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EFFECTS OF GRADED LEVELS OF *Adansonia digitata* (BAOBAB) LEAVES ON TESTICULAR MORPHOMETRY AND GONADAL SPERM RESERVE OF RED SOKOTO BUCKS

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ABSTRACT

This study was designed to evaluate the effects of graded levels of *Adansonia digitata* leaves on testicular morphometry and gonadal sperm reserve of Red Sokoto bucks (RSB). Twenty RSBS were randomly assigned to four groups (A, B, C and D) of five bucks. Group B, C, and D received graded levels of *Adansonia digitata* leaves powder in their diet for 14 weeks, while group A served as a control. Open castration was performed on eight (8) bucks (randomly selected, with two (2) from each group) at week fifteen (15). The RSB scrotal circumference, scrotal length, testicular volume, testicular width, and gonadal sperm reserves were evaluated. There was no significant difference ($P > 0.05$) in scrotal circumference, scrotal length, testicular volume, and testicular width in bucks fed with *Adansonia digitata* leaves and those in the control group throughout the study. A Significant ($P < 0.05$) difference in GSR between the groups was observed. This study, therefore, found a decrease in scrotal circumference, scrotal length, testicular volume, and testicular width, but with GSR improvement between their respective groups. It was concluded that feeding graded levels of *Adansonia digitata* leaves at 3, 6, and 9 g/h/day to RSB may compromise their scrotal circumference, scrotal length, testicular volume, and testicular width, but increase their gonadal sperm reserve, especially at 6g/h/day, which can improve their reproductive potential. Further studies on the effects of antioxidants from the *Adansonia digitata* leaves, such as vitamins A, C and E, on other testicular parameters are also recommended.

Keywords: *Adansonia digitata*, Gonadal sperm reserve, Red Sokoto Bucks, Testicular morphometry

INTRODUCTION

Goat belongs to the *Capra hircus* family, and there are many variants in Nigeria, including the Red Sokoto goat (RSG), Sahel goat, and West African dwarf goat. In Nigeria, small ruminants, such as sheep and goats, are important domesticated animals due to their contribution of meat, skin, fibre, manure, milk, and other milk products such as cheese, butter, and ice cream. In some countries, goats' horns are used to make spoons, and their intestines are used for musical instruments (Agriculture, 2019). They therefore contribute significantly to the subsistence and socio-economic livelihoods of a large human population in low-input, smallholder production systems in developing countries (Workneh, 2000; Tibbo, 2006). Goats experience seasonal fluctuations in feed supply, which leads to wet-season live weight gains and dry-season live weight losses until animals reach marketable weight (Poppi and McLennan, 1995). This results in a scarcity of good-quality feed during the dry season. Feed intake is one of the most important factors in an animal's productivity, health, and carcass quality (Bawa *et al.,* 2003). This led to an increased demand for conventional animal feed ingredients such as soybeans or groundnut cake, which are costly. In Nigeria, seasonal shortage and scarcity of natural forage for livestock during the dry season led to low reproductive performance (Adeyeye *et al.* 2020). Searching for an alternative feed source, such as browses, herbs, and plants, as nutrient sources for ruminants (Okoli *et al.,* 2002) becomes necessary. The Red Sokoto goat is predominantly found in the semi-arid region of Nigeria, an area characterised by the cultivation of millet, sorghum, and groundnuts. This region also supports various economic trees, including the Baobab (*Adansonia digitata*), Shea-butter Nut (*Butyrospermum parkii*), and Locust Bean (*Parkia biglobosa*), among others (Hunter, 2018). The *Adansonia digitata*, commonly known as the Baobab, also goes by names such as Monkey Bread Tree, Upside Down Tree, and Cream of Tartar Tree. Within Nigeria, it has distinct local names: Kuka in Hausa, Oshe in Yoruba, and Usi in Bini. The *Adansonia digitata* leaves contain many classes of feed (Namratha and Sahithi, 2015), which enhance the reproductive and non-reproductive capabilities of animals and humans (Jamie, 2016; Kenneth *et al.,* 2019). *Adansonia digitata* leaves are traditionally used to cure diseases such as smallpox, kidney, bladder, and chest-related ailments, such as asthma (Namratha and Sahithi, 2015); these medicinal properties make them useful for various purposes. Many plants that contain antioxidants have been used for their ability to counteract oxidative stress, and *Adansonia digitata* is one of the plants that have antioxidant effects. In a study conducted by Babatunde *et al.* (2021), they reported that administration of *Adansonia digitata* leaves counteracted the testicular damage in rats following cotton seed extract administration, thereby maintaining testicular integrity and spermatogenesis. In addition to that, it causes a significant increase in sperm count and antioxidants such as glutathione peroxidase, etc. Previously, studies concentrated more on the phytochemical analysis and medicinal values, but few studies on the antioxidant effect have been conducted on *Adansonia digitata* leaves in RSB. There is also a dearth of information on the effects of graded levels of *Adansonia digitata* leaves on testicular morphometry and gonadal sperm reserve of Red Sokoto bucks (RSB), which this study aimed to address.

MATERIALS AND METHODS

Study Area

This study was conducted at the small ruminant pen in the Faculty of Veterinary Medicine, Usmanu Danfodiyo University, Sokoto. Sokoto State is in the northwestern part of Nigeria and lies between 13° and 14 ° North (Latlong, 2018). It has an average of 15.75 mm of rain, a temperature of 36.3°C, and a relative humidity close to 31% (World Weather Online, 2025).

Experimental Animals and Their Management

The study was approved by the Faculty of Veterinary Medicine Animal Research Ethics Committee (FAREC), Usmanu Danfodiyo Sokoto, Nigeria, with approval number UDUS/FAREC/2019/AUP-RO-8. Twenty healthy Red Sokoto bucks (RSBS) with clinically normal genitalia aged 7 to 12 months were sourced from local markets in Sokoto and its environs. The buck's average weight was 12.5 kg. They were clinically examined, stabilised, and managed intensively in a pen for three (3) weeks before the commencement of the study. They were prophylactically treated with 20% Oxytetracycline inj. 20mg/kg $x^1/_7$ i.m, Ivermectin inj. 1ml/50kg $x^1/_7$ S.C. against bacterial infection and parasitic infestation. Feed was provided to the bucks daily (each one was fed 3% of his body weight), and clean water *ad libitum* was offered. The Red Sokoto Bucks were vaccinated against *Pest des Petit Ruminants (PPR)*.

Sourcing and Processing of Test Ingredient

Adansonia digitata leaves were sourced from the Silame Local Government Area of Sokoto State, Nigeria. The leaves were identified, collected and shade-dried for four (4) weeks at room temperature before grinding them into powder.

Phytochemical screening

The powdered leaves were analysed using the standard procedure described by AOAC (1990). Table 1 presents the qualitative phytochemical content of *Adansonia digitata* leaves.

Study design

Complete Randomised Design (CRD) was employed whereby simple random sampling was used to allocate the 20 bucks into four groups of 5 each. The groups A, B, C, and D received 0, 3, 6 and 9 mg/kg/h/day of *Adansonia digitata.* The scrotal circumference, length, and width were measured weekly for 14 weeks, while gonadal sperm reserve was determined at week 15 after castrating the sampled Red Sokoto Bucks (Table 2).

Testicular Measurements of Red Sokoto Buck

Scrotal circumference and testicular width

Testicular or scrotal circumference is the maximum dimension around the pendulous scrotum after pushing the testis firmly into the scrotum and then measuring the greatest circumference with a flexible tape in centimetres (Akpa *et al.,* 2006). The testicular width (medial-lateral) was calculated by dividing the value of testicular circumference by two (2), measured in centimetres.

Scrotal length

Testicular or scrotal length was also measured using a flexible tape in centimetres. It was placed from the head to the bottom of the testicle as described by Ajani *et al.* (2015), and the measurements were recorded.

Testicular volume

The testicular volume (T.V) was calculated using the formula described by Sakamoto *et al.* (2008) as follows: Testicular volume (cm^3) = length of testis x width of testis ^{2} x 0.52 (constant).

Gonadal Sperm Reserves

This was done using the modified method of Rekwot *et al.* (1994). The weight and volume of each testis were determined and recorded. The *Tunica albuginea* was carefully removed using a scalpel blade. Each testis was homogenised in 35 ml of normal saline with antibiotics (Sodium penicillin G, 100 IU/ml and Streptomycin sulphate, 1mg /ml) to prevent bacterial growth and blended for about two minutes. The homogenate volume, after rinsing the blender container with 35 ml of normal saline and adding the effluent, was measured. About 5 ml of the homogenate was transferred to a conical flask, and further dilution was made with 20 ml of saline, and the homogenate was stored at 5°C for 24 hours to allow sperm cells to ooze out of the tissues. Finally, the testicular sperm/spermatid concentration was determined using an improved Neuber hemocytometer as described by Rekwot *et al.* (1994). The lengths of the testes were measured using a measuring tape (Tailoring tape ®). The testes were weighed on an electronic balance (L- Assistance scientific instrument company), model: WT 3003N, USA.

Statistical analysis

The data on scrotal circumference, scrotal length, testicular volume, and testicular width were subjected to Repeated Measure Analysis of Variance (RM-ANOVA), the gonadal sperm reserves was subjected to One -Way Analysis of Variance and analysed using InVivoStat version 3.7.0.0 (InVivoStat 2016) and expressed as mean ± Standard deviation (SD). Values of $P < 0.05$ were considered statistically significant.

RESULTS AND DISCUSSION

Table 1: Phytochemical analysis of *Adansonia digitata* leaves

Phytochemical	Level
Flavonoids	++
Tannins	+
Saponins	++
Glycosides	+++
Alkaloids	-
Cardiac glycosides	-
Steroids	+++
Saponin glycosides	-
Balsams	+
Anthraquinones	-
Volatile oils	-

Table 2: Table of feed composition given to the Red Sokoto bucks

Group	Basal diet	*Adansonia digitata* leaves powder (g/head/day)
A	Groundnut haulm, bean husk and wheat offal	0
B	Groundnut haulm, beans, husk and wheat offal	3
C	Groundnut haulm, beans, husk and wheat offal	6
D	Groundnut haulm, beans, husk and wheat offal	9

Scrotal circumference

Table 3 shows the mean scrotal circumference of Red Sokoto bucks (RSB) fed graded levels of *Adansonia digitata* leaves. Throughout the study, no significant difference ($P > 0.05$) in scrotal circumference was observed between the control group and the groups fed *Adansonia digitata* leaves.

Scrotal length

Table 3 shows the mean scrotal length of Red Sokoto bucks (RSB) fed graded levels of *Adansonia digitata* leaves. At week 2, a significant increase ($P < 0.05$) in scrotal length was observed in groups C and D, which were fed *Adansonia digitata* leaves, compared to the control group. Although group B had the highest mean scrotal length, there was no statistically significant difference between all the groups ($P > 0.05$).

Testicular volume

Table 3 shows the mean testicular volume of Red Sokoto bucks (RSB) fed graded levels of *Adansonia digitata* leaves. Throughout the study, no significant difference ($P > 0.05$) in mean testicular volume was observed between the groups. Although group B had the highest mean testicular volume, this difference was not statistically significant between all the groups ($P > 0.05$).

Testicular width

The mean testicular width of the RSB fed graded levels of *Adansonia digitata* leaves is presented in Table 3. There was a significant ($P < 0.05$) difference between groups B and C at week 14. Although group B had the highest mean, there was no statistically significant difference between all the groups ($P > 0.05$).

Table 3: Mean ±SD scrotal circumference, scrotal length, testicular volume and testicular width of RSB fed with graded levels of *Adansonia digitata* leaves

Scrotal Circumference	Groups			
	A (cm)	B (cm)	C (cm)	D (cm)
WEEK 0	18.32 ± 1.36*	17.78 ± 1.23	18.52 ± 1.62*	16.42 ± 1.43**
WEEK 1	19.40 ± 0.96	19.36 ± 0.79	19.00 ± 1.66	18.50 ± 1.41
WEEK 2	18.40 ± 0.55	18.50 ± 0.50	18.70 ± 1.57	17.60 ± 1.29
WEEK 3	17.90 ± 1.03	18.10 ± 0.42	18.50 ± 1.41	17.00 ± 1.17
WEEK 4	17.30 ± 1.57	17.90 ± 0.42	17.60 ± 1.56	16.60 ± 1.34
WEEK 5	16.90 ± 1.52	17.80 ± 0.27	17.30 ± 1.72	17.20 ± 0.84
WEEK 6	16.60 ± 1.43	17.80 ± 0.27	17.10 ± 2.07	17.12 ± 0.97
WEEK 7	16.40 ± 1.71	17.30 ± 0.57	16.70 ± 1.89	16.70 ± 0.76
WEEK 8	15.90 ± 1.64	17.30 ± 0.45	16.50 ± 1.94	16.70 ± 0.76
WEEK 9	16.20 ± 1.79	17.10 ± 0.55	16.40 ± 1.95	16.40 ± 0.89
WEEK 10	16.10 ± 1.82	16.90 ± 0.89	15.90 ± 2.41	15.60 ± 0.96
WEEK 11	15.40 ± 1.85	16.46 ± 0.68	15.30 ± 2.23	15.80 ± 1.04
WEEK 12	16.10 ± 2.07	16.90 ± 1.03	15.80 ± 2.68	16.30 ± 1.10
WEEK 13	15.90 ± 2.20	17.14 ± 0.47	15.60 ± 2.82	16.20 ± 0.84
WEEK 14	16.20 ± 2.20	17.00 ± 0.71	16.38 ± 2.96	16.30 ± 1.30
Overall mean	16.87±1.85	17.56±0.94	17.03±2.20	16.70±1.21
Scrotal length				
WEEK 0	10.42 ± 0.89	10.24 ± 0.65	9.62 ± 1.11	9.60 ± 0.89
WEEK 1	8.90 ± 0.65	9.80 ± 1.15	9.60 ± 0.89	9.10 ± 0.89
WEEK 2	8.80 ± 0.84	9.10 ± 0.42	9.30 ± 0.98*	8.00 ± 1.00*
WEEK 3	8.40 ± 0.96	8.40 ± 0.96	9.10 ± 1.14	7.90 ± 0.96
WEEK 4	8.40 ± 0.89	9.30 ± 1.10	9.00 ± 1.00	8.30 ± 0.98
WEEK 5	8.10 ± 0.42	9.00 ± 1.12	9.20 ± 1.20	8.30 ± 0.76
WEEK 6	7.80 ± 0.76	8.80 ± 0.76	8.60 ± 1.19	8.10 ± 0.55
WEEK 7	7.60 ± 0.89	8.30 ± 1.10	8.10 ± 0.65	7.90 ± 0.74
WEEK 8	7.60 ± 0.89	8.46 ± 1.42	8.10 ± 0.89	7.60 ± 0.22
WEEK 9	7.70 ± 1.10	8.50 ± 0.79	8.20 ± 1.04	8.00 ± 0.35
WEEK 10	7.70 ± 1.15	8.50 ± 1.00	8.00 ± 1.00	7.90 ± 0.65
WEEK 11	7.70 ± 1.04	8.80 ± 0.91	8.10 ± 1.43	8.10 ± 0.22
WEEK 12	8.20 ± 1.89	8.20 ± 0.91	7.68 ± 1.50	7.50 ± 0.50
WEEK 13	7.40 ± 1.08	8.00 ± 0.94	7.54 ± 1.34	7.50 ± 0.5
WEEK 14	7.80 ± 1.15	8.30 ± 0.97	8.25 ± 1.55	7.70 ± 0.57
Overall mean	8.17 ± 1.19	8.78 ± 1.06	8.56 ± 1.23	8.10 ± 0.84

Testicular volume	**A (cm^3)**	**B (cm^3)**	**C (cm^3)**	**D (cm^3)**
WEEK 0	455.99±69.01	423.27±69.24	438.25±129.00	342.82±92.57
WEEK 1	438.03±70.22	478.80±74.70	457.72±114.80	408.86±84.83
WEEK 2	387.97±48.82	405.60±35.91	430.85±111.06	324.83±68.65
WEEK 3	352.65±72.23	358.20±47.49	412.76±111.44	300.30±66.27
WEEK 4	332.07±89.13	389.09±63.68	370.14±102.20	302.33±75.47
WEEK 5	303.85±64.87	371.47±53.62	367.21±112.68	320.44±47.66
WEEK 6	284.03±74.53	363.04±39.55	338.54±122.58	309.09±37.41
WEEK 7	272.31±89.56	324.40±59.01	299.75±82.22	288.48±49.94
WEEK 8	256.05±84.93	331.48±73.96	295.56±96.88	276.12±27.40
WEEK 9	271.27±102.55	324.50±48.66	296.18±108.34	281.22±39.53
WEEK 10	268.36±98.36	318.75±68.82	274.72±109.88	252.10±45.27
WEEK 11	245.43±93.15	311.73±53.90	260.51±116.69	263.85±34.33
WEEK 12	291.13±146.28	306.79±61.90	267.77±132.01	260.58±41.48
WEEK 13	254.39±106.12	306.88±50.56	256.72±130.87	257.26±38.42
WEEK 14	277.36±110.30	314.07±61.59	246.85±192.22	268.88±53.10
Overall mean	312.73±104.65	355.21±72.23	334.24±129.81	297.14±64.89
Testicular width	**A (cm)**	**B (cm)**	**C (cm)**	**D (cm)**
WEEK 0	9.16±0.68	8.89±0.62	9.26±0.81	8.21±0.72
WEEK 1	9.70±0.48	9.68±0.40	9.50±0.83	9.25±0.71
WEEK 2	9.20±0.27	9.25±0.25	9.35±0.78	8.80±0.64
WEEK 3	8.95±0.51	9.05±0.21	9.25±0.71	8.50±0.59
WEEK 4	8.65±0.78	8.95±0.21	8.80±0.78	8.30±0.67
WEEK 5	8.45±0.76	8.90±0.14	8.65±0.86	8.60±0.42
WEEK 6	8.30±0.72	8.90±0.14	8.55±1.04	8.56±0.49
WEEK 7	8.20±0.86	8.65±0.28	8.35±0.95	8.35±0.38
WEEK 8	7.95±0.82	8.65±0.22	8.25±0.97	8.35±0.38
WEEK 9	8.10±0.89	8.55±0.27	8.20±0.98	8.20±0.45
WEEK 10	8.05±0.91	8.45±0.45	7.95±1.20	7.80±0.48
WEEK 11	7.70±0.93	8.23±0.34	7.65±1.11	7.90±0.52
WEEK 12	8.05±1.04	8.45±0.51	7.90±1.34	8.15±0.55
WEEK 13	7.95±1.10	8.57±0.24	7.80±1.41	8.10±0.42
WEEK 14	8.10±1.10	8.50±0.35	6.55±3.89	8.15±0.65
Overall mean	8.43±0.93	8.78±0.47	8.40±1.47	8.35±0.61

Values in rows with different superscripts differ significantly (p<0.05)

Gonadal Sperm Reserves

Group B had the lowest cauda sperm reserve (148.25 ± 15.91/g of testis) and also testis sperm reserve at 22.50 ± 0.21/g of testis. The cauda sperm reserve P-value was 0.022, while that of the testes was 0.012. The overall gonadal sperm reserve revealed statistically significant differences (P < 0.05) between all the groups (Table 4).

Table 4: Mean ± SD Gonadal Sperm Reserves (GSR) of Red Sokoto bucks fed with graded levels of *Adansonia digitata* leaves

	GSR (x 10^6/g of testis)	
	Cauda	**Testis**
Group A (0g of *Adansonia digitata* leaves)	194.25 ± 48.44	28.00 ± 1.64
Group B (3g of *Adansonia digitata* leaves)	148.25 ± 15.91	22.50 ± 0.21
Group C (6g of *Adansonia digitata* leaves)	276.25 ± 30.05	28.50 ± 1.23
Group D (9g of *Adansonia digitata* leaves)	293.25 ± 7.43	25.25 ± 0.21

GSR= Cauda (P < 0.05); Testes (P < 0.05)

Discussion

In this study, the result of qualitative screening of *Adansonia digitata* leaves concurred with the findings of Namratha and Sahithi (2015) that reported the presence of similar phytochemical constituents, such as saponins and flavonoids, in *Adansonia digitata* leaves. The similarity can be due to the plant species and edaphic factors. The findings of this study are lower than the report of Ogwuegbu *et al.* (1985), who reported 21.1cm of scrotal circumference in Red Sokoto bucks. The difference can be attributed to the age and body weight of the Red Sokoto Bucks he used in his study (One (1) to three (3) years; 28.53 ± 7.38 kg) compared to this study. The changes in scrotal circumference revealed differences at week 0 between groups C and D, which can be due to their management system before purchase from the market. There was a decrease in scrotal circumference in all the groups over the 14 weeks, which can be attributed to the control feeding (3% of their body weight, including the *Adansonia digitata* leaves supplement). The findings in this study on scrotal length are similar to the findings of Abba and Igbokwe (2015), who reported 8.39±0.68 cm in Sahel goats, but lower than the findings of Raji *et al.* (2008), who reported 13.26 cm

in Red Sokoto bucks. The difference can be due to the body weight of the bucks used in the two studies. Group B had the highest mean scrotal length, which can be due to scrotal circumference and testicular volume (Abba and Igbokwe, 2015). The changes in scrotal length from weeks 0 to 14 elicit a decrease in the scrotal length. Similarly, in this study, the decreasing testicular volume difference observed between the groups can be due to the difference in their scrotal length and body weight. Group B had the highest mean testicular volume, which can be due to scrotal length. The mean testicular volume obtained in our study was higher than the findings of Amare and Kefelegn (2017), who reported an overall testicular volume of 68.1±6.18 cm^3 (67.1±6.77 in Afar; 69.8 ± 5.83 in long-eared Somali and 67.3 ± 5.92 in Woyto-Guji goats). The disparity can be attributed to the supplement, breeds, and formula used in the calculation of the testicular volume. This study revealed that the mean testicular width decreases between all the groups, which can be due to scrotal circumference, scrotal length, and testicular volume (Perumal, 2014) and the control feeding (3% of their body weight, supplement inclusive). In the GSR study, group B (3 g) revealed a decline in both cauda and testis GSR, possibly due to the inhibitory effect at this dose. Group C (6 g) shows a significant increase in cauda GSR over control, while Testis GSR was slightly higher than control and, therefore, balanced improvement without excessive variation. In addition, group D (9 g) revealed the highest cauda GSR, but the testis GSR is lower than that of group C. The smallest variation in cauda values suggests stability, but potential diminishing returns in testis sperm reserve. The findings of this study were lower than those of Daudu (1984), who reported a mean gonadal reserve of 45.64±7.87x10^9. This difference can be associated with testicular weight. The higher cauda sperm reserves in group D in this study can be due to sperm cell transit from the testes to the epididymis. Similarly, Group C shows a substantial increase in cauda and testis GSR, indicating better spermatogenic activity and sperm maturation. It also avoids the testicular GSR drop seen in Group D (9 g), suggesting that excessive dose might impair testicular reserves. Therefore, it gives a balanced benefit without potential toxicity at higher doses. The findings of our study are similar to those of Raji *et al.* (2014), who reported that a 50% level of Moringa oleifera leaf supplement in a diet can enhance gonadal sperm reserves in Red Sokoto bucks. The similarities can be attributed to the anatomical location of the sperm samples collected.

CONCLUSION

The study concluded that feeding graded levels of *Adansonia digitata* leaves at 3, 6, and 9 g/h/day to RSB may compromise their scrotal circumference, scrotal length, testicular volume, and testicular width but increase their mean gonadal sperm reserve. Group C (6 g of *Adansonia digitata* leaves/h/day) optimally enhances sperm reserves in both testis and cauda, which indicates improved male reproductive potential. Based on the findings of this research, we recommend the extraction of antioxidants such as vitamin A, C and E content of *Adansonia digitata* leaves to study their effects on other testicular parameters.

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REFERENCES

Abba, Y. and Igbokwe, I. O. (2015). Testicular and Related Size Evaluations in Nigerian Sahel Goats with Optimal Cauda Epididymal Sperm Reserve. *Hindawi Publishing Corporation Veterinary Medicine International,* 3(57): 519.

Adeyeye A.A., Muhammad B.I., Adamu U. (2020) Reproductive performance and its associated factors in cows raised in Sokoto. *Nigeria Journal of Agriculture and Environment*, 16(2):35–42.

Agriculture (2019). *Goat.* Available at: https://agriculturenigeria.com/farming-production/livestock/goat. Accessed on 27/9/2019, 9:28 a.m.

Ajani, S.O., Oyeyemi, M. O. and Olusoji, J. M. (2015). Correlation between age, weight, scrotal circumference, and the testicular and epididymal parameters of Red Sokoto bucks. *Journal of Veterinary Medicine and Animal Health*, 7(5): 159-163.

Akpa, G. N., Alphonsus, C., Duru, S. and Abdulrashid, M. (2006). Factors affecting body size and horn length in smallholder rams. *Savannah Journal of Agriculture,* 1 (2):130-137.

Amare, E. G. and Kefelegn, W. (2017). Body weight and scrotal-testicular biometry in three indigenous breeds of bucks in Arid and semi-arid Agroecology, Ethiopia. *Hindawi Journal of Veterinary Medicine*, https://doi.org/10.1155/2017/5276106.

AOAC (1990): *Official methods of analysis, Association of Official Analytical Chemists,* 15th edition, Washington, D.C., USA. Pp. 807-928.

Babatunde, D. J., Tope, O. O., Fidelis, O. E., Enevwo, O. G., and Olugbenga, E. (2021). Aqueous Extract of *Adansonia digitata* reversed Cotton Seed Extract-Induced Testicular Damage in Wistar rats. *JBRA Assisted Reproduction*, 25(2): 257–265.

Bawa, G. S., Tegbe, T. S. B., Ogundipe, S. O., Dafwang, I. I. and Abu, E. A. (2003). The effect of the duration of cooking lablab seeds on the level of some anti-nutritional factors. In: Ogundipe, S. O., Dafwang, I. I., Abu, E. A. and Bawa, G. S. (eds.), *28th Proceedings of the Annual Conference of the Nigeria Society for Animal Production (NSAP)*, held in Ibadan, 16–20th March 2003. Pp. 213–215.

Daudu, C. S. (1984). Spermatozoa output, testicular sperm reserve, and epididymal storage capacity of the Red Sokoto goats indigenous to northern Nigeria. *Theriogenology*, 21(2): 317–324.

Hunter, N. (2018). *Feeding Program for Dairy Goats - Hunter Nutrition.* Available at:

www.hunternutrition.com/goatfeedingprogram.html. Accessed on 30/6/2018, 6:27 pm.

InVivoStat (2016). InVivoStat statistics software package version 3.7.0.0 for Windows, UK. Available at: www.invivostat.co.uk

Jamie, N. H. (2016). *Too Much of a Good Thing*, Kansas State Veterinary Diagnostic Laboratory, Available at: https://www.bovinevetonline.com/article/too-much-good-thing. Accessed on 12/04/2019

Kenneth, C., Jean, W., Douglas, W. K., and Stewart, A. T. (2019). *Human nutrition*, Encyclopedia Britannica, available at: https://www.britannica.com/science/human-nutrition. Accessed on 12/04/2019.

Latlong, N. (2018). Sokoto, Nigeria. Available at: https://www.latlong.net/place/sokoto-nigeria-21027.html. Accessed on 21/10/2018.

Namratha, V., and Sahithi, P. (2015). Baobab: A review of "The Tree of Life". *International Journal of Advanced Herbal Science and Technology*, 1(1): 20.

Ogwuegbu, S. O., Oke, B. O., Akusu, M. O. and Aire, T.A. (1985). Gonadal and extragonadal sperm reserves of the maradi (Red Sokoto) goat. *Bulletin of Animal Health and Production,* 33(2): 139-141.

Okoli, I. C., Ebere, C. S., Uchegbu, M. C., Uddah, C. A. and Ibeaewuchi, I. I. (2002). Survey of the diversity of plants utilised for small ruminant feeding in southeastern Nigeria. *Agriculture Ecosystem and Environment*, 45(6): 25–29.

Perumal P. (2014). Scrotal Circumference and Its Relationship with Testicular Growth, Age, and Body Weight in Tho Tho (Bos indicus) Bulls. *International scholarly research notices*, https://doi.org/10.1155/2014/249537.

Poppi, D. P. and McLennan, S. R. (1995). Protein and Energy Utilisation by Ruminants at Pasture. *Journal of Animal Science*, 73(1): 278–290.

Raji, A. O., Igwebuike, J. U. and Aliyu, J. (2008). "Testicular biometry and its relationship with body weight of indigenous goats in a semi-arid region of Nigeria," *ARPN. Journal of Agricultural and Biological Science*, 3(4): 6–9.

Raji, A. Y., & Njidda, A. A. (2014). Gonadal and extra-gonadal sperm reserves of the Red Sokoto goats fed Moringa oleifera supplemented diets. *International Journal of Agriculture and Biosciences, 3*(2), 61–64

Rekwot, P. I., Oyedipe, E. O., and Ehoche, O. W. (1994). The effects of feed restriction and re-alimentation on the growth and reproductive function of *Bokoloji* bulls. *Theriogenology*, *42*(2): 287-295.

Sakamoto, H., Katsuyuki, S., Michiya, O., Katuki, I., Yoshio, O. and Hideki, Y. (2008). Testicular Volume Measurement: Comparison of Ultrasonography, Orchidometry, and Water Displacement. *Urology*, 69(1): 152-157.

Tibbo, M. (2006). Productivity and health of indigenous sheep breeds and crossbreds in central Ethiopian Highlands. A Doctoral dissertation, Swedish University of Agricultural Sciences.

Workneh, A. (2000). Do smallholder farmers benefit more from crossbred (Somali× Anglo-Nubian) than from indigenous goats? A Doctoral dissertation submitted to Georg-August University of Goettingen.

World Weather Online (2025). *Sokoto Annual Weather Averages*. Available at: https://www.worldweatheronline.com/sokoto-weather-averages/sokoto/ng.aspx. Retrieved on 11/5/2025.