

TESTICULAR SIZE AND SPERM OUTPUT IN HOLSTEIN-FRIESIAN AND N'DAMA BULLS

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SUMMARY

Records collected over a period of four months from October 1978 to January 1979 from four Holstein-Friesian and four N'dama bulls, were used to study the relationship between testicular size and sperm output. Semen samples were collected from the bulls twice a week using the artificial vagina and non-oestrous female teasers.

The means (\pm s.e.) of testicular measurements for Holstein-Friesian and N'dama, respectively, were 35.6 ± 1.8 and 7.9 ± 0.3 cm. for scrotal circumference, 12.6 ± 0.3 and 7.7 ± 0.8 cm for testis length, 6.7 ± 0.3 and 3.7 ± 0.2 cm for testis diameter. Calculated mean testicular volumes were 296.8 ± 22.2 and 57.4 ± 10.1 ml respectively for Holstein-Friesian and N'dama bulls.

The mean total sperm per ejaculate were $8.80 \pm 3.045 \times 10^9$ for the Holstein-Friesian and $3.03 \pm 0.905 \times 10^9$ for the N'dama bulls. Simple correlations for Holstein-Friesian and N'dama in the same order, were between body weight and scrotal circumference 0.49 and 0.66, body weight and sperm output/ejaculate 0.48 and 0.88, scrotal circumference and testicular volume 0.74 and 0.60, scrotal circumference and sperm output/ejaculate 0.18 and 0.69, and testicular volume and sperm output/ejaculate -0.45 and 0.84.

Regression equations for predicting sperm output/ejaculate from testicular volume are given as $Y = 13.458 - .031X$ and $Y = -.650 + 0.038X$, respectively, for Holstein-Friesian and N'dama bulls.

(Key words: Testicular size, sperm output, Holstein-Friesian, N'dama).

INTRODUCTION

Methods for predicting potential sperm production, and particularly for identifying bulls with high sperm output potential at an early age are important. Previous investigations (Willett and Ohms, 1957; Almquist and Amann, 1961; Amann and Almquist, 1962) have demonstrated that a close relationship exists between testes size and sperm output of growing bulls under frequent collection regimes.

Coulter *et al.* (1975) indicated that the use of scrotal circumference measurements made at 1 to 2 years of age may be valuable as a predictor of sperm output in the mature bull. Foote (1969) showed that in the bull, testes size may be estimated *in situ* by the measurement of scrotal circumference or by linear measurements of testicular length, diameter and scrotal fold thickness.

In this study, testicular size, body size and sperm output were measured in Holstein-Friesian and N'dama bulls to determine the degree of relationship and thus provide the basis for prediction of future sperm output of the bulls.

MATERIALS AND METHODS

Experimental Animals: The study was conducted over a period of four months from October 1978 to January 1979, using four Holstein-Friesian and four N'dama bulls aged 2 to 3 years, body weight varying from 328 kg to 528.8 kg for the Holstein and 166.9 kg to 228.6 kg for the N'dama. The bulls were housed in the bull stud, grazed in nearby paddocks and given supplemental feeding and free access to water.

Biometric Measurements: Three biometric measurements were taken on the scrotum of the live animals consisting of scrotal circumference, testis length and testis diameter. Scrotal circumference was measured at the greatest diameter of the scrotum with the bull standing, using a flexible canvass tape (Foote, 1969). Testis length was obtained by measuring the long axis of the testis with a pair of calipers. Testis diameter was measured

also with a pair of calipers at the greatest width. The testicular measurements were corrected for skin thickness by subtracting the scrotal fold thickness which has obtained by means of vernier calipers. The measurements on the two testicles of each bull were averaged for each trait.

The scrotal measurements and body weights were taken at the beginning, middle and end of the experiment and their means were used in each case. The testicular volume was calculated from the formula for a rotational ellipsoid which is $\frac{4}{3}\pi abc$, taking the testis to be ellipsoidal (Egbunike and Steinbach, 1975), where a is the half length, b the half diameter and c the radius of the equatorial plane. Since the rotation is about the major axis, b and c are equal, being radii of the same circle and the formula resolves to:

$$\text{Volume} = \frac{4}{3}\pi ab^2$$

Semen collection and evaluation: The bulls were first subjected to a training programme of one month for semen collection following which semen samples were collected twice a day with one hour interval and two days a week after 4 and 3 days' rest throughout the experimental period, using the artificial vagina and

non-oestrous female teasers. Each bull was given one false mount before semen collection.

The ejaculate volume was read directly from the calibrated collection tube. Sperm concentration was determined by the optical density technique (Salisbury *et al.*, 1943).

Statistical Analysis: The procedures of Snedecor and Cochran (1967) were used in all statistical computations. The means and standard errors of the traits under study were calculated for each breed. Mean total sperm per ejaculate was also determined. Simple correlations between body weight, testicular measurements and sperm output were obtained within breed. Regression equations were derived for predicting sperm output from testicular measurements.

RESULTS

The means and standard errors of body weight and various measures of testicular size are presented in Table 1. Average body weight was 427kg for Holstein-Friesian and 206kg for N'dama bulls, the range being 328.0 to 528.8 and 166.9 to 228.6kg respectively. Body weight to

TABLE 1
Body Weight and Measures of Testicular Size of Holstein-Friesian and N'dama Bulls

Parameter	Means and Standard Errors	
	Holstein-Friesian	N'dama
Body weight (kg)	427.3 ± 43.13	206.3 ± 14.20
Scrotal circumference (cm)	35.63 ± 1.807	7.88 ± 0.331
Testis length (cm)	12.63 ± 2.268	7.69 ± 0.764
Testis diameter (cm)	6.68 ± 0.310	3.72 ± 0.244
Testicular volume (ml)	296.84 ± 22.21	57.36 ± 10.10

scrotal circumference ratios were 12:1 for Holstein-Friesian and 26:1 for N'dama bulls. Corresponding body weight to testicular volume ratios were 1.4:1 and 3.6:1. The ratio of testis length to diameter was 1.9:1 in the Holstein-Friesian and 2.1:1 in the N'dama.

Mean ejaculate volume of the Holstein-Friesian was 2.28ml, about twice that of the N'dama bulls, 1.20ml (Table 2). Sperm concentration was 3.42 and 2.68×10^9 and total spermatozoa/ejaculate 8.80 and 3.03×10^9 in the Holstein-Friesian and the N'dama, respectively.

TABLE 2

Spermatozoa Output of Holstein-Friesian and N'dama Bulls

Sperm Output	Means and Standard Errors	
	Holstein-Friesian	N'dama
Ejaculate volume (ml)	2.28 ± 0.516	1.20 ± 0.341
Sperm concentration ($\times 10^9$ /ml)	3.42 ± 1.021	2.68 ± 0.824
Total spermatozoa/ejaculate ($\times 10^9$)	8.80 ± 3.045	3.03 ± 0.905

TABLE 3

Simple Correlations between Body Weight, Measures of Testicular Size and Sperm Output in Holstein-Friesian Bulls

Variable	Variable Code					
	Code	1	2	3	4	5
Body weight (kg)	1					
Scrotal circumference (cm)	2	.49				
Testis length (cm)	3	-.24	-.53			
Testis diameter (cm)	4	-.05	.72**	-.83**		
Testicular volume (ml)	5	-.13	.74**	-.71**	.98**	
Average sperm/ejaculate	6	.48	.18	.65*	-.53	-.45

*(P 0.05, r = 0.58) d.f. = 10

** (P 0.01, r = 0.71) d.f. = 10

Simple correlations among the various characteristics for the Holstein-Friesian are given in Table 3. There were highly significant positive correlations (P 0.01) between scrotal circumference and testis diameter, scrotal circumference and testicular volume and testis diameter

and testicular volume. For the N'dama bulls (Table 4), the correlations were all positive and generally highly significant, ranging from 0.29 between body weight and testis diameter to 0.99 between body weight and testicular volume. Correla-

TABLE 4

Simple Correlations between Body Weight, Measures of Testicular Size and Sperm Output in N'dama Bulls

Variable	Variable Code					
	Code	1	2	3	4	5
Body weight (kg)	1					
Scrotal circumference (cm)	2	.63*				
Testis length (cm)	3	.80**	.90**			
Testis diameter (cm)	4	.89**	.29	.43		
Testicular volume (ml)	5	.99**	.60*	.77**	.90**	
Average sperm/ejaculate	6	.88**	.69*	.61*	.83**	.84**

*(P = 0.05, r = 0.58) d.f. = 10

** (P = 0.05, r = 0.71) d.f. = 10

tions between testicular volume and sperm output were $-.45$ and 0.84 in the Holstein-Friesian and N'dama bulls, respectively, the latter being highly significant (P = 0.01).

Regression equations were computed for predicting sperm output/ejaculate ($\times 10^9$) from testicular measurements. For the Holstein-Friesian bulls, the equations for prediction sperm output/ejaculate ($\times 10^9$) from scrotal circumference and testicular volume were, respectively, $Y = -1.730 + 0.296 \times$ and $Y = 13.458 - 0.031 \times$; corresponding equations for the N'dama bulls were $Y = -11.787 + 1.881 \times$ and $Y = -.650 + 0.038 \times$.

DISCUSSION

When purchasing and selecting breeding males for a herd, a great deal of emphasis is laid both on the normal development of the animal and its testes. The economic importance of the accurate prediction of the sperm production potential of farm animals had long been recognized. Vandemark (1956) had shown a high correlation coefficient of 0.90 between the body weight of young bulls and testes weight. Foote (1969) and Igboeli and Rakha (1971) on bulls, Egbunike and

Steinbach (1975) on boars, and Colyer (1971) on rams had reported highly significant associations between the testis linear measurements and the testis weight and hence the testis size.

In the case of N'dama bulls (Table 4) the present data show that larger animals tended to have bigger testes, that is, the linear measurements taken on the larger testes were higher than those taken on the smaller testes although this is not so evident in the Holstein-Friesians. However, these relationships were not directly linear. For instance, while the ratio of body weight to scrotal circumference in the Holstein-Friesian is 12:1, the ratio is 26:1 in the N'dama. Whereas the ratio of the testis length to the diameter is 1.9:1 for the Holstein-Friesian, this is 2.1:1 for the N'dama, which values are about equal.

Egbunike and Steinbach (1975) on pigs had reported that the estimated volume of testis represented 97% of the actual volume. In the present study, the bulls were breeding bulls and so could not be sacrificed for comparison, but in another trial (Nwakalor and Orji unpublished data) using some bull testes from slaughter cattle measured before and after excision, the calculated volume was within 98% of the actual volume.

The highly significant correlations ($P < 0.01$) between testis diameter and sperm output and testicular volume and sperm output in the N'dama indicate a close association between these traits and sperm output. This is in agreement with the reports of several investigators (Willett and Ohms, 1957; Almquist and Amann, 1961; Amann and Almquist, 1962) of a close relationship between testis size and sperm output of growing bulls when collected frequently. Ortavant (1956) had demonstrated with rams, a correlation of 0.80 between testicular size and the number of spermatozoa produced by the testes. In an exhaustion trial on bulls, Willett and Ohms (1957) found a correlation coefficient of 0.92 between scrotal circumference and the number of sperm cells produced. The bulls used in the present study were ejaculated twice a day (with one hour interval) and two times a week (at 4 and 3 days' intervals) after only one false mount in each case and this may not have been sufficient to exhaust the bulls. Because of this shortcoming, the use of the regression equations to predict the sperm output must be done with caution. Igboeli and Rakha (1971) demonstrated that when the regression formula devised by Willett and Ohms (1957) for the estimation of testicular weight using scrotal circumference was applied to the dimensions obtained from Angoni bulls, it was found that the weights were over-estimated. A similar formula by Hahn *et al.* (1969) tended to give an under-estimate. These findings emphasize the need for more studies to establish adequate formulae for specific breeds.

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