Sperm production rate, gonadal and extragonadal sperm reserves in slaughtered White Fulani (Bunaji) bulls in a lowland tropical environment

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Abstract

Reproductive tract morphometry, sperm production rates, gonadal and extragonadal sperm reserves in Bunaji bulls were evaluated using samples from a total of 13 mature animals. The morphometric characteristics of the reproductive organs had generally low values but showed normal development. The daily sperm production (DSP) averaged $1.23 \pm 0.16 \times 10^9$, while the daily sperm production (DSP/g) was $0.62 \pm 0.11 \times 10^7$. Gonadal sperm reserve was $2.17 \pm 0.73 \times 10^9$ while the extragonadal sperm reserve was 3.82×10^9 for caput, 2.68×10^9 for corpus, 4.36×10^9 for cauda epididymis and 0.62×10^9 for the ductus deferens. The relative contributions of the epididymal segments and the ductus deferens to the total extragonadal sperm reserves were 33.28%, 23.34%, 37.98% and 5.40% respectively. Testicular morphometric characteristics correlated highly with themselves and with sperm production parameters as well as extragonadal sperm reserve. While these results provided information that will be useful in the determination of male / female ratio during natural mating and artificial insemination programmes, the study also shows that good sires could be obtained from these animals for breeding and improvement programmes in this breed.

Key words: Bunaji, testicular morphometry, sperm production, sperm reserves.

Introduction

Cattle occupy an important place in the Nigerian livestock economy. Of the several breeds of cattle in the country, the white Fulani (Bunaji) is reported to be the most numerous and most widely adapted (McLeroy and Carter, 1968; Mbap and Bawa, 2001). It is reported that about 90% of these animals are at present under the care of the nomadic herdsman (Mbanasor, 2000). It is hoped that the application of advances in artificial insemination (AI) will bring about the improvement of these animals in their native environment.

Besides a control of factors like nutrition, disease management and climate which are all known

to affect productivity, the improvement of Zebu cattle will require a proper understanding of all aspects of the physiology of reproduction in the male. The bull plays an important role in herd fertility and makes a significant contribution to genetic improvements in both naturally or artificially bred herds (Tegegne *et al.*, 1992). With several studies (Igboeli and Rakha, 1971; Salau Daudu and Shoyinka, 1983; Perry *et al.*, 1991 and Tegegne *et al.*, 1992) indicating that reproductive potential in *Bos indicus* is lower than in *Bos Taurus* breeds and that variations occur even within *B indicus* breeds (Tegegne *et al.*, 1992), investigations of the reproductive potentials of Bunaji bulls in relation to the natural environment become a necessity.

Osinowo *et al.*, (1977), Osinowo *et al.*, (1981) and Egbunike *et al.*, (1985) have reported on important aspects of the physiology of reproduction in Bunaji bulls. Such reports in the Benue region of Nigeria (where these animals have for generations adapted) are completely lacking. This study therefore evaluated testicular morphometry, daily sperm production, the efficiency of spermatogenesis, gonadal and extragonadal sperm reserves in Bunaji bulls in Makurdi, Nigeria.

Materials and Methods

Sample collection

13 reproductive tracts of mature Bunaji bulls were obtained *intoto* after slaughter from the Makurdi modern market and Wurukum abattoirs in Makurdi. Collections were done between 0530 and 0700 hours on separate days within a month. The reproductive tracts were brought to our laboratory in an insulated ice box containing crushed ice.

Testicular Morphometry:

Scrotal circumference was evaluated using a piece of thread placed at the greatest diameter and measured on a rule as reported by Osinowo *et al.*, (1981). The testes were carefully dissected out and trimmed free of adhering fat and connective tissue. The epididymis was then separated from each testis and divided into caput, corpus and cauda segments. The weighing of samples was done with highly sensitive balances in our laboratory. Testicular and epididymal volumes were obtained by water displacement as already reported (Bitto, 1989).

Gonadal and extragonadal sperm reserves:

Estimates of testicular and epididymal sperm reserves were determined by homogenization

techniques (Almquist and Amann, 1961); as already reported by Igboeli and Rakha (1971), Egbunike (1980), Bitto (1989) and Tegegne *et al.*, (1992).

Daily sperm production and daily sperm production/g testis:

Daily sperm production was estimated from the testicular homogenates by dividing the gonadal sperm reserves by a time divisor of 3.27 proposed by Amann (1970) and Amann *et al.* (1976) for cattle.

Statistical Analysis:

Data were subjected to the student 't' test and the one way analysis of variance (ANOVA) and correlation analysis (Steel and Torrie, 1980).

Results and Discussion

A summary of the morphometric characteristics and their derivations are presented in Tables 1 and 2 respectively. Testicular weights in the present study were comparable to the report of Egbunike *et al.* (1985) in the same breed elsewhere in the tropics in the wet season but lower than the mean value for the same breed in the dry season reported by Egbunike *et al.* (1985). Our paired testes weights in the present study were also lower than the values reported for three genotypes of Zebu bulls (Small East African Zebu, Borana and Boran) by Tegegne *et al.*, (1992) in Ethiopia. These differences could be due to nutrition, and other environmental factors and not an inherent lower potential in our animals as testes density in the present study was comparable to that reported by Egbunike *et al.* (1985). We also found similarities ($P > 0.05$) between the left and right organs (Table 3) in testicular morphometry.

Gonadal and extragonadal sperm reserves in White Fulani (Bunaji) bulls

Table 1. *The morphometric characteristics of the reproductive organs of Bunaji Bulls (Mean $\pm$ s.e.m)*

Measurements	Values
Weight of reproductive tract <i>intoto</i> (g)	853.64 $\pm$ 70.22
Scrotal circumference (cm)	29.66 $\pm$ 0.82
Scrotal Sac weight (g)	329.59 $\pm$ 28.08
Right testis weight (g)	152.54 $\pm$ 12.07
Left testis weight (g)	150.18 $\pm$ 12.25
Paired testis weight (g)	302.71 $\pm$ 24.17
Right epididymal weight (g)	18.08 $\pm$ 1.32
Left epididymal weight (g)	18.15 $\pm$ 1.36
Paired epididymal weight (g)	36.27 $\pm$ 2.65
Right ductus deferens weight (g)	3.43 $\pm$ 0.39
Left ductus deferens weight (g)	3.39 $\pm$ 0.40
Paired ductus deferens weight (g)	6.78 $\pm$ 0.76
Right tunic weight (g)	15.44 $\pm$ 1.29
Left tunic weight (g)	16.25 $\pm$ 1.34
Paired tunic weight (g)	30.92 $\pm$ 2.57
Right caput weight (g)	8.00 $\pm$ 0.59
Left caput weight (g)	8.42 $\pm$ 0.67
Paired caput weight (g)	16.45 $\pm$ 1.25
Right corpus weight (g)	4.35 $\pm$ 0.48
Left corpus weight (g)	4.35 $\pm$ 0.54
Paired corpus weight (g)	8.81 $\pm$ 0.98
Right cauda weight (g)	5.25 $\pm$ 0.49
Left cauda weight (g)	5.45 $\pm$ 0.49
Paired cauda weight (g)	10.70 $\pm$ 0.95
Right epididymal Length (cm)	16.08 $\pm$ 0.60
Left epididymal Length (cm)	15.91 $\pm$ 0.58
Mean epididymal Length (cm)	15.87 $\pm$ 0.64
Right testis volume (ml)	414.92 $\pm$ 11.65
Left testis volume (ml)	142.31 $\pm$ 12.03
Mean testis volume (ml)	142.12 $\pm$ 11.80
Right testis density (g/cm ³)	1.08 $\pm$ 0.03
Left testis density (g/cm ³)	1.06 $\pm$ 0.03
Mean testis density (g/cm ³)	1.09 $\pm$ 0.03
Right epididymal volume (ml)	19.08 $\pm$ 1.48
Left epididymal volume (ml)	19.08 $\pm$ 1.48
Mean epididymal; volume (ml)	19.08 $\pm$ 1.48
Right epididymal; density (g/cm ³)	0.98 $\pm$ 0.05
Left epididymal density (g/cm ³)	0.97 $\pm$ 0.06
Mean epididymal density (g/cm ³)	0.98 $\pm$ 0.05

s.e.m=Standard error of mean

Table 2. Derivations from the morphometric characteristics of the reproductive organs of Bunaji bulls based on body weight (means $\pm$ s.e.m).

Measurements	Values
Paired testis weight (%)	35.97 $\pm$ 1.30
weight of reproductive <i>intoto</i>	
Paired tunica albuginea weight (%)	10.26 $\pm$ 0.49
Paired testis weight	
Paired caput epididymal weight (%)	5.50 $\pm$ 0.28
Paired testis weight	
Paired corpus epididymal weight (%)	2.83 $\pm$ 0.28
Paired testis weight	
Paired ductus deferens weight (%)	2.21 $\pm$ 0.13
Paired testis weight	
Paired cauda epididymal weight (%)	3.56 $\pm$ 0.19
Paired testis weight	
Paired epididymal weight (%)	12.09 $\pm$ 0.35
Paired testis weight	
Paired caput epididymal weight (%)	45.40 $\pm$ 2.00
Paired epididymal weight	
Paired corpus epididymal weight (%)	23.61 $\pm$ 1.13
Paired epididymal weight	
Paired cauda epididymal weight (%)	29.25 $\pm$ 1.10
Paired epididymal weight	

s.e.m.: = standard error of mean

Table 3. Derivations (II) from the morphometric characteristics of the reproductive organs of Bunaji bulls in Makurdi (means $\pm$ s.e.m)

Measurements	Left	Ratios of left organs Right	Level of significance
Testis	100.00 $\pm$ 0.00	102.07 $\pm$ 1.65	ns
Epididymis	100.00 $\pm$ 0.00	101.71 $\pm$ 2.67	ns
Tunica albuginea	100.00 $\pm$ 0.00	97.96 $\pm$ 3.82	ns
Dustus deferens	100.00 $\pm$ 0.00	94.98 $\pm$ 3.61	ns

s.e.m = standard error of mean

ns = not significant (P>0.05)

II = Ratios of left to right organs

Gonadal and extragonadal sperm reserves in White Fulani (Bunaji) bulls

Table 4. Daily sperm production (DSP) and daily sperm production per gram testis (DSP/g) in Bunaji bulls (means $\pm$ s.e.m)*

Measurements	Values	Level of significance
DSP ($\times 10^9$)	Left 0.46 ± 0.23	ns
	Right 0.77 ± 0.54	
	Paired 1.23 ± 0.16	
DSP/g ($\times 10^7$)	Left 0.42 ± 0.19	ns
	Right 0.20 ± 0.07	
	Paired 0.62 ± 0.11	

s.e.m = standard error of mean ns = not significant ($P > 0.05$)

* = $P < 0.05$ ** = $P < 0.01$

With regard to sperm production rate (Table 4), our values in daily sperm production (DSP) and the efficiency of spermatogenesis (DSP/g) were only about half of what was reported in the same breed in the wet season by Egbunike *et al.*, (1985) and about one quarter of what the same authors reported in the same breed in the dry season. Both our results and those of Egbunike *et al.* (1985) were likewise much lower than values for DSP and DSP/g reported for each of the three genotypes of Zebu cattle in Ethiopia (Tegegne *et al.*, 1992). These differences are obviously due to nutrition and perhaps the environment. The animals Egbunike *et al.* (1985) and Tegegne *et al.* (1992) used were on a better plan of nutrition than our animals. Our animals besides being reared in pastoralism spent an appreciable amount of time at the Makurdi cattle market with little to eat before they were taken to the abattoir for slaughter.

Wildeus and Entwistle (1982) also reported higher sperm production rates in post pubertal *Bos indicus* strain bulls on natural pasture in

Australia than obtained in our study. The inferiority of our animals to the others in the literature in terms of sperm production must have come from the smaller testicular sizes in our animals which may be due to genotypic and nutritional differences in testicular weights. Gonadal and extragonadal sperm reserves (Table 5) were similarly lower than values reported by other workers in the *Bos indicus* strain (Tegegne *et al.* 1982 and Wildens and Entwistle, 1982) else where.

The high positive correlations (Table 6) between the weight of the reproductive tract and the scrotal circumference ($r = 0.92$; $p < 0.001$), paired testis weight ($r = 1$; $p < 0.001$), paired tunic weight ($r = 0.84$; $p < 0.01$), paired epididymal weight ($r = 1$; $p < 0.001$) and sperm production / g testis ($r = 0.86$, $p < 0.01$) are in agreement with reports in other species, other breeds of cattle and in the Bunaji; else where (Willet and Ohms, 1957; Amann 1970; Hahn *et al.*, 1969; Egbunike, 1980; Osinowo *et al.*, 1981, Tegegne *et al.*, 1992).

Table 5. Gonadal and extragonadal sperm reserves in Bunaji bulls (means $\pm$ s.e.m)

Measurements **	Values (X10 ⁹)	Level of significance *
Testis : Left	1.50 $\pm$ 0.37	ns
Right	0.67 $\pm$ 0.17	
Paired	2.17 $\pm$ 0.73	
Caput : Left	1.71 $\pm$ 0.80	ns
Right	2.11 $\pm$ 0.79	
Paired	2.68 $\pm$ 0.86	
% of contribution of caput: 33.27%		
Corpus: Left	1.40 $\pm$ 0.61	ns
Right	1.28 $\pm$ 0.53	
Paired	2.68 $\pm$ 0.86	
% of contribution of corpus: 23.35%		
Cauda: Left	1.56 $\pm$ 0.17	ns
Right	2.80 $\pm$ 0.28	
Paired	4.36 $\pm$ 0.73	
% of contribution of cauda: 38.00%		
Ductus deferens:		
Left	0.20 $\pm$ 0.10	ns
Right	0.42 $\pm$ 0.12	
Paired	0.62 $\pm$ 0.3	
% of contribution of ductus deferens: 5.38%		

s.e.m = standard error of mean

* 't' test between left and right organs

** ANOVA between regions

Conclusion

This study reveals the reproductive potential of the Bunaji bull in a lowland humid tropical environment and suggests that genetic selection coupled with good nutrition and management are essential to its improvement.

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Table 6. *The correlation matrix showing the relationships between testicular morphometry, sperm production and sperm storage in Bunaji bulls*

	12	11	10	9	8	7	6	5	4	3	2	1
1.	-0.32	0.87***	0.8***	0.42	0.53	0.85**	0.31	0.99***	1.0**	0.84**	1.0***	0.92***
2.	-0.40	0.62*	0.93***	0.47	0.30	0.40	0.07	0.86***	0.94***	0.58*	0.96***	-
3.	-0.35	0.97***	0.90***	0.25	0.81**	0.96***	0.46	0.95***	0.97***	0.79**	-	-
4.	-0.10	1.0***	0.79**	0.84**	0.84**	0.78**	-0.65	0.91***	0.82**	-	-	-
5.	-0.44	0.84**	0.30	0.51*	0.37	-0.97***	0.28	0.98***	-	-	-	-
6.	-0.22	0.44	0.70**	0.47	0.33	0.60*	0.38	-	-	-	-	-
7.	0.08	0.30	0.16	0.20	0.35	0.15	-	-	-	-	-	-
8.	-0.53	0.87***	0.20	0.25	0.28	-	-	-	-	-	-	-
9.	-0.50	0.46	0.42	0.30	-	-	-	-	-	-	-	-
10.	-0.30	0.52*	0.18	-	-	-	-	-	-	-	-	-
11.	-0.18	0.59*	-	-	-	-	-	-	-	-	-	-
12.	0.70**	-	-	-	-	-	-	-	-	-	-	-

1 = weight of reproductive tract *intoto*.,

2. = scrotal circumference

3. = paired testis weight

4. = paired tunica weight

5. = mean testis volume

6. = paired epididymal weight

7. = paired ductus weight

8. = gonadal sperm reserve

9. = caput epididymal sperm reserve

10. = corpus epididymal sperm reserve

11. = cauda epididymal sperm reserve

12. = daily sperm production

13. = daily sperm production/g

* = (P< 0.005), ** = (P< 0.001), *** = (P< 0.001)

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