

Testicular morphometry of the Uda rams (*Ovis aries*) during the dry season in North-West Nigeria

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ABSTRACT: The Uda ram (*Ovis aries*) is the predominant species in the Northwest of Nigeria, and the morphology of the testes is an important marker for the reproductive capability of rams. Rams play a pivotal role as a source of livelihood and food, providing milk and meat. This study was conducted to determine the morphometry of the testis for this species during the dry season. This study was conducted by acquiring and assessing the testicular samples of eighty (80) rams during the dry season months to contribute data on the reproductive function during this period. Testicular weight was observed to vary significantly, with the right testis showing greater mean values than the left. The weight of the right testicles varied from 82.00 to 218.00 g (191.80 ± 40.90 g), whereas the weight of the left testicles varied from 74.00 to 210.00 g (184.50 ± 41.70 g). The range of whole testicular weights was 156.00 to 428.00 g (376.30 ± 81.70 g). There were statistically significant ($p < 0.05$) variations in length, breadth, and circumference, indicating a right-sided predominance. Age and body weight were observed to have a significant association with testicular dimensions. This study also provides baseline morphometric data for Uda rams; the results support reports on lateral asymmetry in testicular morphometry that favours the right side, and they highlight key predictors of reproductive potential.

Keywords: Nigeria, Northwest, dry season, testis, morphology, Uda rams.

INTRODUCTION

Uda sheep are a breed adapted to the Sudano-Sahel region (Keubeng *et al.*, 2024). It is the predominant sheep species in North-West Nigeria, as an important economic animal (Baba *et al.*, 2015). A profile on the management and cost implications of a herd has been extensively reported, but not its reproductive biology for the region. Reproductive efficiency is a critical determinant of flock productivity, and testicular development plays a central role in male fertility. Despite the adaptation of the species to the region, such as lower respiratory rates (67.76 breaths per minute), suggesting a degree of thermal resilience, potentially contributing to possible efficient scrotal thermoregulation, increased vascularisation aiding heat dissipation that can protect reproductive function by

lowering the risk of hormone disruptions (Okeke *et al.*, 2020).

Testicular morphometry refers to the quantitative assessment of testicular characteristics such as testicular weight, length, width, thickness, volume, and scrotal circumference. These parameters are widely recognised as reliable indicators of reproductive capacity and sperm production in rams (Salhab *et al.*, 2001). This varies significantly across different breeds of sheep, with the photoperiod (day length) and ambient temperature acting as the most critical drivers of these changes (Aguirre *et al.* 2007a; 2007b, Sarlós *et al.* 2013; Zaher *et al.*, 2020). Testicular weight and volume are directly related to the mass of seminiferous tubules, which constitute the primary

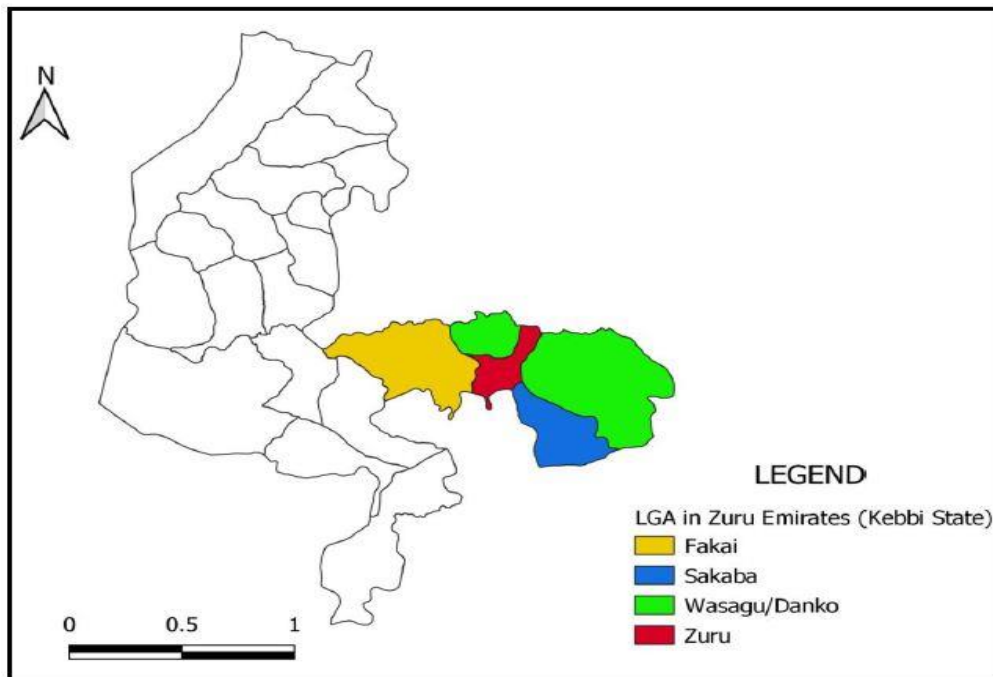


Figure 1. Map of Kebbi State, showing Zuru Emirate (Mamman *et al.*, 2025).

site of spermatogenesis (Atawalna *et al.*, 2022). Testicular morphometric traits are influenced by genetic, physiological, and environmental factors, with seasonality being one important extrinsic regulator (Hafez and Hafez, 2000). Seasonality affects the productivity and reproductive capabilities of various domestic animal species (Rosa and Bryant, 2003); therefore, seasonal data can offer insight into the potential effect of these changes, but little information currently exists on the reproductive biology along with seasonality for this species.

There are, unfortunately, various challenges, such as nomadism, distant pastures, and uncooperative breeders in recording comprehensive data, which often make it difficult to produce accurate information for the Uda sheep. The dry season usually lasts between November and March and increasingly to June in recent years, with rainfall lasting between the months of June and October (Salisu *et al.*, 2024; Benson, 2025). Rainfall greatly affects the supply of feed, with reports that it also alters the photoperiodic response to breeding (Walker *et al.*, 2019), which may affect observations taken within dry seasons. Despite the importance of Uda sheep, there is limited information on their testicular morphometric characteristics, for this region, the dry season, and how these may relate to reproductive potential. Understanding these relationships is essential for improving breeding efficiency and flock productivity, and data obtained in the dry season can be used to offer a baseline for seasonal and climate studies with regard to reproduction in the species. This study was conducted to provide data on the

Uda Rams in Northwest Nigeria using the Zuru emirate, Kebbi state, as the location of the study.

METHODOLOGY

Study area

A collection of tissue samples was obtained from abattoirs in the region of Zuru, Kebbi State (North-West Nigeria), located at latitude 33°5' and longitude 6°11' (Figure 1), with an average annual temperature of 27°C, and mean annual precipitation of 80 mm (Udeh *et al.*, 2024) during the dry season (November to February).

Gross morphology of the testes

Prior to slaughter, ages were estimated using dentition as previously described (Bello *et al.*, 2013; Hassanat *et al.*, 2025) and weighed. Immediately after the slaughter of the rams, the scrotal sac, testes, and epididymis were inspected for any obvious pathological anomalies as previously described (Adeyeye *et al.*, 2022; Ebegebulem *et al.*, 2024). Testicular gross abnormalities, including bilateral testicular hypoplasia, unilateral hypoplasia, unilateral and bilateral cryptorchidism, and epididymitis, were identified visually by alterations in the size, texture, and consistency of the testes. The existence and degree of gross pathological changes were assessed by serial



Figure 2. A group of Uda Rams in the marketplace and a pair of testicles.



Figure 3. Testicular weight measurement.

and systematic dissection into the testes; deep palpation was undertaken to assess consistency in terms of texture and shape. The gross morphological features of the Uda rams were observed before slaughter and after slaughter, when the testes were collected, and morphometric measures were captured (Figures 2, 3, and 4).

Testicular morphometry

The Rams and testicular organs included in this study were obtained from the slaughter slabs and various abattoirs located across Zuru Emirates. Eighty (80) rams in all, twenty from each area, Zuru, Fakai, Sakaba, and Wasagu/Danko, were carefully chosen from respective

slaughter slabs and abattoirs. The rams' dentition was used to assess their age (above 4 years), as previously described (Bello *et al.*, 2013; Hassanat *et al.*, 2025). Prior to slaughter, the testicular samples were briefly examined (Figure 2). A standard gradient ruler with the widest diameter was used to measure the testicular circumference and length. Following slaughter, testicular weight was measured using a digital sensitive scale (New Spring Laboratory Digital Weighing Balance) (Figure 3). Using a standard ruler graduated in centimetres (cm), the testicular length was measured in centimetres along the longitudinal axis of the testis, starting from one pole and ending at the other (Figure 4). Post-slaughter testicular morphometry was used in analyses.



Figure 4. Image illustrating testicular measurements.

Table 1. Descriptive statistics of testicular parameters of Uda sheep.

Parameter	Min	Max	Mean \pm SD	Mean \pm SEM
Age (years)*	4.00	5.00	4.50 \pm 0.53	4.50 \pm 0.17
Body Weight (kg)	100.00	150.00	137.60 \pm 15.80	137.60 \pm 5.11
Left Testicular Weight (g)	74.00	210.00	184.50 \pm 41.70	184.50 \pm 12.66
Right Testicular Weight (g)	82.00	218.00	191.80 \pm 40.90	191.80 \pm 12.54
Whole Testicular Weight (g)	156.00	428.00	376.30 \pm 81.70	376.30 \pm 25.19
Left Testicular Length (cm) *	9.09	14.02	12.91 \pm 1.45	12.91 \pm 0.45
Right Testicular Length (cm) *	10.06	14.52	13.37 \pm 1.36	13.37 \pm 0.39
Left Testicular Width (cm) *	5.56	7.51	6.93 \pm 0.55	6.93 \pm 0.18
Right Testicular Width (cm) *	5.60	7.76	7.19 \pm 0.53	7.19 \pm 0.19
Left Testicular Circumference (cm) *	11.12	15.02	14.05 \pm 1.18	14.05 \pm 0.35
Right Testicular Circumference (cm) *	11.20	15.52	14.50 \pm 1.15	14.50 \pm 0.39

*Statistical difference.

Statistical analysis

The morphometric data generated were analysed using SPSS (Version 2.0), descriptive statistics for all measures, and Pearson's correlation was performed to assess the relationship between parameters, and it was considered statistically significant if $p \leq 0.05$. Results were reported using narration and graphical representation.

RESULTS

The mean age of the animals (4.50 ± 0.53 years) indicates that the sampled rams were within their peak reproductive maturity, which is critical for interpreting the relatively high values observed in testicular dimensions and body weight. Table 1 shows the minimum, maximum, and mean \pm standard deviation values for body weight and testicular morphometric parameters of Uda sheep testicle samples collected. The body weight of the animals ranged from

100.00 to 150.00 kg, with a mean value of 137.60 ± 15.80 kg.

The left testicular weight ranged from 74.00 to 210.00 g, with a mean of 184.50 ± 41.70 g, while the right testicular weight ranged from 82.00 to 218.00 g, with a slightly higher mean of 191.80 ± 40.90 g. The whole testicular weight varied between 156.00 and 428.00 g, with a mean of 376.30 ± 81.70 g. The consistently higher mean values observed in the right testis suggest lateral asymmetry favouring the right side. Correlation between left and right testicular weights ($r = 0.998-1.000$, $p < 0.01$), standard error of mean (SEM) was 12.91 ± 0.45 and 13.37 ± 0.39 , respectively.

The mean left testicular length was 12.91 ± 1.45 cm, compared to 13.37 ± 1.36 cm on the right. Left and right testicular widths averaged 6.93 ± 0.55 cm and 7.19 ± 0.53 cm, respectively. Testicular circumference followed the same pattern, with left and right means of 14.05 ± 1.18 cm and 14.50 ± 1.15 cm, respectively. The asterisked parameters indicate statistically significant differences

Table 2. Pearson correlation analysis of testicular parameters of the Uda breed.

	Age	Bwt	LTW	RTW	WTW	LTL	RTL	LTWT	RTWT	LTC	RTC
Age	1	.945**	.932**	.931**	.932**	.889**	.851**	.844**	.863**	.844**	.863**
Bwt	.945**	1	.920**	.914**	.917**	.872**	.809**	.842**	.854**	.841**	.853**
LTW	.932**	.920**	1	.998**	1.000**	.963**	.925**	.938**	.950**	.938**	.950**
RTW	.931**	.914**	.998**	1	1.000**	.961**	.936**	.934**	.947**	.934**	.947**
WTW	.932**	.917**	1.000**	1.000**	1	.962**	.931**	.936**	.949**	.936**	.949**
LTL	.889**	.872**	.963**	.961**	.962**	1	.969**	.995**	.998**	.995**	.998**
RTL	.851**	.809**	.925**	.936**	.931**	.969**	1	.961**	.965**	.961**	.965**
LTWT	.844**	.842**	.938**	.934**	.936**	.995**	.961**	1	.999**	1.000**	.999**
RTWT	.863**	.854**	.950**	.947**	.949**	.998**	.965**	.999**	1	.999**	1.000**
LTC	.844**	.841**	.938**	.934**	.936**	.995**	.961**	1.000**	.999**	1	.999**
RTC	.863**	.853**	.950**	.947**	.949**	.998**	.965**	.999**	1.000**	.999**	1

** Correlation is significant at the 0.01 level (2-tailed). **Key:** BWT – Body weight, LTW – Left Testicular Weight, RTW – Right Testicular Weight, WTW – Whole Testicular Weight, LTL – Left Testicular Length, RTL – Right Testicular Length, LTWT – Left Testicular Width, RTWT – Right Testicular Width, LTC – Left Testicular Circumference, RTC – Right Testicular Weight, WRT-weight of right testis.

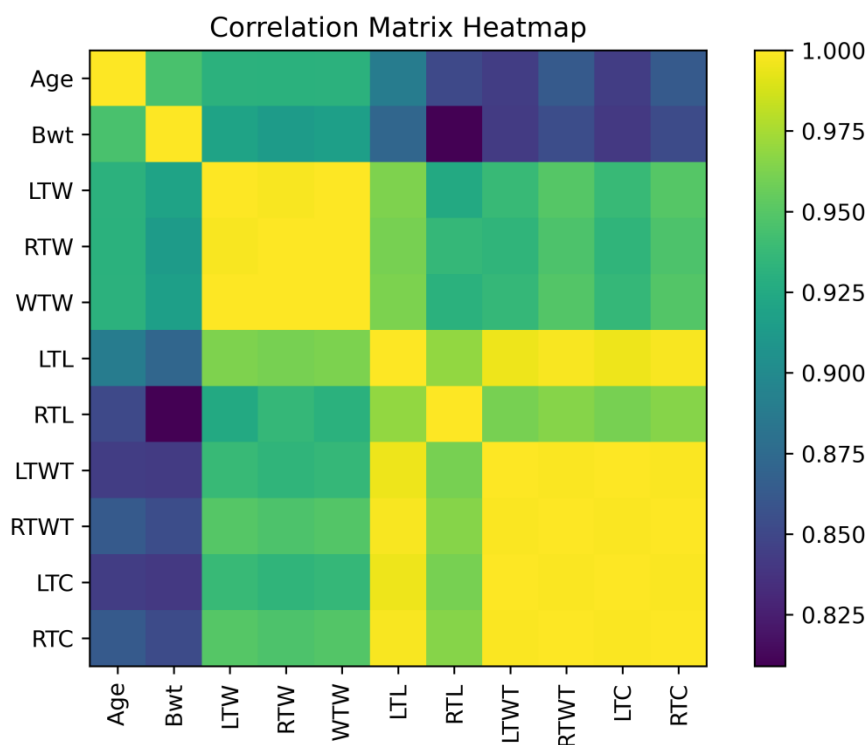


Figure 5. Correlation matrix heatmap. **Key:** BWT – Body weight, LTW – Left Testicular Weight, RTW – Right Testicular Weight, WTW – Whole Testicular Weight, LTL – Left Testicular Length, RTL – Right Testicular Length, LTWT – Left Testicular Width, RTWT – Right Testicular Width, LTC – Left Testicular Circumference, RTC – Right Testicular Weight, WRT-weight of right testis.

between the left and right testes ($p < 0.05$).

Pearson’s correlation analyses were performed using age, body weight, and testicular morphometric parameters. All reported correlations were significant at the 0.01

level (2-tailed), indicating strong statistical associations (Table 2, Figure 5).

Age correlates with left testicular weight ($r = 0.932$), right testicular weight ($r = 0.931$), and whole testicular weight (r

= 0.932). Associations were observed between age and testicular dimensions, including length (LTL: $r = 0.889$; RTL: $r = 0.851$), width (LTWT: $r = 0.844$; RTWT: $r = 0.863$), and circumference (LTC: $r = 0.844$; RTC: $r = 0.863$).

Body weight and testicular parameters

Body weight and whole testicular weight: $r = 0.917$. Body weight and left testicular weight: $r = 0.920$, and body weight and right testicular weight: $r = 0.914$. Correlations were observed between body weight and testicular dimensions (r values ranging from 0.809 to 0.872).

Testicular parameters interrelationship

Positive correlations were observed among testicular weight, length, width, and circumference (r values ranging from 0.934 to 1.000).

DISCUSSION

The present study gathered morphometric evidence describing testicular development in Uda rams reared in North-West Nigeria and examined the interrelationship between age, body weight, and seasonal influences on gonadal parameters. Testicular morphometry remains a cornerstone in the evaluation of male reproductive potential; testicular size and weight are related to spermatogenic capacity (Atawalna *et al.*, 2022; Dasa *et al.*, 2025). The findings demonstrate significant associations between age, body weight, and testicular dimensions and are in agreement with other studies, that the measurement and examination of testes size, volume, and structure are important markers of male fertility, including reproductive potential and general health in Uda rams (Atawalna *et al.*, 2022).

The mean body weight (137.60 ± 15.80 kg) recorded in this study is relatively high for indigenous breeds, suggesting good nutritional status despite the harsh dry season conditions. This is significant because body weight is strongly associated with testicular development and spermatogenic capacity (Salhab *et al.*, 2001). The strong positive correlation observed between body weight and all testicular parameters ($r = 0.809$ – 0.920 , $p < 0.01$) indicates that heavier rams possess larger testes and, by implication, potentially higher sperm production capacity. Larger testes typically contain more seminiferous tubules, which directly increases spermatogenic efficiency. The mean left and right testicular weights (184.50 ± 41.70 g and 191.80 ± 40.90 g, respectively) and the whole testicular weight (376.30 ± 81.70 g) demonstrate well-developed gonads in the studied animals. The close similarity between left and right testes suggests a high

degree of bilateral symmetry, which is often associated with normal testicular function and absence of pathological conditions.

The correlation observed between left and right testicular weights ($r = 0.998$ – 1.000 , $p < 0.01$) indicates synchronised development of both testes. Such strong associations imply that measurement of a single testis could reliably predict total testicular mass, which has practical implications for field-based reproductive assessment. The testicular lengths (12.91 ± 1.45 cm left; 13.37 ± 1.36 cm right), widths (6.93 ± 0.55 cm left; 7.19 ± 0.53 cm right), and circumferences (14.05 ± 1.18 cm left; 14.50 ± 1.15 cm right) indicate substantial gonadal development. These parameters are widely recognised as indirect indicators of sperm production capacity.

The correlation among these morphometric traits ($r = 0.925$ – 1.000 , $p < 0.01$) highlights a tightly coordinated growth pattern. For instance, testicular length showed strong associations with width and circumference, suggesting proportional enlargement of the testes rather than irregular growth. The correlation matrix reveals consistently strong positive relationships among all variables ($r = 0.809$ – 1.000 , $p < 0.01$). These findings suggest that selection based on easily measurable traits such as body weight or scrotal circumference could effectively improve reproductive performance in breeding programs. The strength of these correlations also indicates low variability in proportional development, which is desirable in livestock selection.

The relatively high standard deviations observed (e.g., ± 81.70 g for whole testicular weight) indicate biological variability within the population. However, the much smaller standard error of the mean (± 25.19 g) for this measure suggests that the sample mean is a reliable estimate of the population mean. Age exhibited strong positive correlations with testicular weight, length, width, and circumference, reflecting progressive gonadal development toward reproductive maturity. These observations are consistent with reported information that the activation of the hypothalamic–pituitary–gonadal axis during puberty stimulates gonadotropin secretion, testosterone production, and seminiferous tubule expansion (Li *et al.*, 2024). Variation in testicular morphometry is mediated through the hypothalamic–pituitary–gonadal axis (Xu *et al.*, 2022).

Despite the known adverse effects of high ambient temperatures during the dry season, the results indicate that Uda rams maintain substantial testicular size and strong interrelationships among reproductive parameters due to the persistence of high testicular weights and dimensions observed in this study, implying that Uda rams are well adapted to tropical climates and can sustain reproductive function despite dry season conditions. The observed right-sided predominance in testicular size is consistent with previous reports in Nigerian sheep breeds. Oyeyemi and Olusoji (2018) reported that the right testis

was generally larger than the left, both in length and circumference. Similar asymmetry has been documented in other domestic ruminants and is often attributed to anatomical and vascular differences between the two spermatic cords. However, it is important to note that while structural parameters might be high, functional parameters such as semen quality may still be affected by prolonged heat exposure and are a limitation in this study.

Seasonal fluctuations could potentially have a major impact on rams' reproductive systems, especially those related to temperature and photoperiod (the amount of daylight) and testicular measures decline during hot, dry times when supplies are scarce, leading to corresponding variations in reproductive rates and semen quality (Barragán *et al.*, 2023) with reports on elevated scrotal temperature causing impaired spermatogenesis and testicular degeneration if prolonged (Martin *et al.*, 2010). Seasonal rainfall patterns in North-West Nigeria influence pasture availability and body condition; shortened rainy seasons may limit forage availability (Salisu *et al.*, 2024; Benson, 2025), thereby indirectly affecting testicular morphometry. Further studies similar to the current one may offer a better understanding of the Uda species.

Understanding seasonal and breed-related variations in testicular morphometry has practical implications for breeding evaluation and flock fertility management. Measuring testicular parameters during various seasons can improve selection accuracy for breeding rams and potentially offer insight into seasonal and possibly climate influences.

Conclusion

This study demonstrates that testicular morphometry in Uda rams is strongly associated with age and body weight. Significant right-sided asymmetry was observed, although bilateral development remained highly coordinated. The strong correlations among morphometric parameters indicate that these measurements can serve as reliable indicators of reproductive potential. The findings provide baseline reference data for Uda rams in North-West Nigeria during the dry season and highlight the importance of considering age and body weight in breeding selection. Further studies incorporating multiple seasons, semen studies and environmental variables are recommended to better understand external influences such as seasonality and climate change on reproductive performance contributing to the conservation and improvement of this economically important indigenous breed.

COMPETING INTERESTS

The authors have no competing interests to declare.

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