight of each epididymis were recorded. Each epididymis was then meticulously separated into its three regions: caput, corpus, and cauda epididymides. The length and weight of each of these segments were measured, and each segment was minced in 20 ml of normal saline using sharp scissors and stored overnight at 5°C. The minced epididymal tissues were filtered through gauze, and the volume of the filtrate was measured. A one-milliliter (1 ml) aliquot of the filtrate was placed in a test tube and further diluted with 2 ml of normal saline. Epididymal sperm reserves were determined using a hemocytometer, following the procedures described by Rekwot et al. (1987) and Gyang (1990). Sperm reserves were expressed in billions using the procedure outlined by Osinowo et al. (1982) and Buwat and Zaharaddeen (1994). Testicular and epididymal weights were obtained using an electronic weighing scale, while lengths were measured in centimeters (cm) using a meter rule.

Weather Information of the Experimental Site

The temperature and relative humidity within the experimental pens and the surrounding environment were monitored across the three seasons. Minimum temperatures were recorded at 8:00 am, and maximum temperatures were recorded at 2:00 pm using digital thermo-hygrometers (Brannan England). Two (2) digital thermo-hygrometers (Brannan England) were utilized. One (1) was positioned on the wall inside the experimental pens at a height of 120 cm above the ground, and the other was placed outside to record

the ambient temperature and relative humidity experienced by the animals during the experimental periods. The collected temperature and relative humidity data were used to calculate a temperature-humidity index (THI) to assess the thermal comfort zone for the bucks. The THI was calculated using the following equation (Marai et al., 2001):

THI=dboC–{(0.31−0.31RH) (dboC–14.4)}

where: dboC = dry bulb temperature (°C) RH = relative humidity (%) / 100

Information on the macroclimate, including minimum and maximum temperatures (26 to 42°C), relative humidity (20 to 65%), and rainfall (698 to 985 mm), was also obtained from the meteorological station at Aminu Kano International Airport for the period from November 2016 to December 2017.

Table 1: Mean temperature (ºC) and relative humidity (%) of the experimental site

Variables	Seasons		
	Dry	Rainy	Harmattan
Temperature (ºC)	39.37±2	28.32±2	26.21±2
Relative humidity (%)	20.05±2	68.79±2	32.89±2

Statistical analysis

Data collected was subjected to analysis of variance (ANOVA) using the general linear model (GLM) procedure of SAS (2002, version 9.1) where significant differences observed mean was separated using the Duncan multiple range test (DMRT).

RESULTS AND DISCUSSION

The results regarding gonadal sperm reserves in Kano Brown bucks are summarized in Table 2. A statistically significant difference ($P<0.05$) was observed in gonadal sperm concentration across the seasons. The dry season yielded the highest mean sperm concentrations, recorded at 2896.83 x 10^6/g/testis for the right testis and 3015.08 x 10^6/g/testis for the left testis. Conversely, the rainy season exhibited the lowest mean concentration at 2350.15 x 10^6/g/testis. Additionally, the interaction between season and feeding regime significantly affected extra-gonadal sperm reserves (x 10^6/g/testis), with the dry season consistently favoring higher reserves. This finding aligns with the observations of Martin et al. (2004) and Samuel and Salaku (2007), who reported elevated sperm concentrations in rams on higher protein diets during the dry season.

Table 3 presents the results for extra-gonadal sperm reserves in Kano Brown bucks. Significant differences ($P<0.05$) were detected among seasons for the left and right caput, corpus, and cauda epididymides. The right caput epididymis recorded the highest mean value of 1734.00 x 10^6/ml during the dry season, while the lowest mean value of 1017.67 x 10^6/ml was noted in the rainy season. For the left cauda epididymis, the highest mean value was 2651.17 x 10^6/ml during the dry season, compared to the lowest value of 1194.32 x 10^6/ml recorded during the rainy season.

The mean values of gonadal sperm reserves obtained in this study were highest in treatment three, corroborating findings reported by Tibbo (2006) and Nasir et al. (2014). This observation is further supported by previous research (Coulson et al., 1980; Sakesena and Salmonsen, 1982; Velesquez Pereira et al., 1998; Taha et al., 2006).

Notably, treatment three exhibited high sperm concentrations in both the right and left testes. This increase can likely be attributed to the morning and evening supplementation provided in this treatment group. These results are consistent with the findings of Hassan (2010), who noted improvements in semen volume, color, and concentration correlating with higher dietary protein levels in yearling Kano Brown bucks.

In summary, this study underscores the critical role of seasonal variations and dietary management in optimizing sperm reserves, providing valuable insights for enhancing reproductive performance in Kano Brown bucks.

Table 2: Gonadal sperm reserve (x10^6) /g/testes of Kano brown bucks influenced by season and feeding regime

Parameters (x10^6) /g / testes	Seasons			SEM
	Dry	Rainy	Harmatttan	
Right testis	2896.83^a	2350.15^b	2364.14^b	31.25
Left testis	3015.08^a	2380.15^b	2378.58^b	4.16

^{ab} means within the same rows with different super script are significantly different ($P < 0.05$)

Table 3: Extra gonadal sperm reserves (x10^6)/ml of Kano Brown bucks as affected by season and feeding regime.

Parameters (x10^6) / ml	Seasons			SEM
	Dry	Rainy	Harmattan	
Right caput epididymides	1734.00^a	1017.67^c	1037.50^b	2.39
Left caput epididymides	1755.25^a	835.50^c	853.50^b	4.14
Right capus epididymides	1617.00^a	1120.33^b	1119.99^b	3.27
Left capus epididymides	1611.33^a	1112.83^b	1119.99^b	4.07
Right cauda epididymides	2423.67^a	1667.25^b	1112.83^c	6.01
Left cauda epididymides	2651.17^a	1194.32^c	168850^b	16.19

^{abc} means within the same row with different super scripts are significantly ($P < 0.05$) different

CONCLUSION

The reproductive parameters of Kano Brown bucks, as influenced by seasonal variations and feeding regimes in this study, exhibited significant differences across the seasons under the different feeding regimens. Based on the findings, it can be concluded that Kano Brown bucks tend to exhibit optimal reproductive performance during the dry and harmattan seasons, particularly when subjected to a feeding regime involving morning and evening supplementation. Furthermore, it is recommended that these animals be provided with a high level of nutrition and can be successfully raised within a temperature range of 26-39°C without

significant adverse physiological effects on their reproductive parameters.

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