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Research Article
Evaluation of Body Morphometry of Uda Rams Under Different Housing Types and Seasons in a Semi-Arid Region, Nigeria

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Abstract

Background and Objectives: Linear body measurements are vital when examining relationships between economic characteristics and reproductive performance because of the interactions between heredity and the environment in several animals. A study was conducted at the Usmanu Danfodiyo University, Sokoto, Livestock Teaching and Research Farm to evaluate the effects of housing type and season on the performance and some physiological parameters of Uda rams. **Materials and Methods:** A total of sixty (60) yearling Uda rams were used in the study with twenty (20) rams in each season. Factorial completely randomised design (3×5) was used in this experiment with animals (4) representing replicates while housing types (5) and season (3) representing the factors (treatments). Four animals were allotted to each housing type with each animal serving as replicate, the housing types were half wall with zinc roofing (HZ), the half wall with thatch roofing (HT), the full wall with zinc roofing (FZ), the full wall with thatch roofing (FT) and finally natural without wall and roofing (N). Data were collected each season on body morphometric and linear measurements. **Results:** The result shows significant ($p<0.05$) variation among the housing type with regards to change in BL, HG, SL, TWT and TV. There was no significant variation ($p>0.05$) observed with regards to the season in terms of initial SC and final SL. **Conclusion:** Animals housed in the half wall with thatch had significantly higher, Testicular Weight (TWT) and better and testicular volume and were higher during the rainy season.

Key words: Uda rams, housing, season, scrotal length, heart girth, testicular volume, body length

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Linear body measurements have been used in animals to estimate body weight and the price of sheep in open markets[1]. linear body measurements are vital when examining relationships between economic characteristics and reproductive performance because of the interactions between heredity and the environment in several animals[2,3]. This method of evaluating livestock is especially important in rural communities where weighing scales are not conveniently available[4,5]. Some of the body linear measurements studied by various authors in livestock were neck length, back length, height at wither, loin girth, chest girth and leg length[5-7]. It was reported on the use of skeletal dimensions such as shoulder width, heart girth and height at withers as good indicators of live weight and condition score[3]. Simple linear measurements that can reliably predict body weight without the use of weighing scales[2]. Linear measurements together with live body weight were influenced significantly by breed, age and sex of the animal[7]. Information on body morphometry of sheep breeds mainly found in northern Nigeria is lacking. However, some authors have studied the relationship between linear body size and live weight in Nigerian West African dwarfs and Yankasa sheep[1,2,4]. Yet none of the authors determines the effect of season and different housing systems on body morphometric of Uda rams.

This study evaluates determine the effect of housing system and season on scrotal and body morphometric and of Uda rams. The study conclude that animals housed in the half wall with thatch had significantly higher, testicular weight (TWT) and better and testicular volume and were higher during the rainy season. The study concludes that there is an interaction between season and housing system on body morphometric.

MATERIALS AND METHODS

Experimental site: The study was conducted at the Teaching and Research Farm of the Department of Animal Science of Usmanu Danfodiyo University, Sokoto, Nigeria from March, 2018 to February, 2019. The teaching and research farm lies at longitude 5°27"E and latitude 13°08"N, it was situated at altitude 266 m above sea level, the readings were obtained using GNSS viewer software for androids (Mamman *et al*., 2000) (Mamman *et al*., 2000). The average annual ambient temperature is 28.3°C (82.9°F). However, the daily maximum temperature for most of the year is typically below 40°C (104.0°F). Sokoto's low humidity makes it tolerant of heat. Although the state is hotter in March and April, the state's weather is always cold in the mornings and hot in the afternoons, except during Harmatan[9]. The rainy season starts from late May to October. Rain starts late and ends early, with annual precipitation ranging from 500-1200 mm[9]. The state has two main seasons, wet and dry. The dry season starts in October and lasts until April and can last until May or June. On the other hand, in most of the states, the rainy season starts in May and lasts until September or October[8].

Experimental design: A factorial design (3×5) was used in this experiment with the number of animals representing replicates while housing types and season representing the factors (treatment combination). Four animals were allotted to each housing type with each animal serving as a replicate. The weight of the animals was balanced between treatments. Five housing types were used; full wall with zinc roofing (FZ), the full wall with thatch roofing (FT), the half wall with zinc roofing (HZ), the half wall with thatch roofing (HT) and without walls and shade (N). The FZ, FT, HZ, HT and N environments received 4 animals each.

Three studies, one each in a defined season was carried out to determine the effect of housing on performance and some physiological responses of Uda rams during different seasons. Season 1 (hot season) from March to June, here there is high temperature and low humidity, the temperature may reach up to 41°C during the day, there is no rain usually, but we experience little drop during the last month of the period. Season 2 (wet season) from July to October, this season is characterised by low temperature and high humidity, it is the main season for vegetative growth, low temperature of 25°C and humidity may reach up to 85% and season 3 (cold season), from November to February, when the growth of vegetation stops, there is a low temperature (value) and low humidity.

Experimental animals and their management: Twenty yearling rams aged by dentition in each season were used in this experiment, the animals were purchased from local markets around Sokoto state[9]. The healthy sheep were quarantined at the Livestock Teaching and Research Farm for 14 days for adaptation to the new environment. The animals were diagnosed with possible infection or disease and treated before the commencement of the experiment. The feeding pens were cleaned regularly so also the feeding and water troughs every morning before feeding. The gross composition of the experimental feed is presented in Table 1.

Table 1: Gross composition of the experimental diet

Ingredients (%)	Diet
Maize	17.00
Wheat offal	20.2
Cowpea husk	7.60
Cowpea haulms	17.20
Rice offal	12.45
Cotton seed cake	42.0
Salt	0.5
Total	100
Calculated chemical composition	
Energy (Kcal kg^{-1})	2514
Crude protein (%)	14
Crude fibre (%)	22.1

Data collection

Measurements of body morphometric features: Measurement of linear (centimetres (cm)) conformation traits were taken at the beginning of experiments using flexible tape and subsequently on a weekly basis[10,11]. The traits are described as follows.

Heart girth (HG): This is the circumference of the body at a point immediately behind the forelimbs and perpendicular to the body axis.

Body length (BL): This was measured from the point of the shoulder to the ischium.

Reproductive parameters

Scrotal morphometric: Testicular traits were measured on weekly basis. The testicular length was measured with a flexible tape in cm as the distance along the caudal surface of the scrotum from its point of attachment to the tip of the scrotum. Testicular circumference was taken as the maximum dimension around the pendulous scrotum[12]. Testicular width was obtained by dividing the scrotal circumference by 2, testicular weight was obtained from the following formula:

$$TWT = 0.5533 \times TL \times TW^2$$

Where:
TWT = Testicular weight
TL = Testicular length
TW = Testicular width and 0.5533 is constant

So also the testicular volume was obtained from the formula:

$$TV = 1/6 \times \pi \times TL \times TW \times 0.945$$

Where:
TV = Testicular volume
TL = Testicular length
TW = Testicular width

Statistical analysis: The data generated were subjected to analysis of variance with season and housing as the independent variables (Steel and Torrie, 1980), to determine their effects on other parameters, the interaction of season vs. housing was obtained. Duncan's Multiple Range Test (DMRT) was used to express the difference between treatment means each.

RESULTS

Effect of housing on the body and testicular morphometric of uda rams during hot, rainy and cold seasons: Results indicated that during the hot season (Table 2) there is variation ($p<0.05$) in all the parameters (Initial BL, change in BL, initial, final and change in HG, final SL, change in SL, final TWT and final TV) measured except scrotal circumference measurements, final body length and initial scrotal length. Animal placed on HT had significantly ($p<0.05$) higher values of initial BL compared to rams placed in N and FT, while those on N and HT had a lower change in BL. The only difference ($p<0.05$) in terms of initial and final HG is between animals on N and those on HZ. The results showed animals on HT had higher ($p<0.05$) values of change in HG, final and change in SL. The only difference ($p<0.05$) observe in terms of TWT and TV is between animals on HT and those on N.

There was significant ($p<0.05$) variations on change in BL, HG and SL, final HG, final SL, TWT and TV during the rainy season. Animals on HT and HZ had significantly ($p<0.05$) higher values of change in BL and HG compared to those on other treatments (Table 3).

In the cold season, initial HG, SC, SL, final SL and gain in SL showed no significant ($p>0.05$) variations. Animals placed on FT had significantly ($p<0.05$) higher values of all the morphometric traits measured. The only difference ($p<0.05$) for final SC is between animals placed in FZ and those placed in HZ, but for final HG was between animals in FT and those in FZ. Animals placed on FT had higher TWT and TV compared to those in HT and HZ (Table 4).

Main (overall) and interaction effect of housing types and seasons on morphometric indices of Uda rams: The interaction and main effect results were presented in Table 5 and 6. There was significant ($p<0.05$) variation among the housing type with regards to change in BL, HG, SL, TWT and TV. There was no significant variation ($p>0.05$) observed with regards to the season in terms of initial SC and final SL. Change

Table 2: Effect of housing types on the body and scrotal morphometric of Uda rams in the hot season

	Housing type					
Parameters (cm)	N	HT	HZ	FT	FZ	SEM
Initial BL	50.90^{a}	54.55^{a}	52.07^{ab}	51.75^{b}	53.03^{a}	0.87
Final BL	52.71	56.58	56.89	56.54	58.97	2.19
Change in BL	1.81^{b}	2.03^{b}	4.80^{a}	4.79^{a}	5.94^{a}	0.35
Initial H	71.62^{a}	63.31^{ab}	60.17^{b}	64.50^{ab}	69.28^{ab}	3.08
Final HG	77.47^{a}	77.47^{a}	70.01^{b}	73.04^{ab}	75.57^{ab}	2.22
Change in HG	5.85^{d}	14.16^{a}	9.84^{b}	8.54^{bc}	6.29^{cd}	0.87
Initial SC	15.41	15.30	15.37	16.00	15.62	2.26
Final SC	20.96	20.95	20.04	20.04	20.77	1.93
Change in SC	5.25	5.65	5.67	5.03	4.14	0.61
Initial S	10.99	11.75	13.84	12.83	11.11	1.45
Final SL	13.65^{c}	18.73^{a}	17.46^{ab}	18.09^{ab}	15.87^{bc}	0.87
Change in SL	2.67^{c}	6.99^{a}	3.62^{bc}	5.27^{ab}	4.76^{abc}	0.86
Final TWT (g)	829.50^{b}	1127.12^{a}	969.93^{ab}	1004.93^{ab}	947^{ab}	97.31
Final TV (cm^{3})	71.17^{b}	97.60^{a}	87.03^{ab}	90.17^{ab}	81.99^{ab}	6.81

^{a,b,c}Means in the same row with different superscripts are significant (p<0.05) different, N: Without shade and walls, HT: Half wall with thatch, HZ: Half wall with zinc, FT: Full wall with thatch, FZ: Full wall with zinc, BL: Body length, HG: Heart girth, SL: Scrotal length, SC: Scrotal circumference, TV: Testicular volume and TWT: testicular weight

Table 3: Effect of housing types and season on body testicular morphometric of Uda rams in the rainy season

	Housing type					
Parameters (cm)	N	HT	HZ	FT	FZ	SEM
Initial BL	55.75	55.50	55.00	57.00	56.00	0.87
Final BL	60.00	60.75	60.23	60.75	60.00	0.99
Change in BL	4.25^{b}	5.25^{a}	5.23^{a}	3.75^{b}	4.00^{b}	0.32
Initial HG	73.50	74.00	71.00	74.50	74.75	1.53
Final HG	84.00^{ab}	87.27^{a}	83.75^{b}	85.75^{ab}	85.25^{ab}	1.09
Change in HG	10.50^{b}	13.25^{a}	12.75^{a}	11.00^{b}	10.50^{b}	0.57
Initial SC	15.25	15.50	14.00	14.50	16.00	0.85
Final SC	25.27	25.50	25.00	25.21	23.50	0.96
Change in SC	10.02	10.00	11.00	10.75	7.50	1.34
Initial S	8.00	6.63	8.25	6.50	7.75	0.66
Final SL	18.75^{a}	18.50^{a}	16.25^{b}	16.75^{ab}	17.75^{ab}	0.72
Change in SL	10.75^{ab}	11.89^{a}	8.00^{b}	10.25^{ab}	10.00^{ab}	0.98
Final TWT (g)	1653.58^{b}	2203.67^{a}	1404.83^{bc}	1471.35^{bc}	1355.92^{c}	91.62
Final TV (cm^{3})	117.76^{b}	155.40^{a}	100.99^{c}	104.16^{bc}	103.76^{bc}	5.43

^{a,b,c}Means in the same row with different superscripts are significant (p<0.05) different, N: Without shade and walls, HT: Half wall with thatch, HZ: Half wall with zinc, FT: Full wall with thatch, FZ: Full wall with zinc, BL: Body length, HG: Heart girth, SL: Scrotal length, SC: Scrotal circumference, TV: Testicular volume and TWT: Testicular weight

Table 4: Effect of housing types and season on body testicular morphometric of Uda rams in the cold season

	Housing type					
Parameters (cm)	N	HT	HZ	FT	FZ	SEM
Initial BL	54.50^{ab}	52.25^{b}	56.00^{a}	56.50^{a}	55.50^{a}	0.77
Final BL	59.75^{cd}	57.25^{d}	60.00^{bc}	63.00^{a}	62.50^{ab}	0.85
Change in BL	5.25^{ab}	5.00^{ab}	4.00^{b}	6.50^{a}	6.50^{a}	0.45
Initial HG	70.25	70.25	68.00	70.75	70.00	1.69
Final HG	86.75^{ab}	85.50^{ab}	84.50^{ab}	87.75^{a}	83.00^{b}	1.37
Change in HG	16.50^{a}	13.25^{a}	16.50^{a}	17.00^{a}	13.00^{b}	0.59
Initial SC	14.00	11.00	10.75	14.00	13.00	1.29
Final SC	16.75^{b}	18.25^{ab}	20.13^{ab}	22.25^{a}	20.50^{ab}	1.69
Change in SC	2.750^{c}	7.25^{b}	10.38^{a}	8.25^{ab}	7.50^{b}	0.94
Initial S	7.50	7.00	6.88	6.25	6.25	0.69
Final SL	17.50	16.50	16.50	17.75	17.00	0.64
Change in SL	10.00	9.50	9.63	11.00	10.75	0.84
Final TWT (g)	679.15^{c}	760.17^{bc}	924.85^{bc}	1215.51^{a}	988.23^{ab}	87.01
Final TV (cm^{3})	72.91^{b}	74.90^{b}	82.62^{ab}	98.24^{a}	86.69^{ab}	6.70

^{a,b,c}Means in the same row with different superscripts are significant (p<0.05) different, N: Without shade and walls, HT: Half wall with thatch, HZ: Half wall with zinc, FT: Full wall with thatch, FZ: Full wall with zinc, BL: Body length, HG: Heart girth, SL: Scrotal length, SC: Scrotal circumference, TV: Testicular volume and TWT: Testicular weight

Table 5: Main effect of housing type and season on the body and scrotal morphometric of Uda rams

	Housing types					
Parameters (cm)	N	HT	HZ	FT	FZ	SEM
Initial BL	53.72	54.10	54.36	55.08	54.85	0.79
Final BL	57.49	58.19	59.05	60.10	60.49	1.48
Change in BL	8.77^{b}	4.09^{b}	4.69^{ab}	5.02^{a}	5.64^{a}	0.33
Initial HG	71.79	69.19	66.39	69.92	71.34	2.31
Final HG	82.74	83.41	79.42	82.18	81.27	1.68
Change in HG	10.95^{bc}	14.22^{a}	13.03^{ab}	12.26^{abc}	9.93^{c}	0.81
Initial SC	14.89	13.93	13.37	14.83	14.87	1.39
Final SC	20.99	21.57	21.72	22.50	21.59	1.61
Change in SC	6.10	7.64	8.35	7.37	6.72	0.84
Initial SL	9.50	9.58	10.57	8.53	8.37	0.86
Final SL	16.63	17.91	16.64	17.53	16.87	0.76
Change in SL	7.13^{ab}	8.33^{ab}	6.07^{b}	9.00^{a}	8.50^{ab}	0.83
Final TWT (g)	1054.08^{b}	1366.99^{a}	1099.87^{b}	1230.60^{ab}	1097.05^{b}	98.3
Final TV (cm^{3})	87.28^{b}	109.3^{a}	90.21^{b}	97.52^{ab}	90.81^{b}	6.01
	Seasons					
	Hot season	Wet season	Cold season			SEM
Initial BL	52.46^{b}	55.85^{a}	54.95^{a}			0.84
Final BL	56.34^{b}	60.35^{ab}	60.50^{a}			1.34
Change in BL	3.87^{b}	5.50^{ab}	5.45^{a}			0.37
Initial HG	67.78^{b}	73.55^{a}	69.85^{a}			2.1
Final HG	74.71^{b}	85.10^{a}	85.50^{a}			1.56
Change in HG	8.94^{c}	11.60^{b}	15.25^{a}			0.65
Initial SC	15.54	15.05	12.55			1.47
Final SC	20.55^{ab}	24.89^{a}	19.58^{b}			1.53
Change in SC	5.15^{b}	9.85^{a}	7.23^{ab}			0.96
Initial SL	12.10^{a}	7.43^{b}	6.78^{b}			0.93
Final SL	16.67	17.60	17.05			0.74
Change in SL	4.66^{b}	10.18^{a}	10.28^{a}			0.89
Final TWT (g)	977.70^{b}	1617.87^{a}	913.58^{b}			91.98
Final TV (cm^{3})	85.59^{b}	116.41^{a}	83.07^{b}			6.31

^{a,b,c}Means in the same row with different superscripts are significant (p<0.05) different, N: Without shade and walls, HT: Half wall with thatch, HZ: Half wall with zinc, FT: Full wall with thatch, FZ: Full wall with zinc, BL: Body length, HG: Heart girth, SL: Scrotal length, SC: Scrotal circumference, TV: Testicular volume and TWT: Testicular weight

Table 6: Interactive effect of housing type and season on the body and scrotal morphometric of Uda rams

	Interactive effect of housing type/season
Parameters	Level of significant
Initial BL	*
Final BL	**
Change in BL	*
Initial HG	*
Final HG	*
Change in HG	*
Initial SC	***
Final SC	**
Change in SC	**
Initial SL	***
Final SL	NS
Change in SL	*
Final TWT (g)	*
Final TV (cm^{3})	NS

BL: Body length, HG: Heart girth, SL: Scrotal length, SC: Scrotal circumference, TV: Testicular volume, TWT: Testicular weight, NS: Not significant, *p<0.05, **p<0.01 and ***p<0.001

in HG was higher in HT and lower in FZ. There was a significant difference (p<0.05) observed with regards to change in BL between animals housed in FT and FZ and those in N and HT. With regards to change in SL, the only difference (p<0.05) observed is between animals on FT and those on HZ. Final TWT and TV was higher for animals in HT compared to those in HZ, N and FZ. Concerning seasons, significantly (p<0.05) lower measurements were observed for all the parameters except initial SL and final SC. There were significantly higher measurements in the rainy season except for gain in HG and initial SL. All the parameters measured in the cold season are significantly (p<0.05) higher except for final SC, initial SL, final TWT and TV.

That there was a significant interaction between housing and season for all the parameters except final scrotal length and scrotal volume. A higher significant interaction was found in initial scrotal circumference and length.

DISCUSSION

The result shows significant ($p<0.05$) variation in body morphometry with regards to housing types. Seasonal variations also exist, except in final scrotal length, the results shows that the body morphometry of Uda is higher during the rainy and cold season compared to the hot season. There is significant interaction between housing and season on the body morphometry of Uda rams. The results of body measurement in this study were higher than previous results in animals of the same age[13]. The relationship between morphological measurements provides a rough explanation of animal production and breed characteristics. Linear body measurements and weight reflect animal breed characteristics and rearing conditions. Animals can exhibit different growth rates so that they can be reared under different controlled conditions. Non-variations between several parameters (initial body length, changes in scrotal perimeter and final pericardial length) may be due to the animal's balance in terms of body weight, it affected the morphometry of the body and scrotum. This is because scrotal morphometry is positively correlated with the age and bodyweight of animal[14]. There is not much variation with body and scrotal morphometric with regards to housing types, but testicular volume, heart girth gain and testicular weight are better in animals placed in HT. This could be due to the level of comfort in HT. There is a strong relationship between stress and body weight which in turn affects the body measurements, the variation may be due to management conditions (housing types) but the balances or ratios between body parts cannot change[13,15]. These differences might be explained by the changes in fat deposition due to feeding and management status based on especially seasonal changes[16]. Additionally, butchers based on this fact (there are strong relationships and balance between animal body parts) say that total carcass weight equals tenfold forearm weight and they have been used to determine carcass weight for a long time[16].

The scrotal morphometric are lower in the cold season compared to the hot and rainy season this may be as a result of contraction of the tissues around the testicles to avoid excess removal of heat to the surroundings to maintain thermoregulation within the testicle[17]. The heart girth, body length a scrotal morphometric being lower during the hot season may also be due to average body weight during the experiment because in the rainy and cold season animals have a higher average weight than in the hot season. There was no variation in other parameters to the housing type except for the change in heart girth and scrotal length, testicular weight and testicular volume. This could be due to the lower level of stress experienced by the animals shown by their performance. The values obtained for scrotal circumference is higher than 23.8, 22.9, 20.8 and 23 cm for the Romney Marsh, Mora Colombian, Creole and Hampshire breeds, respectively[18]. In the present study, testicular volume was between 87.28-109.30 cm^3 across housing types and 83.07-116.41 cm^3 across seasons which is slightly lower than previous studies where 117.23-141.77 cm^3 was reported for Uda rams[19]. The values were higher than the obtained when evaluating the testicular characteristics of Ile de France x Akkaraman rams[20]. The study recommends well-ventilated housing (half wall with either thatch or zinc roofing) should be adopted for fattening Uda rams. Farmers should endeavour to put in place adequate management measures to mitigate the effect of environmental heat stress on intensively managed sheep in the semi-arid tropics to enhance production performance. Some of the limitations are only one breed and sex was involved in the study.

CONCLUSION

Animals housed in the half wall with thatch had significantly higher, testicular weight (TWT) and better and testicular volume and were higher during the rainy season. The study concludes that there is an interaction between season and housing system on body morphometric.

SIGNIFICANCE STATEMENT

This study discovers a strong interaction between microclimate were the animal leaves with its body morphometry. The knowledge of variation in morphological traits is the first step in the characterization of local genetic resources. It was a fact that an animal phenotypic appearance, it's a combination of its genes and the environment where it leaves. Most of the studies on linear measurement are tailored towards the genetic aspect with little regard to the environmental aspect of it. Thus this is what this study brings forward.

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