Genotype-diet effect on comparative semen parameters of chickens fed graded levels of *Moringa oleifera* seed meal

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Abstract

Moringa oleifera seed meal is a novel feed ingredient that has attracted the attention of many researchers as it affects the utilization since it thrives well in almost all ecological zones. However, it is ascertained that there is variation within and across different genotypes of chickens. The study aimed to determine the genotype-diet effect on semen and spermiogramic parameters of chickens fed graded *Moringa oleifera* seed meal (MOSM). The study evaluated the comparative influence of dietary MOSM on semen and spermiogramic characteristics of Yoruba Ecotype Nigerian Local Chickens (YENLC) and Isa Brown chickens. Data obtained were subjected to correlation and forward-stepwise regression using the Statistical Package for Social Sciences (SPSS) software Version 22. The findings of the study showed that the inclusion of MOSM in the diets of the birds of both genotypes affected the spermiogramic and semen parameters of the cocks. There was a significant high positive correlation ($p<0.05$) between body weight and spermatozoa reserves in the testes of YENLC. The positive relationship between body weight and spermatozoa reserves in the epididymis significantly increased ($p<0.05$) up to 10% inclusion of MOSM but significantly reduced at 15% inclusion. The relationship between body weight and sperm motility was negative but became positive and significantly low ($P<0.05$) at 15% inclusion of MOSM. Bodyweight can be significantly predicted ($p<0.05$) from spermiogramic parameters (R^2=82.40%) and spermatozoa reserves in the testes can be significantly predicted ($p<0.05$) from bodyweight for YENLC but predictions of both body weight and spermiogramic parameters could not be done for Isa Brown cocks since the R^2 values were significantly low ($p<0.05$) hence with very low reliability. However, there were associations between body weight and spermiogramic parameters and Body weights predicted sperm characteristics. These components could, however, be used in the selection for sperm characteristics in YENLC and Isa Brown Cocks.

Keywords: Comparative, Semen, Spermiogramic, *Moringa oleifera*, Cocks

Introduction

It is necessary to evaluate the degrees of associations and the predictive abilities of various reproductive parts of chickens. This will help select males that could be used in breeding programmes and for sustainable meat and egg production in Nigeria. Oke and

Ihemeson (2010) reported differences between genotypes and species in the volume of semen concentration and the total number of spermatozoa in an ejaculate. Differences in volume and sperm concentration depend primarily on the various reproductive glands (Hafez, 1987). It has also been established that diet significantly influenced reproduction cum semen production in livestock. However, basic morphometric data and correlation and predictive abilities of the reproductive organs and sperm reserve of the two genotypes (YENLC and Isa Brown chickens) and the influence of MOSM on these parameters is limited. This study's efficiency will help improve breeding practices as influenced by the feeding of graded levels of MOSM since a baseline for assessing the reproductive organs in relation to the sperm reserves of the genotypes, and the effect of MOSM will be established.

Materials and Methods

Location of the study

The study was carried out at the Livestock Section of the Teaching and Research Farm of the Federal College of Animal Health and Production Technology, Moor Plantation, Ibadan. The experiment lasted for forty weeks.

Data collection and analysis

Data collected were used to estimate the correlation and regression for spermiogramic indices and semen characteristics in Yoruba Ecotype Nigeria Local Chickens and Isa Brown Chickens and the overall effect on graded levels of MOSM.

Pearson correlations between body weight and semen quality traits were assessed for the two genotypes of chickens and the four graded levels of MOSM for all the chickens irrespective of the genotypes using SPSS Version 20 (2012). Predicting late semen and egg parameters of the two genotypes of chickens and all the chickens in the various dietary treatments.

A forward regression procedure using a stepwise variable selection was used to obtain models of estimation from biometric measurements and established principal components factor scores (Dahloum *et al*., 2016):

$$Y = a + b_1X_1 + ... + b_kX_k,$$

where Y is the dependent variable, a is the regression intercept, bi is the ith partial regression coefficients of the ith measurement or principal component, and X_i and PCi are the ith traits or principal components.

Results

Table 1 showed the correlations between the various semen quality traits and body weight. Most correlations irrespective of direction ranged from low to moderate and high. However, the correlations were highly significant ($p<0.05$).

Table 2 shows a high positive correlation between body weight and spermatozoa reserves in the testes (r=0.917). However, correlations coefficients varied from low to moderate to high for YENLC.

Table 3 shows a high positive correlation between body weight and spermatozoa reserves in the testes (r=0.655) and paired testis volume and paired testis weight (r=0.573). However, correlations coefficients varied from low to moderate to high for Isa Brown cocks.

From Table 4, it was discovered that there was a significant positive ($p<0.05$) relationship between body weight and spermatozoa reserves in the testis (r=0.877) and paired testis volume (r=0.815) but a significant negative correlation ($p<0.05$) between body weight and semen volume (r=-0.889) and sperm concentration (r=-0.823).

Also, there was a significant positive correlation ($p<0.05$) between paired testis weight and spermatozoa reserves in the testis ($r=0.804$).

Table 5 reveals that there was a significant positive ($p<0.05$) relationship between paired testis weight and paired testis volume ($r=0.850$). Also, there was a significant positive relationship ($p<0.05$) between body weight and spermatozoa reserves in the testis ($r=0.961$) as well as body weight and spermatozoa reserves in the epididymis ($r=0.805$). A significantly high positive relationship ($p<0.05$) also existed between spermatozoa reserves in the epididymis and spermatozoa reserves in the testis ($r=0.844$).

Table 6 also shows that there was a significant positive ($p<0.05$) relationship between paired testis weight and paired testis volume ($r=0.946$), paired epididymis weight and body weight ($r=0.952$), body weight and spermatozoa reserves in the testis ($r=0.937$) and spermatozoa reserves in the testis and paired epididymis weight ($r=0.911$). There was a high but significant negative correlation ($p<0.05$) between paired epididymis weight and semen volume ($r=-0.952$) and body weight and semen volume ($r=-0.922$).

From Table 7, it was revealed that there was a significant positive ($p<0.05$) relationship between body weight and spermatozoa reserves in the testis ($r=0.970$). However, correlations coefficients varied from low to moderate to high for YENLC, and Isa Brown cocks fed 15% MOSM.

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 Tables 8 and 9, respectively. From the tables, most of the regression equations had low R^2 values ranging from 0.00 to 0.468 but bodyweight could predict spermatozoa reserves in the testis; hence the high R^2 value of 0.840. However, from Table 9, the spermiogramic parameters are good predictors of body weight ($R^2 = 0.853$)

Regression equations relating semen traits to body parameters with their standard errors and accuracy of prediction (R^2) values for the YENLC cocks are presented in Tables 10 and 11, respectively. Table 10 observed that body weight could predict spermatozoa reserves in the testis compared with the other parameters, hence the high R^2 value of 0.823. However, from Table 11, the spermiogramic parameters are good predictors of body weight ($R^2 = 0.824$)

Regression equations relating semen traits to body parameters with their standard errors and accuracy of prediction (R^2) values for the YENLC cocks are presented in Tables 12 and 13, respectively. Table 12 observed that body weight could not predict well the sperm parameters as the R^2 values are very low. However, from Table 13, the spermiogramic parameters are good predictors of body weight ($R^2 = 0.528$).

Table 1. Correlations of spermiogramic parameters of birds irrespective of diets and genotypes

	Paired testis weight	Paired epididymis	Paired testis volume	BW	Spermatozoa reserves TESTIS	Spermatozoa reserves – EPIDIDYMIS	Semen Volume	Mass Activity	Sperm Motility	Sperm Conc.
Paired testis weight	1.000									
Paired epididymis weight	.505	1.000								
aired testis volume	.768	.511	1.000							
Body Weight	.579	.618	.684	1.000						
Spermatozoa reserves-TESTIS	.647	.641	.718	.917	1.000					
Spermatozoa reserves - EPIDIDYMIS	.215	.248	.163	.405	.366	1.000				
Semen Volume	.080	.069	-.106	.161	.204	.637	1.000			
Mass Activity	-.333	-.331	-.351	-.478	-.432	-.179	-.105	1.000		
Sperm Motility	-.131	-.171	-.145	-.164	-.258	-.412	-.322	.109	1.000	
Sperm Concentration	-.315	-.257	-.383	-.449	-.420	-.138	-.060	.241	-.167	1.000

Table 2. Correlations of spermiogramic parameters of YENLC irrespective of diets

	Paired testis weight	Paired epididymis	Paired testis volume	BW	Spermatozoa reserves - TESTIS	Spermatozoa reserves - EPIDIDYMIS	Semen Volume	Mass Activity	Sperm Motility	Sperm Conc.
Paired testis weight	1.000									
Paired epididymis	.505	1.000								
Paired testis volume	.768	.511	1.000							
BW	.579	.618	.684	1.000						
Spermatozoa reserves – TESTIS	.647	.641	.718	.917	1.000					
Spermatozoa reserves – EPIDIDYMIS	.215	.248	.163	.405	.366	1.000				
Semen Volume	.080	.069	-.106	.161	.204	.637	1.000			
Mass Activity	-.333	-.331	-.351	-.478	-.432	-.179	-.105	1.000		
Sperm Motility	-.131	-.171	-.145	-.164	-.258	-.412	-.322	.109	1.000	
Sperm Conc.	-.315	-.257	-.383	-.449	-.420	-.138	-.060	.241	-.167	1.000

Table 3. Correlations of spermiogramic parameters of Isa Brown irrespective of diets

	Paired testis weight	Paired epididymis	Paired volume	BW	Spermatozoa reserves - TESTIS	Spermatozoa reserves - EPIDIDYMIS	Semen Volume	Mass Activity	Sperm Motility	Sperm Conc.
Paired testis weight	1.000									
Paired epididymis	.227	1.000								
Paired testis volume	.573	.118	1.000							
BW	.028	-.293	.129	1.000						
Spermatozoa reserves – TESTIS	.256	.012	.255	.655	1.000					
Spermatozoa reserves – EPIDIDYMIS	-.070	-.175	-.228	.016	-.050	1.000				
Semen Volume	-.065	.034	-.199	-.034	-.057	-.106	1.000			
Mass Activity	.119	.280	.200	-.106	.221	.100	-.215	1.000		
Sperm Motility	.004	-.021	.073	.054	-.192	-.456	.166	-.069	1.000	
Sperm Conc.	-.185	.047	-.310	-.236	-.313	.044	-.240	.105	-.303	1.000

Table 4. Correlations of spermiogramic parameters of birds fed 0% MOSM

	Paired testis weight	Paired epididymis	Paired testis volume	BW	Spermatozoa reserves - TESTIS	Spermatozoa reserves - EPIDIDYMIS	Semen Volume	Mass Activity	Sperm Motility	Sperm Conc.
Paired testis weight	1.000									
Paired epididymis	-.082	1.000								
Paired testis volume	.623	-.086	1.000							
BW	.687	-.372	.815	1.000						
Spermatozoa reserves - TESTIS	.804	-.096	.759	.877	1.000					
Spermatozoa reserves-EPIDIDYMIS	.538	-.236	.434	.534	.664	1.000				
Semen Volume	-.759	.217	-.721	-.878	-.889	-.571	1.000			
Mass Activity	-.302	.447	-.386	-.548	-.349	-.179	.474	1.000		
Sperm Motility	-.586	-.142	-.528	-.387	-.535	-.413	.396	-.101	1.000	
Sperm Conc.	-.593	.307	-.694	-.823	-.788	-.733	.764	.487	.587	1.000

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Table 5. Correlations of spermiogramic parameters of birds fed 5% MOSM

	Paired testis weight	Paired epididymis	Paired testis volume	BW	Spermatozoa reserves - TESTIS	Spermatozoa reserves – EPIDIDYMIS	Semen Volume	Mass Activity	Sperm Motility	Sperm Conc.
Paired testis weight	1.000									
Paired epididymis	.625	1.000								
Paired testis volume	.850	.481	1.000							
BW	.628	.686	.606	1.000						
Spermatozoa reserves - TESTIS	.697	.739	.711	.961	1.000					
Spermatozoa reserves - EPIDIDYMIS	.549	.405	.668	.805	.844	1.000				
Semen Volume	-.128	.080	-.279	.015	.011	-.261	1.000			
Mass Activity	-.221	-.444	-.186	-.781	-.701	-.488	-.382	1.000		
Sperm Motility	.159	-.133	.090	-.166	-.134	-.117	.054	.075	1.000	
Sperm Conc.	-.195	-.066	-.265	.033	.004	.150	-.182	-.050	-.407	1.000

Table 6. Correlations of spermiogramic parameters of birds fed 10% MOSM

	Paired testis weight	Paired epididymis	Paired testis volume	BW	Spermatozoa reserves - TESTIS	Spermatozoa reserves - EPIDIDYMIS	Semen Volume	Mass Activity	Sperm Motility	Sperm Conc.
Paired testis weight	1.000									
Paired epididymis	.686	1.000								
Paired testis volume	.946	.787	1.000							
BW	.649	.952	.758	1.000						
Spermatozoa reserves – TESTIS	.590	.911	.685	.937	1.000					
Spermatozoa reserves – EPIDIDYMIS	.615	.815	.620	.820	.857	1.000				
Semen Volume	-.631	-.952	-.721	-.922	-.866	-.743	1.000			
Mass Activity	-.475	-.482	-.514	-.549	-.479	-.317	.458	1.000		
Sperm Motility	-.300	-.406	-.371	-.499	-.572	-.645	.285	.171	1.000	
Sperm Conc.	.121	.262	.232	.211	.188	.235	-.320	.300	-.032	1.000

Table 7. Correlations of spermiogramic parameters of birds fed 15% MOSM

	Paired testis weight	Paired epididymis	Paired testis volume	BW	spermatozoa reserves-TESTIS	Spermatozoa reserves-EPIDIDYMIS	Semen Volume	Mass Activity	Sperm Motility	Sperm Conc.
Paired testis weight	1.000									
Paired epididymis	.571	1.000								
Paired testis volume	.699	.731	1.000							
BW	.533	.861	.730	1.000						
Spermatozoa reserves-TESTIS	.581	.846	.797	.970	1.000					
Spermatozoa reserves – EPIDIDYMIS	.056	.256	-.078	.510	.382	1.000				
Semen Volume	-.018	-.092	-.200	-.234	-.149	-.209	1.000			
Mass Activity	-.320	-.553	-.290	-.373	-.317	-.130	.018	1.000		
Sperm Motility	.212	.249	.375	.032	.111	-.666	.097	-.176	1.000	
Sperm Conc.	-.572	-.840	-.761	-.743	-.744	-.149	-.044	.598	-.342	1.000

Table 8. Simple regression equations to predict some semen traits of the cocks irrespective of genotype from body weights at 24 weeks of age

Independent Variable (x)	Dependent Variables (y)	Regression equation	R^2	SE
BW	Volume	-1.31 + 0.007BW	0.468*	0.298
	Testes Weight	-0.0809 + 0.005BW	0.336*	0.323
	Epididymis Weight	0.061+0.000BW	0.382*	0.222
	Spermatozoa Reserves(testes)	0.087 +0.001BW	0.840*	0.256
	Spermatozoa Reserves (epididymis)	0.003 + 0.00BW	0.164*	0.136

Key: BW (Body Weight), R^2=Variance explained, SE (Associated Standard Error)

Table 9. Simple regression equation to predict body weight of the cocks irrespective of genotype from some semen traits at 24 weeks of age

Independent Variables (x)	Dependent Variable (y)	Regression equation	R^2	SE
Volume Testes Weight Epididymis Weight Spermatozoa Reserves(testes) Spermatozoa Reserves (epididymis)	BW	211.720 + (-10.069)TW + 80.085EW 546.067SRT + 260.729SRE + 13.227V	0.853*	0.168

Key: BW (Body Weight), TW (Testes Weight), EW (Epididymis Weight), SRT (Spermatozoa Reserves – Testes), SRE (Spermatozoa Reserves – Epididymis), V (Volume), R^2=Variance explained, SE (Associated Standard Error)

Table 10. Simple regression equations to predict some semen traits of the YENLC cocks from body weights at 24 weeks of age

Independent Variable (x)	Dependent Variables (y)	Regression equation	R^2	SE
BW	Volume	-1.039 + 0.006BW	0.596*	0.193
	Testes	1.886 + 0.003BW	0.449*	0.121
	Epididymis	0.009 + 0.0BW	0.252*	0.276
	SRT	0.411 + 0.001BW	0.823*	0.194
	SRE	0.017 + 0.000BW	0.567*	0.408

Key: BW (Body Weight), TW (Testes Weight), EW (Epididymis Weight), SRT (Spermatozoa Reserves – Testes), SRE (Spermatozoa Reserves – Epididymis), V (Volume), R^2=Variance explained, SE (Associated Standard Error)

Table 11. Simple regression equation to predict body weight of the YENLC cocks from some semen traits at 24 weeks of age

Independent Variables (x)	Dependent Variable (y)	Regression equation	R^2	SE
Volume Testes Epididymis SRT SRE	BW	-34.891 + (-12.716)EW + 7.418V + 691.125SRT + 378.441SRE + (6.760)TW	0.824*	0.173

Key: BW (Body Weight), TW (Testes Weight), EW (Epididymis Weight), SRT (Spermatozoa Reserves – Testes), SRE (Spermatozoa Reserves – Epididymis), V (Volume), R^2=Variance explained, SE (Associated Standard Error)

Table 12. Simple regression equations to predict some semen traits of the Isa Brown cocks from body weights at 24 weeks of age

Independent	Dependent	Regression equation	R^2	SE
BW	Volume	7.304 + 0.003BW	0.017*	0.340
	Testes	9.433 + 0.001BW	0.001*	0.382
	Epididymis	1.436 + 0.000BW	0.086	0.14
	SRT	0.117 + 0.001BW	0.0430*	0.27
	SRE	0.263 + (1.576*10-5)BW	0.000	0.16

Key: BW (Body Weight), TW (Testes Weight), EW (Epididymis Weight), SRT (Spermatozoa Reserves – Testes), SRE (Spermatozoa Reserves – Epididymis), V (Volume), R^2=Variance explained, SE (Associated Standard Error)

Table 13. Simple regression equation to predict body weight of the Isa Brown cocks from some semen traits at 24 weeks of age

Independent	Dependent	Regression equation	R^2	SE
Volume	BW	1399.316 + (-5.002)TS + (-315.653)ES + 2.783V	0.528*	0.12296
Testes		+ 320.866SR + 5.812SRE		
Epididymis				
SRT				
SRE				

Key: BW (Body Weight), TW (Testes Weight), EW (Epididymis Weight), SRT (Spermatozoa Reserves – Testes), SRE (Spermatozoa Reserves – Epididymis), V (Volume), R^2=Variance explained, SE (Associated Standard Error)

Discussion

The information relating to the reproductive tract's morphometric parameters have been observed to give invaluable information on adjudging the breeding and fertilizing ability of animals (Ogbuewu et al., 2009). Also, in the study conducted by Ahemen et al. (2016), a significant positive relationship was observed between live weight and testes weight (r=0.65; p<0.05) as well as epididymal weight (r=0.85; p<0.05). The excellent and positive correlations between live weight and testes weight indicate the possibility of predicting testes weight from live weight Since testes weight is known to be very positively correlated with sperm production and testicular sperm reserves (Ahemen et al. 2013). Togun et al. (2006) also reported live weight to be significantly correlated with testes weight. Togun et al. (2006) opined that males with larger testes would tend to produce more sperm.

A high positive and significant correlation between volume and concentration in the control diet had been reported (Bilcik et al., 2005; Gebriel et al., 2009; Abd El Ghany et al., 2011). This showed that the inclusion of MOSM was responsible for the low negative correlation between the two variables. This study also observed that body weight was positive but not significantly correlated with volume and concentration in some and negatively correlated in birds fed 0%, 10% and 15% MOSM and when all the birds were considered. Some other reports have shown a positive relationship between these parameters (Gebriel et al., 2009; Abd El Ghany et al., 2011). A positive correlation between body weight and volume had also been reported by El Sahn (2007). However, Makhafola et al. (2012) reported that body weight was negatively correlated with ejaculate volume, semen concentration in Naked neck and Ovampo but a positive correlation was reported between body weight and volume in Potchefstroom Koekoek strains of Southern African indigenous cockerels.

Conclusion

Correlations of all the birds were from low to medium to high and when separated by genotypes. Feeding 5% MOSM strengthened the association of spermatozoa reserves in the epididymis with other parameters while it lowered the association between the spermatozoa reserves in the testis and all semen characteristics Feeding MOSM up to 10% reduced the association of sperm concentration with other spermiogramic parameters with an exception of spermatozoa reserves in the epididymis but at 15% MOSM, semen volume reduced. However, the bodyweight of the cocks could be predicted using all the spermiogramic parameters and spermatozoa reserves in the testis could be predicted from bodyweight with greater than 80% accuracy. The traits could only predict the bodyweight of Isa Brown cocks with higher than 55% accuracy.

It is therefore recommended from this study that the inclusion of MOSM up to 10% could significantly influence the relationship between body weight and spermiogramic parameters.

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