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Testicular Morphometric Measurements and Their Relationship with Heart Girth in Red Mbororo Bulls

N. K. Alade*, J. U. Igwebuike and M. Y. Kida

Department of Animal Science, Faculty of Agriculture, University of Maiduguri,
P. M. B. 1069, Maiduguri, Nigeria

ABSTRACT

Records of heart girth (HGT) and testicular morphometric measurements (testicular weight, tunica albuginea weight, caput weight, corpus weight, cauda weight, epididymal weight and ductus deferens weight) (TMM) were obtained in dry and wet seasons from twenty (20) matured Red M "Bororo" bulls to determine the relationship between HGT and TMM and, to check the effect of season on the TMM. The results showed that correlation between HGT and Testicular weight was highly significant ($p<0.01$) while, correlations between HGT and other TMM were significant ($p<0.05$). Among all TMM, testicular weight was the best predicted by HGT ($R^2 = 0.608$). Seasonal variation affected TMM with higher measurements obtained in the wet season. Season could therefore be assumed to be a source of variation of fertility in bulls while, HGT could be assumed to be a good indicator of sperm production.

Key words: Testicular, measurements, heart girth, bull

INTRODUCTION

In any livestock breeding system, fertility of the male is crucial to successful breeding for high pregnancy rate. The factors that influence bull fertility are: sperm cell output, normal male reproductive tract, physical normality of the bull, percent normal sperm cells produced, general structural soundness and health, libido, social interactions between bulls, age of the bull, body condition of the bull and nutrition (Whittier and Bailey, 2000).

To help eliminate reproduction losses due to poor fertility, bull should be evaluated for breeding soundness, 30-60 days prior to the breeding season (Robert, 1994). Testicular weight is a reliable indicator of fertility in male and, together with the other variables, scrotal circumference and testicular size can be used to select sires for breeding and improvement programme since testicular development is related to sperm production (Amann, 1970) as well as sperm output and semen quality (Almquist *et al*., 1976).

Heart girth is another trait that can be selected for improving reproductive performance (Gilbert *et al*., 1993). It is a reliable estimate of body weight (Afolayan *et al*., 2006) and there is significant relationship between testicular weight and body weight (Mekasha, 2007). It therefore provides a reliable estimate of testicular weight in a situation where weighingbridges are not available for measuring body weight (Buvanendran *et al*., 1980; Goonerwardene and Sahaayuraban, 1983).

In the literature (Oyeyemi and Ubiogoro, 2005; Bitto and Eghunike, 2006), body weight had been reported to have significant positive relationship with testicular morphometric measurents and, is therefore accepted as a reliable indicator of fertility. However, knowledge of the relationship between heart girth and testicular morphormetric measurements is equally important since weighing bridges are increasingly expensive and unaffordable to local farmers in the rural areas where we have the largest population of livestock.

The objectives of this study were, therefore, to determine the relationship between heart girth and testicular morphometric measurements and find out how testicular morphometry measurements are influenced by season in a semi arid environment.

*Author for correspondence

MATERIALS AND METHODS

Location, vegetation and climate of study area

The study was conducted at Maiduguri, Borno state Nigeria. Maiduguri is located within the sahelian (semi-arid) region of Africa on the latitude $11^0.38^1$N and longitude is $32^0.17^1$E at an altitude of 354 m above sea level.

Maiduguri falls within this Sahel region which is characteristicted by short raining season (June-September) and a long dry season (October - June) (Fada and Rayar, 1988). Relative humidity and temperature of the area during the dry season are 5-10% and 39.8^0C - 40.7^0C, respectively while the corresponding values for wet season are 45% and 31.0^0C (Alaku, 1983).

The typical Sahel savannah vegetation is predominant in the area. The few scattered trees found are mostly the Neem trees (*Azakdarata indica.*), Baobab (*Adasonia digitata*), and Gum Arabic (*Acasia senegal*) The most predominant plants are shrubs and thorny bushes. Grasses are the very short varieties that complete their life cycle within the three month of rainfall.

Data collection and analysis

Morphometric measurements were carried out on forty (40) testicles (left and right) from twenty (20) matured Red M "Bororo" bulls during the hot and the wet season (10 animals per season) of the year. The samples were collected from the Maiduguri abattoir in Borno State, Nigeria.

The testes, collected after slaughter, were placed in a cooler to maintain temperature to avoid deterioration in the hot weather condition. The testes, epididymis and ductus deferens were dissected out using razor blade and carefully trimmed free of adhering fat and connective tissues for morphometric analysis.

The testicles, tunica albuginea and epididymis (caput, corpus and cauda) were weighed in grammes (g) using electronic meter weighing balance. The heart girth of each animal was measured in centimeter (cm) prior to slaughter using a cloth measuring tape.

Analysis of the least squares means for the effect of season and differences between right and left measurements were conducted using analysis of vaiance of General Linear Model of SPSS (2006) using the following model:

$$Y_{ijk} = U + Y_i + S_j + E_{ijk}$$

where, Y_{ijk} = observation of an individual with i^{th} testicle collected in j^{th} season.
U = Overall mean
Y_i and S_j are fixed effects of i^{th} testicle (i= 1,2) of the jth season (j= 1,2).
E_{ijk} = random error.

Correlation coefficients were calculated between heart girth, testicular and epididymal measurements. Regression analysis was carried out by regressing heart girth on the mophormetric measurements using the following equation:

$$Y = a+bx$$

where, Y= Testicular morphometric measurement
x = Heart girth
a = Intercept of the regression line
b= Regression coefficient

RESULTS AND DISCUSSION

Testicular morphometric measurements

Table 1 shows least square means of right and left testicular morphometric measurements. The overall values recorded for epididymal weight (30.23 g), caput epididymal weight (11.04 g), corpus epididymal weight (3.28 g) and cauda epididymal weight (7.24 g) are comparable to corresponding values (32.0 g, 12 g, 3.9 g and 6.237 g) reported for Boron bulls by Tegegne *et al*. (1992). They are however lower than those [caput weight (29.84 g), corpus weight (10.68 g) and cauda weight (80.8 g)] reported by Egbunike and Elemo (1978) among crosses of European boars raised and maintained in the tropics . The results of this study show that similar corpus plus caput weight (14.6 vs.14.316 g)but higher caudal weight (9.1 g vs. 7.237 g) were reported by Coulter *et al* (1987) in Angus bulls.

Although the average testicular weight recorded (173.18 g) was higher than the value (128 g) recorded by Wildeus and Entwistle (1983) in Bos indicus cross bulls, it is lower than a range of 182 - 242 g reported by Igboeli and Rakha (1971) and Aire and Akpokoje (1975) in pubertal Bos indicus bulls. It is also lower than 223 g and 247 g reported for Hereford and Angus bulls respectively by Lunstra *et al* (1978). Paired epididymal weight (33.8g) for Angus and Hereford bulls reported by Coulter *et al* (1988) is similar to average epididymal weight (30.24g) in this study. Breed is one of the factor that influence testicular and seminal traits in domestic animals (Karagiannidis

et al., 2000) and breed differences in paired testes weight is responsible for differences in daily sperm production in Angus and Hereford breeds of cattle (Coulter *et al*., 1987). Effect of breed on testicular characteristics is due to weight differences. Large breeds are heavier and have large testicular measurement than small breeds (AlGalban *et al*., 2004). Coulter and Foote (1975) also noted that bull testis weight was influenced by age.

Table 1: Least squares means(g ± SE.) of right and left testicular morphometric measurement in bulls

Variable	Right	Left	Combined
Testicular weight (TWT)	171.242±3.95^{b}	175.125±3.95^{a}	173.184±2.79^{b}
Tunica albuginea weight (TALBWT)	11.514±1.06^{a}	10.154±1.06^{b}	10.834±0.97^{b}
Caput epididymal weight (CAPEPWT)	11.592±0.34^{a}	10.479±0.34^{b}	11.036±0.75^{a}
Corpus epididymal weight (COPEPWT)	2.965±0.63^{b}	3.595±0.63^{a}	3.280±0.24^{a}
Cauda epididymal weight (CAUDEPWT)	7.271±0.63^{a}	7.203±0.59^{a}	7.237±0.45^{a}
Epididymal weight (EPWT)	31.042±4.90^{a}	29.430±4.90^{b}	30.236±3.47^{b}
Ductus deferens weight (DUCTWT)	2.889±0.27^{a}	2.695±0.27^{a}	2.792±0.19^{a}

Means on the same row with different superscripts were significantly different. Level of significance ($p<0.05$)

Statistical analysis (Table 1) also shows differences in the left and right testicular morphometric measurements. The result is similar to the report of Oyeyemi and Eunice (2006) who stated that the weight of left testis with epididymis is higher than the weight of right testis with epididymis in White Fulani bulls. It is also similar to the report of Egbunike and Elemo (1978) who stated that testicular and epididymal weight are higher in the left organ than in the right organ in boars. This variation may be due to the fact that more sperm cells are deposited in the left than right testicular morphometrics (Oyeyemi and Eunice, 2006).

Seasonal effect on testicular morphometric measurement

Table 2 shows least squares means of testicular morphometric measurements of dry and wet seasons. All the testicular morphometric measurements were affected by season except caput and corpus epididymal weight. Generally, higher values were recorded in the rainy season. This result is similar to the report of Ortavant (1974) who stated that average testicular weight (300 g) taken between June and October were more than that (200 g) taken between January to May. In Brahman and Hereford bulls, increased testicular size during the coolest month and decreased testicular size during the hottest months had also been observed by Godfrey *et al.* (1990). The seasonal variation in testicular measurements had been attributed to the seasonal variation in the conception rate of beef cattle by Steinbach and Balogun, (1971). However, Bitto and Egbunike (2006) reported that all testicular morphometric characteristics of West African Dwarf bucks were unaffected by the season. During the wet season, there is availability of lush green fodder rich in vitamin A and minerals which enhanced spermatogenesis leading to an increase testicular morphometric measurements (Amann *et al.,* 1986; Ahmad *et al.*, 1991).

Relationship between testicular morphometric measurement and heart girth

Table 3 shows phenotypic correlations between heart girth and testicular morphometry measurements. The correlation coefficients were generally high and positive except for negative correlations which ductus deferens weight had with testicular weight and heart girth. This indicates that any of the traits can be improved by selecting for the other though, selection for testicular weight and heart girth may have a reverse effect on ductus deferens weight.

Correlation of 0.78 recorded between heart girth and testicular weight is consistent with the report of Bagu *et al.* (2006), Osinowo *et al* (1981), and Tegegne *et al.* (1992) who reported correlation coefficients 0.73, 0.75 and 0.76 respectively between testicular weight and body weight. It is however slightly lower than 0.98 and 0.92 reported by Oyeyemi and Ubiogoro (2005) and Bitto and Egbunike (2006) respectively.

The correlation coefficient of 0.53 recorded between heart girth and tunica albuginea weight (TALBWT) is lower than 0.90 correlation reported between body weight and paired tunica albuginea weight by Bitto and Egbunike (2006) in West African bucks. Correlation coefficient (0.57) recorded between heart girth and epididymal weight (EPWT) which is also lower than 0.82 (Osinowo *et al*., 1981), 0.99 (Oyeyemi and Ubiogoro, 2005) and 0.88 (Bitto and Egbunike, 2006) reported between body weight and paired epididymal weight in Bunaji bulls, Large White boars and West African Dwarf bucks respectively. Correlation of -0.02 recorded between ductus deferens weight and heart girth is contrary to the report of Bitto and Egbunike (2006) who reported 0.69 correlation between ductus deferens weight and body weight.

The relationship between heart girth with testicular morphometric measurements is compared with relationship between body weight and testicular morphometric measurement in the literature due to the fact that heart girth accounted close to 90% of the body weight (Afolayan *et al*., 2006).

Table 2. Least squares means (g±S.E.) of effect of season on right and left testicular morphometric measurement in bulls

Variable	Right		Left		Combined	
	D	W	D	W	D	W
Testicular weight	161.625±4.11[b]	180.860±4.11[a]	162.475±3.3[b]	187.775±3.73[a]	162.050±3.36[b]	184.318±3.36[a]
Tunica albuginea weight	9.325±2.17[b]	13.703±2.17[a]	7.850±1.39[b]	12.458±1.39[a]	8.588±1.71[b]	13.080±1.71[a]
Caput epididymal weight	11.688±1.94[a]	11.496±1.94[a]	10.325±1.03[a]	10.634±1.03[a]	11.006±1.44[a]	11.065±1.44[a]
Corpus epididymal weight	2.912±0.33[a]	3.017±0.33[a]	3.675±0.63[a]	3.515±0.63[a]	3.294±0.36[a]	3.266±0.36[a]
Cauda epididymal weight	6.225±0.89[b]	8.318±0.89[a]	6.613±0.84[b]	7.794±0.84[a]	6.419±0.70[b]	8.055±0.70[a]
Epididymal weight	20.825±6.51[b]	41.260±6.51[a]	20.612±5.89[b]	38.248±5.89[a]	20.179±6.13[b]	39.754±6.13[a]
Ductus deferens weight	2.625±0.46[b]	3.154±0.46[a]	2.812±0.28[a]	2.577±0.28[b]	2.719±0.34[a]	2.866±0.34[a]

Means on the same row with different superscripts were significantly different; level of significance ($p<0.05$)

Table 3: Phenotypic correlations between heart girth and testicular morphometric measurements

Variable	HGT	TWT	TALBWT	CAPEPWT	COPEPWT	CAUDEPWT	EPWT	DUCTWT
Heart girth (HGT)	1							
Testicular weight (TWT)	0.780**	1						
Tunica albuginea weight (TALBWT)	0.531*	0.387	1					
Caput epididymal weight (CAPEPWT)	0.350	0.058	0.607*	1				
Corpus epididymal weight (COPEPWT)	0.338	0.154	0.432	0.712**	1			
Cauda epididymal weight (CAUDEPWT)	0.499*	0.437	0.708**	0.623**	0.457	1		
Epididymal weight (EPWT)	0.591*	0.315	0.843**	0.624**	0.469	0.712**	1	
Ductus deferens weight (DUCTWT)	-0.023	-0.026	0.410	0.246	0.258	0.496	0.556*	1

** = significant at the 0.01 level ($p<0.01$); * = significant at the 0.05 level ($p<0.05$)

Correlation coefficient of 0.39 recorded between testicular weight and tunica albuginea weight is lower than 0.97 (Bitto and Egbunike, 2006) reported between paired testicular weight and paired tunica albuginea weight. Correlation of 0.32 recorded between testicular weight and epididymal weight is lower than 0.86 and 0.90 reported by Osinowo *et al*.(1981) and Bitto and Egbunike (2006) respectively while, a negative value (-0.042) was reported by Oyeyemi and Eunice (2006). Correlation of 0.84 recorded between epididymal weight and tunica albuginea weight is similar to 0.90 reported by Bitto and Egbunike (2006). Correlation coefficient 0.57 recorded between epididymal weight and ductus deferens weight is also similar to 0.43 reported by Bitto and Egbunike (2006).

The prediction equations of different testicular morphometric measurement using heart girth are shown in Table 4. From the R^2 values, testicular weight (TWT) can be predicted with highest accuracy followed by caput epididymal weight, epididymal weight and cauda epididymal weight, while ductus deferens weight and corpus epididymal weight had the lowest accuracy. This result is consistent with the report of Bitto and Egbunike, (2006) who reported that paired testicular weight had the highest prediction accuracy ($R^2 = 0.84$) with body weight, followed by tunica albuginea weight ($R^2 = 0.81$), epididymal weight ($R^2 = 0.78$) and, the lowest is ductus deferens weight with $R^2 = 0.47$. The result is also similar with the report of Raji *et al.* (2008) who reported R^2 values of 0.66 (Borno White) and 0.44 (Red Sokoto) as coefficients of determination in predicting testicular weight with body weight in two breeds of goats

Table 4. Prediction equations for testicular morphometric with heart girth

Dependent variable (Y)	Regression equation	R^2
Testicular weight (TWT)	Y= -47.40+1.23 (X)	0.608
Tunica albuginea weight (TALBWT)	Y= -42.48+0.298(X)	0.282
Caput epididymal weight (CAPEPWT)	Y= -16.17+0.152(X)	0.360
Corpus epididymal weight (COPEPWT)	Y= -3.172+0.036(X)	0.115
Cauda epididymal weight (CAUDEPWT)	Y= -12.91+0.112(X)	0.249
Epididymal weight (EPWT)	Y= -182.80+1.19(X)	0.320
Ductus deferens weight (DUCTWT)	Y= 3.20 - 0.02(X)	0.020

CONCLUSION AND RECOMMENDATION

Based on the information obtained in this study, it can be concluded that season had effect on testicular morphometric measurements while some on the left were higher than those on the right. Heart girth is a reliable estimate of testicular weight and some testicular morphometric measurements in bulls. It can therefore provide useful information for early selection of sires for cattle breeding and improvement programmes in the tropics.

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