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Predicting Semen Traits of Local and Exotic Cocks using Linear Body Measurements

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ABSTRACT
The objective of this study was to predict semen traits of local and exotic cocks using linear body measurements. To achieve this objective, 24 local and 24 exotic cocks aged 30 weeks were used. The cocks in each genetic group were divided into three replicates and housed in deep litter pens where they were fed *ad libitum* broiler finisher ration and water. The exotic cocks were significantly ($p<0.05$) superior to the local types in body weight, beak length, comb length and wing length. The local cocks produced significantly ($p<0.05$) more semen than the exotic cocks. The relationship between bodyweight and semen traits were not significant ($p>0.05$) in the two genetic groups. Significant ($p<0.05$) and positive correlations were observed between beak length and sperm concentration ($r = 0.67$), sperm motility ($r = 0.70$), comb length and sperm concentration ($r = 0.60$) and shank length and sperm motility ($r = 0.59$) in the exotic cocks. A positive and significant ($p<0.05$) correlation between wing length and percent live sperm ($r = 0.59$) was obtained in the local cocks. Beak length was a good predictor of sperm concentration ($R^2 = 0.45$) and sperm motility ($R^2 = 0.49$) in the exotic cocks. In the local cocks, shank length and wing length were good predictors of live sperm with R^2 values of 0.52 and 0.35, respectively. The results of the multiple regression analysis indicate that the body measurements best predicted sperm concentration, sperm motility and semen volume in the exotic cocks and live sperm and abnormal sperm in the local cocks. It was concluded that lengths of beak, comb, shank and wing could be used to predict some semen traits of cocks.

Key words: Accuracy of prediction, body parameters, regression equations, relationships, semen traits

INTRODUCTION
Poultry plays an important role in producing animal protein most effectively within the shortest possible time (Hosseinzadeh *et al.*, 2010). This is because of their prolificacy and fast growth rate. Previous researches on Nigerian local chickens as reviewed by Ajayi (2010) showed that the local chickens were inferior in growth and egg production characteristics compared to the exotic chickens. Some of the problems limiting poultry production in Nigeria are diseases, high cost of feed, heat stress and poor reproductive rate (low fertility and hatchability). Semen qualities of cocks determine the fertility of the male chicken while the female contributes the eggs (Cooper and Rowell, 1958; Liu *et al.*, 2008). Semen qualities of cocks are usually accessed for artificial insemination purposes

(Siudzinska and Lukaszewicz, 2008). One advantage of AI over natural mating is the efficient use of male (Koohpar *et al.*, 2010). In the rural areas where most of the farmers live, facilities for microscopic evaluation of semen are not available. Therefore, simple, reliable and indirect methods for in vivo estimation of semen qualities based on the correlation between body parameters and semen traits are needed by poultry farmers. EL-Saylad *et al.* (1994) recommended the use of lengths of comb and wattle as indicators of good semen traits in chickens. McGary *et al.* (2002) reported that the secondary sexual characters namely comb length and wattle length may be used to predict fertility and semen quality in broiler cocks. Also, a highly significant positive correlation between comb length and fertility was reported by El-Sahn (2007). The author concluded that comb length and wattle length could be used as tools to predict cocks with high semen quality. Galal (2007) reported that bodyweight, length of shank, comb and wattle were good predictors of semen attributes in chickens. The objective of this study was to predict the semen traits of local and exotic cocks using linear body measurements.

MATERIALS AND METHODS

Experimental site: The experiment was conducted at the poultry breeding unit of the Department of Animal Science, Delta State University, Asaba Campus. The Delta State University Asaba Campus is situated on longitude 60^0 45' East and latitude 60^0 12' North. Annual rainfall in Asaba ranges from 1800-3000 mm while maximum day temperature ranges from 27.5-30.9°C (Federal Ministry of Aviation, Department of Meteorological services Asaba, 2006).

The experimental animals: Twenty four cocks each of the exotic and the local aged 30 weeks were used for the study. The body weight range of the exotic cock was 2.50-3.00 kg while that of the local cock was 1.50-2.00 kg. The exotic cocks were raised from day old to sexual maturity at the poultry breeding unit of the Department of Animal Science, Delta State University, Asaba Campus. The local cocks were raised extensively and confined at adult stage. The local and exotic cocks were divided into three replicates with eight cocks per replicate and housed in deep litter pens. They were fed *ad libitum* commercial broiler finisher ration containing about 20% crude protein. Clean drinking water was also provided to the cocks *ad libitum*. Other management operations including cleaning of the poultry house, washing the drinkers and the feeders were also carried out.

Semen collection and evaluation: Collection of semen was done between 7 to 9 am on Tuesdays and Fridays consistently for eight weeks. The cock from which semen was to be harvested was handled with care to avoid fright and undue physical stress. Semen was collected by the manual massage technique (Burrows and Quinn, 1937). Clean small test tubes were used in the collection of the semen. Each semen sample was evaluated within 6 min after collection for volume, motility, livesperm, concentration and abnormal sperm. Semen volume was determined by drawing the semen with tuberculin syringe of 1.0 mL capacity and reading directly to the nearest 0.01 mL. Gross motility was determined by examining a drop of raw, undiluted semen on a prewarmed slide under light microscope as described by Ekpenyong (1983). Progressive motility was evaluated at x 40 magnification and scored 0-90% with O representing no progressive motility. Sperm concentration was determined using haemocytometer in a method described by Ekpenyong (1983). The percentage live and dead sperm and morphologically abnormal sperm were determined using eosin-nigrosin vital staining technique (Marini and Goodman, 1969).

Measurement of bodyweight and body parameters: Bodyweights were recorded at 30 weeks of age. Beaklength was measured with a measuring tape as the distance between the tip of the beak and the base. Comblength was determined using a measuring tape as the distance between the tip of the comb and the base. Shanklength was measured from the posterior aspect of the hockjoint to the foot pad using a calibrated vernier caliper. Winglength was measured using a measuring tape as the distance from the tip of the outstretched wing to the base.

Statistical analysis: Data were subjected to two factors analysis of variance in a completely randomized design according to the procedure by Steel and Torrie (1980). The statistical model used was as follows:

$$Y_{ijk} = \mu+S_i+W_j+ (SXW)_{ij}+e_{ijk}$$

Where:

Y_{ijk}	:	Kth observation eg., semen volume in the ith strain and jth week
μ	:	Overall mean
S_i	:	Effect of the ith strain (i = 1, 2)
W_j	:	Effect of the jth week (j =1, 2.....8)
$(SxW)_{ij}$	:	The interaction between the ith strain and jth week
E_{ijk}	:	Random error associated with individual measurements

The estimates of phenotypic correlations among body measurements and semen traits were obtained for each strain at 30 weeks of age using SPSS (2007).

The simple regression equations used to predict semen traits of cocks from body measurements were established by using the following regression model according to the method of Steel and Torrie (1980):

$$Y = a+bx_i+e_i$$

where, y is dependent variable (semen traits), a is intercept, b is regression coefficient and x_i is independent variable (body measurements) and e_i is residual error.

Multiple linear regression analysis was done using the following model:

$$Y = a+b_1x_1+b_2x_2+b_3x_3+b_4x_4+b_5x_5+e$$

where, Y is the dependent variable (semen traits), a is intercept, b (1-5) are regression coefficient of y on x, x_1-x_5 = independent variables (body measurements) and e is error term, normally distributed with mean zero and variance. The regression analysis was done using SPSS (2007).

RESULTS AND DISCUSSION

Bodyweight and body parameters: Table 1 presents the mean and the standard error for bodyweights and body parameters of the local and exotic cocks. It will be observed that the exotic cocks were significantly ($p<0.05$) superior to the local types in bodyweight, beak length, comb length and wing length. This was in agreement with the reports of Nwosu (1989) and

Table 1: Mean±SE of the bodyweight and body parameters of local and exotic cocks

Parameters	Local	Exotic
Body weight (kg)	1.94±0.01[a]	2.91±0.01[b]
Beak length (cm)	1.61±0.03[a]	1.79±0.03[b]
Comb length (cm)	1.83±0.03[a]	2.13±0.02[b]
Shank length (cm)	4.17±0.03[a]	4.08±0.03[a]
Wing length (cm)	5.22±0.06[a]	6.08±0.05[b]

For each parameter, a<b ($p<0.05$)

Table 2: Mean±SE of the semen characteristics of local and exotic cocks

Semen characteristics	Local	Exotic
Volume (mL)	0.131±0.005[b]	0.078±0.004[a]
Concentration (x 10^6)	6.990±0.11[a]	6.780±0.09[a]
Motility (%)	61.250±0.86[a]	61.670±0.75[a]
Livesperm (%)	55.970±0.88[a]	56.880±0.76[a]
Abnormal sperm (%)	43.750±0.61[a]	43.650±0.53[a]

a<b ($p<0.05$)

Table 3: Phenotypic correlation between body parameters and semen traits of cocks at 30 weeks of age

Semen traits	Body weight	Beak length	Comb length	Shank length	Wing length	Strains
Volume	0.00	0.40	0.38	-0.38	0.24	Local
	-0.50	0.12	0.00	0.53	-0.24	Exotic
Concentration	0.00	0.53	-0.10	0.10	0.31	Local
	0.41	0.67*	0.60*	0.06	0.46	Exotic
Motility	-0.20	0.33	0.29	0.29	-0.14	Local
	0.17	0.70*	0.42	0.59*	0.45	Exotic
Livesperm	-0.19	0.07	0.45	0.72*	0.59*	Local
	0.47	-0.21	0.42	0.07	0.16	Exotic
Abnormal sperm	0.00	-0.38	-0.50	0.00	0.16	Local
	-0.41	0.10	-0.33	0.17	-0.29	Exotic

*$p<0.05$

Peters *et al.* (2008) that the local chickens were inferior to the exotic type in growth characteristics. Similarly, Orlu and Egbunike (2009) reported that the exotic cocks were significantly ($p<0.01$) heavier than the locals with respective values of 2.11 and 1.58 kg.

Semen characteristics: Table 2 presents the mean and the standard error for the semen characteristics of the two strains of cocks. The local cocks produced significantly ($p<0.05$) more semen than the exotic cocks. A similar observation was reported by Omeje and Udeh (1998). This means that the local cocks can inseminate more hens than the exotic cocks. The non significant ($p>0.05$) difference observed between the two strains of cocks in sperm concentration, motility, live sperm and abnormal sperm could imply that the fertility potential of the two strains of cocks were similar.

Phenotypic correlations between body parameters and semen traits of cocks: Table 3 presents the phenotypic correlations between body measurements and semen traits in the local and exotic cocks at 30 weeks of age. There were no relationship between bodyweight and semen volume, bodyweight and concentration and bodyweight and abnormal sperm in the local cocks. However, the relationship between bodyweight and motility and bodyweight and live sperm were negative and non significant ($p>0.05$) in the local cocks implying that the lighter the bodyweight of the local cocks, the better the motility and the live sperm of the spermatozoa produced. A reversed trend was observed in the exotic cocks where positive and non significant ($p>0.05$) correlations were observed between body weight and motility and body weight and live sperm, thus implying that the heavier the bodyweight of the exotic cocks, the better the motility and lives perm of the spermatozoa produced. The negative and non significant ($p>0.05$) correlation between bodyweight and volume ($r = 0.05$) and bodyweight and abnormal sperm ($r = 0.41$) in the exotic cocks could imply that as exotic cocks become heavier, semen production as well as the abnormal sperm declined. A similar observation was reported by Udeh and Mmereole (2005) in the local and exotic cocks. Similarly, Bratte *et al.* (2011) reported negative and non significant ($p>0.05$) correlation between bodyweight and sperm motility, ejaculate volume, concentration and percent live sperm in broiler breeder males. Beak length was positively and non-significantly ($p>0.05$) correlated to semen volume, concentration, motility and live sperm and inversely related to abnormal sperm in the local cocks. The correlation coefficient between beak length and concentration ($r = 0.67$) and beak length and sperm motility ($r = 0.70$) were positive and significant ($p<0.05$) in the exotic cocks implying that the higher the length of beak, the higher the concentration and motility of the spermatozoa produced. This means that beak length can be used to predict sperm concentration and motility with reasonable level of accuracy in the exotic cocks. Similarly, comb length was positively and significantly ($p<0.05$) correlated with concentration in the exotic cocks. Gebriel *et al.* (2009) reported positive and significant correlation between comb length and ejaculate volume, sperm concentration and live sperm in norfa cocks. Similarly, behavioral studies in sexual selection of red jungle fowl showed female preference for males with larger combs (Zuk *et al.*,1995; Ligon and Zwartjes, 1995). There was no relationship between comb length and volume in the exotic cocks. The relationship between comb length and live sperm were positive and non significant ($p>0.05$) in the local cocks. A negative and non significant ($p>0.05$) relationship existed between comb length and concentration and comb length and abnormal sperm in the local cocks. Shank length was negatively and non-significantly ($p>0.05$) correlated with semen volume in the local cocks while the correlations between shanks length and concentration, shank length and motility were positive and non significant ($p>0.05$) in the local cocks. A negative and significant ($p<0.05$) correlation between shank length and live sperm was obtained in the local cocks implying that the longer the length of shank the lower the live sperm of the local cocks. On the contrary, a positive and significant ($p<0.05$) correlation between shank length and motility was obtained in the exotic cocks implying that the higher the shank length of the exotic cocks, the higher the percentage of actively motile sperm cells. The correlation coefficient between wing length and live sperm ($r = 0.59$) was positive and significant ($p<0.05$) in the local cocks implying that wing length could be used to predict live sperm in the local cocks. The correlation coefficients between wing length and other semen traits were not significant ($p>0.05$) in the local and exotic cocks.

Prediction equations: Regression equations relating semen traits to body parameters with their standard errors and accuracy of prediction (R^2) values for the exotic and local cocks are presented in Table 4 and 5, respectively. Most of the regression equations had very low R^2 values ranging from 0.00 to 0.27 which were not significant ($p>0.05$). This means that the regression equations cannot be considered reliable predictors of semen quality in both local and exotic cocks. In the exotic cocks, beak length is a good predictor of sperm concentration ($R^2 = 0.45$) and sperm motility

Table 4: Simple regression equations to predict some semen traits of the exotic cocks from linear body measurements at 30 weeks of age

Independent variables (x)	Dependent variables (y)	Regression equation	SE	R^2(%)
Body weight	Volume (mL)	ŷ = 0.45-0.13x	0.02	25.00^{NS}
	Concentration (×10^6)	ŷ = -3.25+3.44x	0.80	16.40^{NS}
	Motility (%)	ŷ = 25.00 +12.50x	7.42	2.90^{NS}
	Livesperm (%)	ŷ = 42.50+34.38x	6.64	22.20^{NS}
	Abnormal sperm (%)	ŷ = 97.50-18.75x	4.33	16.70^{NS}
Beak length	Volume (mL)	ŷ = 0.60+0.01x	0.03	1.40^{NS}
	Concentration (×10^6)	ŷ = 2.94+2.17x	0.65	45.00*
	Motility (%)	ŷ = 26.86 +19.43x	5.39	49.00*
	Livesperm (%)	ŷ = 68.57-5.71x	7.37	4.20^{NS}
	Abnormal sperm (%)	ŷ = 39.43+1.71x	4.72	1.00^{NS}
Comb length	Volume (mL)	ŷ = 0.08+0.00x	0.03	0.00^{NS}
	Concentration (×10^6)	ŷ = 2.11+2.22x	0.94	36.00*
	Motility (%)	ŷ = 33.33+13.33x	6.83	17.60^{NS}
	Livesperm (%)	ŷ = 30.00+13.33x	6.83	17.60^{NS}
	Abnormal sperm (%)	ŷ = 56.67-6.67x	4.47	11.10^{NS}
Shank length	Volume (mL)	ŷ = -0.10+0.05x	0.02	28.40^{NS}
	Concentration (×10^6)	ŷ = 6.09+0.18x	0.87	4.00^{NS}
	Motility (%)	ŷ = 2.27+14.55x	6.11	34.20*
	Livesperm (%)	ŷ = 50.91+1.82x	7.51	0.54^{NS}
	Abnormal sperm (%)	ŷ = 53.64-2.73x	4.67	3.00^{NS}
Wing length	Volume (mL)	ŷ = 0.15-0.01x	0.03	5.70^{NS}
	Concentration (×10^6)	ŷ = 2.31+0.74x	0.46	21.00^{NS}
	Motility (%)	ŷ = 23.43 +6.29x	3.93	20.34^{NS}
	Livesperm (%)	ŷ = 44.43 +2.29x	7.43	2.70^{NS}
	Abnormal sperm (%)	ŷ = 58.14 -2.50x	4.54	8.60^{NS}

*p<0.05, NS: Not significant (p>0.05)

(R^2 = 0.49). Similarly, comb length is a good predictor of sperm concentration (R^2 = 0.36) in the exotic cocks. However, based on the R^2 values for beak length (R^2 = 0.45) and comb length (R^2 = 0.36), beak length is a better predictor of sperm concentration in the exotic cocks compared to comb length. McGary *et al.* (2002) and El-Sahn (2007) had earlier reported that the secondary sexual characters such as comb length and wattle length could be used to predict good semen quality and fertility in cocks. Shank length is also a good predictor of sperm motility in the exotic cocks (R^2 = 0.34), although beak length had a higher R^2 value (R^2 = 0.49) than shank length. This means that beak length is a better predictor of sperm motility in the exotic cocks. Galal (2007) predicted sperm motility using shank length in Fayoumi Nana genotype of chicken with an accuracy of 0.83. In the local cocks, shank length and wing length are good predictors of live sperm. However, shank length has higher accuracy of prediction (R^2 = 0.52) than wing length (R^2 = 0.35). This makes shank length a better predictor of live sperm than wing length in the local cocks. The results of the multiple regression analysis for the exotic and local cocks are presented in Table 6 and 7, respectively. The regression equations were significant for semen volume, concentration, motility and live sperm in the exotic cocks and significant for live sperm and abnormal sperm in the local cocks. In the exotic cocks the highest R^2 values was recorded for sperm concentration (84.70%), followed by sperm motility (62.00%) and semen volume (60.00%). This re-affirms our earlier assertions that the body parameters such as beak length, comb length and shank length could be used to predict these semen traits with reasonable degree of accuracy.

Table 5: Simple regression equations to predict some semen traits of the local cocks from linear body measurements at 30 weeks of age

Independent variables (x)	Dependent variables (y)	Regression equation	SE	R^2(%)
Body weight	Volume (mL)	ẏ = 0.11+0.00x	0.06	0.00^{NS}
	Concentration (×10^6)	ẏ = 7.22+0.00x	0.89	0.00^{NS}
	Motility (%)	ẏ = 107.50-25.00x	9.06	4.20^{NS}
	Livesperm (%)	ẏ =- 106.39-25.00x	9.74	3.60^{NS}
	Abnormal sperm (%)	ẏ =43.33 +0.00x	5.35	00.00^{NS}
Beak length	Volume (mL)	ẏ = 0.08+0.03x	0.12	1.00^{NS}
	Concentration (×10^6)	ẏ = 9.75-1.75x	1.49	12.00^{NS}
	Motility (%)	ẏ = 39.29+12.86x	8.75	10.70^{NS}
	Livesperm (%)	ẏ = 54.29 +2.86x	9.90	0.50^{NS}
	Abnormal sperm (%)	ẏ = 57.14-8.57x	4.95	14.30^{NS}
Comb length	Volume (mL)	ẏ = -0.04+0.08x	0.05	14.50^{NS}
	Concentration (×10^6)	ẏ = 7.83 -0.33x	0.89	1.00^{NS}
	Motility (%)	ẏ = 41.67+10.00x	8.86	8.30^{NS}
	Livesperm (%)	ẏ = 28.33+16.67x	8.86	20.00^{NS}
	Abnormal sperm (%)	ẏ = 61.67-10.00x	4.63	25.00^{NS}
Shank length	Volume (mL)	ẏ = 0.46-0.08x	0.05	14.50^{NS}
	Concentration (×10^6)	ẏ = 5.83+0.33x	0.89	1.00^{NS}
	Motility (%)	ẏ = 18.33+10.00x	8.86	8.30^{NS}
	Livesperm (%)	ẏ = 170.00-26.67x	6.90	51.60*
	Abnormal sperm (%)	ẏ = 43.33+0.00x	5.35	0.00^{NS}
Wing length	Volume (mL)	ẏ = -0.02+0.03x	0.06	5.70^{NS}
	Concentration (×10^6)	ẏ = 4.54+0.51x	0.85	9.80^{NS}
	Motility (%)	ẏ = 72.70-2.43x	9.16	2.00^{NS}
	Livesperm (%)	ẏ = 2.43 +10.81x	8.01	34.90*
	Abnormal sperm (%)	ẏ = 34.87+1.62x	5.27	2.70^{NS}

*p<0.05, NS: Not significant (p>0.05)

Table 6: Multiple linear regression equations for estimating semen traits from body measurements of the exotic cocks at 30 weeks of age

Semen traits	Prediction equations	R^2 (%)	SE	SIG
Semen volume	Vol. = 0.160-0.068 BW+0.063 ShL-0.011 BKL -0.005 CBL-0.017 WL	60.00	0.02	***
Concentration	Conc = 0.562+1.724 BW -1.722 ShL+2.570 BKL+1.587 CBL+0.044 WL	84.70	0.44	***
Motility	Mot = -69.448+26.434 BW+10.250 ShL+17.291 BKL -7.007 CBL -0.719 WL	62.00	5.99	***
Livesperm	Liv.spm = -14.377+17.238 BW+2.782 ShL-14.298 BKL+15.867 CBL+0.442 WL	44.00	7.27	***
Abnormal sperm	Abn.spm = 97.396 -11.206 BW -3.797 ShL+7.383 BKL -4.311 CBL -1.740 WL	31.30	5.08	NS

BW: Bodyweight, ShL: Shank length, BKL: Beak length, CBL: Comb length, WL: Wing length, R^2: Coefficient of multiple determinant, SE: Standard error, NS: Not significant, ***p<0.001

Table 7: Multiple linear regression equations for estimating semen traits from body measurements of the local cocks at 30 weeks of age

Semen traits	Prediction equations	R^2 (%)	SE	SIG
Semen volume	Vol. = 0.984-0.259 BW-0.133 ShL+0.121 BKL+0.060 CBL-0.025 WL	47.90	0.06	NS
Concentration	Conc = -5.608+3.410 BW+0.466 ShL+2.007 BKL-1.505 CBL+0.754 WL	48.30	0.98	NS
Motility	Mot. = 221.262-73.115 BW-2.098 Shl+16.590 BKL+12.557 CBL-12.131 WL	44.80	10.50	NS
Livesperm	Liv.spm = 244.443-52.131 BW-31.541 Shl+1.246 BKL+14.066 CBL+3.279 WL	96.40	2.87	***
Abnormal sperm	Abn.spm = -65.393+39.672 BW+7.148 Shl-10.885 BKL-11.836 CBL+8.197 WL	61.40	5.07	***

BW: Bodyweight, Shl: Shank length, BKL: Beak length, CBL: Comb length, WL: Wing length, R^2: Coefficient of multiple determinant, SE: Standard error, NS: Not Significant, ***p<0.001

Similarly, in the local cocks, the R^2 value was highest for percent live sperm (96.40%), followed by abnormal sperm (61.40%) implying that the degree of associations between the body parameters and these semen traits were high. This means that we can predict the live sperm and the abnormal sperm using the body measurements.

CONCLUSION AND RECOMMENDATIONS

It was concluded as follows:

- Beaklength was a good predictor of sperm concentration and percent live sperm in the exotic cocks
- Comblength was a good predictor of sperm concentration (R^2 = 0.36) while shanklength was a good predictor of percent motility (R^2 = 0.34) in the exotic cocks.
- Beaklength predicted sperm concentration and sperm motility with higher accuracy compared to comblength and shanklength
- Both shanklength and winglength were good predictors of livesperm in the local cocks. However, shanklength predicted livesperm with higher accuracy compared with winglength

Based on these results, it was suggested that in the rural areas where there is no facility for microscopic evaluation of semen, farmers can use length of beak, shank, comb and wing to predict the semen quality of their breeding cocks.

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