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ORIGINAL RESEARCH ARTICLE

Sperm Characteristics of Nigeria Local Cocks and Exotic Strain of Cocks fed Graded Levels of *Moringa oleifera* Seed Meal

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ABSTRACT
Moringa oleifera seed meal (MOSM) offers a lot of potentials as a feedstuff which could be included in poultry nutrition. The experiment assessed the comparative influence of dietary MOSM on the sperm characteristics (semen volume, semen colour, mass activity, sperm motility, sperm concentration, testicular weights, epididymal weights, sperm reserves in the testis and epididymis and daily sperm production) of Yoruba Ecotype Nigerian Local Chickens (YENLC) and Isa Brown chickens. Data from this study were subjected to analysis of variance. The findings from this study showed that MOSM affected the sperm parameters of the cocks. YENLC had significantly higher values for semen characteristics but the reverse was the case for spermiogramic parameters where Isa Brown cocks had significantly higher (p<0.05) values. For all the chickens, birds fed 5% and 15% MOSM had significantly higher semen volume, 5% and 10% MOSM had higher mass activity and sperm motility while 10% had significantly better (p<0.05) sperm concentration. For YENLC, birds fed 15% MOSM had significantly higher semen volume, 5% and 10% had significantly higher mass activity and sperm motility while 10% and 15% had better sperm concentration. Isa Brown cocks, birds fed 5% and 15% had significantly better (p<0.05) semen volume and sperm motility, 10% had significantly better (p<0.05) mass activity while birds fed MOSM had significantly better (p<0.05) sperm concentration. It was concluded that 10% MOSM dietary inclusion would contribute to optimum growth and reproductive performance in YENLC. The study recommended that up to 10% MOSM can be included in chickens' diet irrespective of the genotype for optimum sperm production and reproductive performance.

Keywords: Genotype, Isa brown chickens, Reproductive response, Yoruba ecotype chickens

INTRODUCTION
Feed has been identified by several scholars as one of the most vital items that determine the production and quality of semen in male birds especially cocks (Hocking and Bernard, 1997; Omeje and Ude, 1998, Ibtisham et al, 2018). In a study by Boone and Hughes (1969) it was observed that cocks starved for six days had a marked reduction in semen quality and quantity and upon the commencement of normal feeding the condition was reversed after 14 days. Nwosu (1979) observed a remarkable improvement in the reproductive traits especially egg yields of local chickens when the birds were raised intensively and with levels of improved feeding. However, for optimum reproductive performance of chickens, adequate diets with balanced nutrients have to be provided. It is therefore imperative to say that for optimum reproductive performance of breeding stock, the birds have to be maintained on adequate nutritional environment. Pana et al. (2000) reported that Cornish broiler cocks whose daily feed consumption was limited to 130g produced ejaculates whose concentration did not differ significantly from their full-fed counterparts. Ezekwe et al. (2003) reported that semen quality traits were adversely affected when animals were underfed. There was more severity with the physical traits rather than the biochemical characteristics. This implied that the spermatogenic functions of the testes are more responsive to underfeeding than the secretory activities of the reproductive tract. In broiler breeder males as reported by Hocking and Bernard (1997), semen production was affected by dietary crude protein and feed intake. Moderate underfeeding was reported to affect semen production and semen quality attributes of local cocks whereas volume, motility and concentration were significantly depressed by severe underfeeding (Ezekwe et al. 2003).
Many researchers have reported the anti-fertility properties of non-conventional feedstuff.

However, it has been shown that diets with phytochemicals may retard spermatogenesis and egg production in animal breeding.

There are many factors that affect the reproductive efficiency of chickens. These factors are breed, age, season, bio-climatic changes, hormone balance, drugs and nutrition. In this study, the possible effect of the inclusion of MOSM in YENLC and Isa Brown chickens' diets on their reproductive potentials was studied. Reproductive efficiency can be reduced because of improper nutrition. It was suggested by Etches et al. (1979) that production of defective spermatozoa and their failure to ascend the oviduct properly is due possibly to defective nutrient metabolism. The differences in genetic make-up coupled with the bird's inherent abilities to adjust and adapt to fluctuating weather conditions are the major factors determining the reproductive performance of any breed of chickens reared in any production environment. Also, it is established that the reproductive potentials (that is sperm production and egg production) differ per different breeds and plane of nutrition. The study is aimed to determine whether the inclusion of MOSM in two genotypes of chickens' diets has a deterrent action on the sperm production. The study also aimed to explore the level at which MOSM can be used for different genotypes of chickens.

MATERIALS AND METHODS

Sources of MOSM

The test ingredient, *Moringa oleifera* seed, was sourced from Kaduna metropolis. The seeds were air dried at the room temperature after which the meal was prepared. The seeds of *Moringa oleifera* were then milled and incorporated into the chickens' diets in appropriate proportion.

Animals, experimental design and management

The YENLC were sourced from the Department of Animal Breeding and Genetics, Federal University of Agriculture, Abeokuta, Nigeria. The Isa Brown cockerels were also sourced from Obasanjo Farm, Ibadan, Oyo State, Nigeria. One hundred and ninety two chickens (ninety six Isa Brown cocks and ninety six local chickens) were allotted to four treatment groups containing graded levels of MOSM: 0% (diet 1), 5% (diet 2), 10% (diet 3), 15% (diet 4) fed independently to the broiler chicks and local chickens such that each treatment comprised of three replicates of eight birds each in a 2 x 4 factorial design. The chickens were weighed weekly till sexually matured. MOSM were fed to the chickens from day 1 to week 8 after which the reproductive parameters (semen colour, semen volume, mass activity, sperm motility, sperm concentration, number of motile sperms, predicted hen bred per ejaculate, testis weights, epididymis weight, testis volume, sperm reserves in the testes and epididymis, relative weight of testis and epididymis and daily sperm production) were examined. This is to examine the effects of early feeding of MOSM on the reproductive performance of chickens.

Semen Collection and Evaluation

Semen was collected from the cocks weekly for eight weeks and assessed for semen volume, semen colour, mass activity, mass motility, sperm concentration and hen bred/ejaculate was calculated using formula as described by Akintunde (2018). Semen was collected into graduated collection tube which made the volume of semen collection to be easily read. The colour of the semen was determined visually. Mass activity was done within sixty seconds of semen collection. This was done by putting a drop of semen in its concentrated form on a slide without coverslip and observed under the microscope at a magnification of (X10). The microscopic wave pattern of the concentrated semen was clearly shown and this ranged from no activity/motion to very rapid motion. The activities were graded as: 0= no mass activity; += slow wave motion; ++= rapid wave motion; +++= very-wave motion. The values for progressive sperm motility were obtained by adding a drop of sodium citrate to a drop of semen on the slide after which a cover slip was placed on the solution. This was further viewed using a microscope at a magnification of 10x. The values were expressed in percentage. Sperm concentration was determined by the use of an improved Neubauer haemocytometer (Bearden and Fuquay, 1997). 0.5ml of the semen collected was pipetted and this was made up to 1.01ml using normal saline. Drops of the solution were later introduced into the boxes of the haemocytometer chamber for counting. The five squares that formed the diagonal segment of the square were counted.

Testes were collected after slaughtering, weighed and processed for testicular sperm reserves and daily sperm production (Ewuola and Egbunike, 2009) and (Amann,1970) respectively.

Testicular and epididymal sperm reserve: This is the total number of spermatozoa and late spermatids counted in testicular/epididymal aqueous suspension. The process involves the homogenisation of known weight of testes and epididymides in ice-cold physiological saline for two minutes, and counting sperm cells with the Neubuar haemocytometer (Egbunike et al., 1975). Daily sperm production (DSP): Daily sperm production was calculated from gonadal sperm reserve using a formula proposed by Amann (1970):

$$DSP = \frac{\text{Spermatozoa count}}{\text{Time divisor}}$$

Also, estimated hens bred per ejaculate was estimated using the formula described by Akintunde (2018) as number of motile sperms per the average number of sperm cells required to fertilize the eggs of hens (which was estimated to be 5 X 10^7/ml as reported by Saleh et al .(2012).

Statistical Analysis

Data from this study were further subjected to a two-way analysis of variance for the effect of breed and treatment and their interactions. Means were separated using Duncan New Multiple Range Test at 95% confidence interval.

Data were analyzed using the General Linear Model procedure of the SPSS Version 22 (IBM, SPSS). The appropriate statistical model used was:

$Y_{ijk} = \mu + G_i + M_j + (GM)_{ijk} + \varepsilon_{ijk}$

Y_{ijk} = observation on k^{th} population, of i^{th} genotype and j^{th} MOSM inclusion

μ = common mean

G_i = fixed effect of genotype (i=2)

M_j =fixed effect of MOSM inclusion (j=4)

$(GM)_{ijk}$ = interaction effect of genotype and MOSM

ε_{ijk} = error term associated with each record (normally, independently and identically distributed with zero mean and constant variance)

RESULTS

From Tables 1 and 2, it was observed that for sperm motility, sperm concentration and estimated hen bred per ejaculate birds fed MOSM at 10% had significantly higher ($p<0.05$) values compared to the control. Also, Table 2 showed that YENLC had significantly higher ($p<0.05$) values for all the semen characteristics studied.

From Table 3, it was observed that the birds in the control groups for both genotypes had the highest weights for left testes, right testes and both testes. Also, diets did not significantly influence the weight of the left epididymis for the exotic chickens. However, the weights decreased across group for the YENLC. Also, the weights of right epididymis decreased across group for YENLC up till the birds in the 10% MOSM group. However, the right epididymal weights for the birds fed MOSM were uniform but significantly lower than that of the control. The paired epididymal weights increased significantly across the group for YENLC while it decreased significantly across group for the ISA Brown Cockerels.

It is noteworthy to state that as the levels of MOSM increased, the body weight was significantly reduced for both genotypes. This implies that the higher the level of the test ingredients the lower their growth rates. it was observed that the relative testis weights decreased significantly across the group. There was no significant difference on the relative epididymis weight for birds fed the graded levels of MOSM. Daily sperm production in the testis was relative the same for all the birds in all the groups.

Considering the genotype effects of the birds, it was observed that the ISA Brown cockerels had significantly higher values for all the parameters when compared with the YENLC.

Also, from Table 4, it was observed that the left testis weight, right testis weight, paired testis weight, left epididymis weight, right epididymis weight, paired epididymis weight, left testes volume, right testes volume paired testes volume decreased significantly ($p<0.05$) from the control (0% MOSM) to 10% MOSM treatments. However, the body weights of the birds decreased significantly ($p<0.05$) across the group.

It was also observed that the spermatozoa reserves decreased significantly ($p<0.05$) across the group while birds fed 15% MOSM had the highest values for epididymal sperm reserves.

Table 1. Semen Characteristics of YENLC and Isa Brown Cocks fed graded levels of Moringa oleifera Seed Meal

	YENLC				ISA BROWN			
	0% MOSM	**5% MOSM**	**10% MOSM**	**15% MOSM**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**
Semen Volume (ml)	0.22 ± 0.01^{c}	0.18 ± 0.01^{b}	0.17 ± 0.01^{b}	0.24 ± 0.09^{d}	0.09 ± 0.01^{ab}	0.21 ± 0.07^{c}	0.06 ± 0.01^{a}	0.16 ± 0.06^{ab}
Semen Colour	Milky	Milky	Milky	Milky	Milky	Milky	Milky	Milky
Mass Activity	1.63 ± 0.26^{d}	2.57 ± 0.20^{f}	2.14 ± 0.40^{e}	1.60 ± 0.24^{c}	0.92 ± 0.19^{a}	0.92 ± 0.19^{a}	1.00 ± 0.17^{b}	0.92 ± 0.16^{a}
Sperm Motility(%)	61.56 ± 0.75^{c}	64.57 ± 1.74^{d}	65.00 ± 3.09^{d}	58.00 ± 1.22^{ab}	58.75 ± 0.90^{b}	63.92 ± 1.42^{cd}	57.50 ± 1.79^{a}	59.17 ± 1.57^{b}
Sperm Concentration ($x10^9$/ml)	5.38 ± 0.21^{c}	4.69 ± 0.24^{ab}	5.87 ± 0.40^{cd}	6.48 ± 0.37^{d}	4.36 ± 0.06^{a}	4.62 ± 0.16^{ab}	6.06 ± 0.09^{d}	4.67 ± 0.13^{ab}
No of Motile Sperms ($x10^9$)	3.32 ± 0.15^{c}	3.03 ± 0.18^{b}	3.81 ± 0.32^{d}	3.75 ± 0.20^{d}	2.56 ± 0.06^{a}	2.93 ± 0.07^{ab}	3.49 ± 0.14^{cd}	2.75 ± 0.07^{a}
Estimated Hen Bred/Ejaculate	66.31 ± 3.09^{c}	60.56 ± 3.64^{b}	76.13 ± 6.38^{d}	75.02 ± 4.06^{d}	51.26 ± 1.22^{a}	58.66 ± 1.42^{ab}	69.84 ± 2.80^{c}	54.99 ± 1.46^{a}

a, b, c means with different superscript within a row are significantly different Group mean, standard error and number count of samples (x±sem(n)) shown
**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*

Table 2. Semen Characteristics of Chickens fed graded levels of MOSM and Genotype effects

	YENLC	**Marshall**	**0% MOSM**	**5% MOSM**	**10% MOSM**	**15% MOSM**	**GXD**
Semen Volume (ml)	0.20 ± 0.02*	0.13 ± 0.02	0.14 ± 0.02^{a}	0.20 ± 0.05^{b}	0.10 ± 0.01^{a}	0.18 ± 0.05^{b}	*
Semen Colour	Milky	Milky	Milky	Milky	Milky	Milky	*
Mass Activity	2.00 ± 0.16*	0.94 ± 0.09	1.20 ± 0.17^{ab}	1.53 ± 0.23^{c}	1.42 ± 0.22^{c}	1.12 ± 0.15^{a}	*
Sperm Motility (%)	62.57 ± 1.05*	59.83 ± 0.78	59.88 ± 0.68^{a}	64.16 ± 1.07^{b}	60.26 ± 1.77^{b}	58.82 ± 1.10^{a}	*
Sperm Concentration ($x10^9$/ml)	5.53 ± 0.19 *	4.93 ± 0.11	4.77 ± 0.14^{a}	4.64 ± 0.13^{a}	5.99 ± 0.15^{c}	5.20 ± 0.25^{abc}	*
No of Motile Sperm cells ($x10^9$)	3.45 ± 0.12 *	2.93 ± 0.07	2.86 ± 0.11^{a}	2.97 ± 0.08^{a}	3.61 ± 0.15^{c}	3.04 ± 0.13^{ab}	*
Estimated Hen Bred/Ejaculate	68.98 ± 2.45*	58.69 ± 1.34	57.28 ± 2.19^{a}	59.36 ± 1.57^{a}	72.16 ± 2.92^{c}	60.88 ± 2.70^{b}	

*a, b, c means with different superscript within a row are significantly different Group mean, standard error and number count of samples (x±sem(n)) shown *(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal*
GxD- Interaction between genotype and diet

Table 3: Spermiogramic parameters of YENLC and Isa Brown Cocks fed graded levels of MOSM

Parameters	YENLC				ISA BROWN COCKEREL			
	0% MOSM	5% MOSM	(10% MOSM)	(15% MOSM)	(0% MOSM)	(5% MOSM)	(10% MOSM)	(15% MOSM)
Testis Weight (g)								
Left	3.88 ± 0.23 ^{b}	3.14 ± 0.26 ^{a}	3.14 ± 0.14^{a}	3.40± 0.24^{b}	6.63 ± 0.81^{de}	5.58 ± 0.83^{d}	5.38 ± 0.63^{cd}	4.63 ± 1.12^{c}
Right	2.00 ± 0.19 ^{ab}	2.14 ± 0.14^{b}	1.86 ± 0.26^{a}	1.80 ± 0.2^{a}	5.25 ± 0.35^{d}	4.50 ± 0.41^{c}	4.63 ± 0.5^{c}	6.25 ± 0.5^{e}
Paired	5.88 ± 0.3^{b}	5.29 ± 0.29^{a}	5.00 ± 0.31^{a}	5.20 ± 0.37^{a}	11.88 ± 0.88^{e}	10.08 ± 1.11^{c}	10.00 ± 1.05^{c}	10.88 ± 1.35^{d}
Epididymis (g)								
Left	0.58 ± 0.05 ^{b}	0.30 ± 0.04^{a}	0.18 ± 0.03 ^{a}	0.17 ± 0.05^{a}	0.48 ± 0.04^{b}	0.44 ± 0.04^{b}	0.47 ± 0.01^{b}	0.49 ± 0.02^{b}
Right	0.39 ± 0.06^{b}	0.18 ± 0.04^{a}	0.14 ± 0.02^{a}	0.15 ± 0.04^{a}	0.40 ± 0.03^{b}	0.45 ± 0.03^{c}	0.45 ± 0.01^{c}	0.45 ± 0.01^{c}
Paired	0.97 ± 0.07^{b}	0.49 ± 0.05^{a}	0.32 ± 0.04^{a}	0.32 ± 0.07^{a}	0.88 ± 0.05^{b}	0.89 ± 0.07^{b}	0.92 ± 0.01^{b}	0.93 ± 0.03^{b}
Testis Volume (ml)								
Left	4.04 ± 0.19^{a}	3.41 ± 0.3^{a}	3.57 ± 0.18^{a}	3.72 ± 0.19^{a}	7.16 ± 0.57^{b}	6.60 ± 0.68^{b}	6.19 ± 0.51^{b}	6.48 ± 0.62^{b}
Right	2.85 ± 0.2^{ab}	3.17 ± 0.35^{b}	2.37 ± 0.22^{a}	2.50 ± 0.23^{a}	6.93 ± 0.58^{d}	5.15 ± 0.58^{c}	5.45 ± 0.47^{c}	6.31 ± 0.44 ^{d}
Paired	6.89 ± 0.29^{b}	6.58 ± 0.52^{ab}	5.94 ± 0.29^{a}	6.22 ± 0.32^{a}	14.09 ± 0.99^{d}	11.75 ± 1.10^{c}	11.64 ± 0.84^{c}	12.78 ± 0.97^{c}
Body Weight(g)	1447.88 ±36.41^{c}	1462.29±15.39^{b}	1167.14 ±27.55^{b}	833.2 ± 82.06^{a}	2204.5 ± 37.14^{e}	2095.75±24.66 ^{de}	1962.17±23.89^{d}	1862.5±39.01 ^{d}
RTW (%)	0.41 ± 0.02^{a}	0.36 ± 0.02^{a}	0.43 ± 0.03^{a}	0.65 ± 0.09^{c}	0.54 ± 0.04^{b}	0.48 ± 0.05^{b}	0.51 ± 0.05^{b}	0.59 ± 0.07^{b}
REW (%)	0.07 ± 0.01	0.03 ± 0.00	0.03 ± 0.00	0.04 ± 0.01	0.04 ± 0.00	0.04 ± 0.00	0.05 ± 0.00	0.05 ± 0.00
Testis density(g/ml)	0.86 ± 0.05	0.82 ± 0.05	0.84 ± 0.04	0.84 ± 0.08	0.90 ± 0.10	0.87 ± 0.06	0.84 ± 0.04	0.86 ± 0.09
SR (Testis, x 10^{9}}	2.01 ± 0.08	1.87 ± 0.03	1.64 ± 0.05	1.46 ± 0.10	3.36 ± 0.06	2.89 ± 0.05	2.77 ± 0.08	2.64 ± 0.08
DSP (TESTIS)	0.46 ± 0.02^{a}	0.43 ± 0.01^{a}	0.38 ± 0.01^{a}	0.33 ± 0.02^{a}	0.77 ± 0.01^{c}	0.66 ± 0.01^{b}	0.63 ± 0.02^{b}	0.60 ± 0.02^{b}
SR(Epididymis,x10^{9})	0.21 ± 0.03^{ab}	0.18 ± 0.00 ^{a}	0.16 ± 0.01^{a}	0.12 ± 0.01^{a}	0.29 ± 0.01^{b}	0.25 ± 0.01^{b}	0.25 ± 0.01^{b}	0.39 ± 0.10 ^{c}

a, b, c means with different superscript within a row are significantly different **(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal, DSP* - Daily Sperm Production, SR- Spermatozoa reserves, RTW- Relative Testis Weight, REW- Relative Epididymis Weight

Table 4: Spermiogramic parameters of Chickens fed graded levels of MOSM and Genotype-diet interaction

	YENLC	ISA BROWN COCKEREL	0%MSOM	5% MOSM	10% MOSM	15% MOSM	GXD
Testis Weight (g)							
Left	3.41 ± 0.12	5.55 ± 0.42*	5.53 ± 0.58[b]	4.68 ± 0.59[a]	4.55 ± 0.47 (19)[a]	4.26 ± 0.75 (17)[a]	*
Right	1.96 ± 0.10	5.16 ± 0.24*	3.95 ± 0.42	3.63 ± 0.37	3.61 ± 0.45 (19)	4.94 ± 0.62 (17)	*
Paired	5.37 ± 0.16	10.71 ± 0.55*	9.48 ± 0.86 [b]	8.32 ± 0.88 [a]	8.16 ± 0.87 [a]	9.21 ± 1.14 [ab]	*
Epididymis Weight (g)							
Left	0.33 ± 0.04	0.47 ± 0.01*	0.52 ± 0.03[b]	0.39 ± 0.03 [a]	0.36 ± 0.04[a]	0.39 ± 0.04 [a]	*
Right	0.23 ± 0.03	0.44 ± 0.01 *	0.40 ± 0.03	0.35 ± 0.04	0.33 ± 0.04	0.36 ± 0.04	*
Paired	0.55 ± 0.06	0.90 ± 0.02 *	0.92 ± 0.04[b]	0.74 ± 0.06 [a]	0.70 ± 0.07[a]	0.75 ± 0.08[a]	*
Testis Volume (ml)							
Left `	3.69 ± 0.12	6.61 ± 0.29*	5.91 ± 0.49	5.42 ± 0.57	5.23 ± 0.44	5.67 ± 0.52	*
Right	2.74 ± 0.14	5.96 ± 0.27*	5.30 ± 0.58 [b]	4.42 ± 0.44 [a]	4.31 ± 0.46[a]	5.19 ± 0.52[b]	*
Paired	6.44 ± 0.19	12.57 ± 0.49 *	11.21 ± 1.00[b]	9.85 ± 0.92 [a]	9.54 ± 0.84[a]	10.85 ± 0.99[b]	*
Body Weight(g)	1265 ±50.5	2031.23 ±24.33 *	1901.85±88.91 [d]	1862.37±73.83 [c]	1669.26±92.11 b	1559.76±122.22[a]	*
Relative Testis Weight (%)	0.45 ± 0.03	0.53 ± 0.03 *	0.49 ± 0.03[a]	0.44 ± 0.04[a]	0.48 ± 0.04[a]	0.61 ± 0.06 [b]	*
Rel. epididymis weight (%)	0.04 ± 0.00	0.05 ± 0.00 *	0.05 ± 0.00	0.04 ± 0.00	0.04 ± 0.00	0.05 ± 0 .00	*
Testis density(g/ml)	0.84 ± 0.02	0.87 ± 0.04 *	0.88 ± 0.06	0.85 ± 0.04	0.84 ± 0.03	0.86 ± 0.06	*
Spermatozoa reserves (Testes) (x10^9}	1.78 ± 0.05	2.91 ± 0.05 *	2.82 ± 0.16[b]	2.51 ± 0.12[b]	2.35 ± 0.14[a]	2.29 ± 0.15 [a]	*
DSP (Testis)	0.41 ± 0.01 (27)	0.67 ± 0.01 *	0.64 ± 0.04[b]	0.58 ± 0.03[ab]	0.54 ± 0.03[a]	0.52 ± 0.03[a]	*
Spermatozoa reserves (x10^9}	0.17 ± 0.01 (27)	0.3 ± 0.02 *	0.26 ± 0.02	0.22 ± 0.01	0.22 ± 0.01	0.31 ± 0.07	*

a, b, c means with different superscript within a row are significantly different
Group mean, standard error and number count of samples (x±sem(n)) shown
**(p<0.05), NS – non-significance, G – Genotype, MOSM – Moringa oleifera Seed meal, GXD- Interaction between genotype and diet*

DISCUSSION

Ogbuewu et al. (2009) highlighted the importance of morphometrics as it relates to the reproductive system as these are vital in providing useful and predictive information in determining the fertilizing and probably the breeding potentials of animals. Also, Gage and Freckleton (2003) established the major roles played by testes size, length and width of mammals in spermatogenesis. They further emphasized the importance of these sperm morphometric parameters in predicting male animals' reproductive potentials as well as the storage and fertilizing abilities of collected semen intended for artificial insemination.

This study agreed with the findings of Priyadarshani and Varma (2014) who studied the effect of *M. oleifera* leaf powder on sperm counts, histology of testis and epididymis of hyperglycaemic mice, they observed that the sperm counts, testes and epididymis weights of hyperglycaemic mice increased significantly with the administration of the leaf powder of *M. oleifera*. However, MOSM was used as the test ingredient in this study.

This result also agreed with the findings of Ojo and Abdurahman (2017) who studied the effect of *M. oleifera* leaf extract (MOLE) on some reproductive parameters of rabbits reared in a semi-humid environment. It was observed that MOLE did not significantly ($p>0.05$) influence paired testes weight, testis length and testis volume but in contrast, the inclusion of MOSM had a significant effect ($p<0.05$) on testis volume.

The result also agreed with the report of Ekeocha (2002) that within species, sperm production is a function of testicular size.

Oyeyemi and Okediran (2007) reported that an increased concentration of spermatozoa is a signal to a possible high fertility rate by the reason of the number of spermatozoa available during service or insemination. In this study, birds fed 10% MOSM had significantly higher ($p<0.05$) sperm concentration for both genotypes. This showed that feeding MOSM up to 10% was safe for effective sperm production.

Ajayi et al. (2009) established the influence of quality feeding on sperm characteristics of rabbits. Oyeyemi et al. (1998) declared that quality nutrition with high percentage of protein will improve motility and concentration of spermatozoa and Moringa seed is known to have high crude protein content, thus this accounts for the good quality of sperm characteristics in the study. This could account for higher values of sperm concentration and number of motile sperms obtained from this study.

In a study involving the use of sperm morphometrics and evaluation of internal reproductive organs of chickens using the genotypes of chickens indigenous to the Southern Guinea Savanna of Nigeria, Ahemen et al. (2016) reported that spermatozoa reserves in the left testis of normal feather bird, naked neck and frizzle feather chickens were not significantly ($p>0.05$) different. These values were similar to the values obtained for YENLC in this present study. Ezekwe (1998) and Perry and Petterson (2001) further stated that the size, length and width of testes could be used to ascertain and determine the sperm production abilities of livestocks. The volume of testis observed in this study for YENLC was however lower than the value of 11.74±4.53ml reported by Bath and Chaudhari (2002) in local cock in the Sahel region of Nigeria. These variations may be as a result of the impacts of the environment on the reproductive parameters of indigenous chickens and chickens indigenous to South Western part of Nigeria was used for this study.

Aviagen (2004) found that at low testis weight (<11g), a high proportion of males were infertile. However, it was reported that there was a general improvement in fertility with an increase in testis weight. Aviagen (2004) however concluded that testis weight less than 5g would be small and non-functional, testis weight of between 6g and 10g would be borderine while testis weight greater than 10g would be functional. This however implied that the testis of the YENLC in this study would be borderine while that of the Isa Brown Cocks were functional. This could account for the high spermatozoa reserves in the Isa Brown cocks reported in this study. Also, the body weight of the Isa Brown which was significantly higher ($p<0.05$) than that of YENLC could account for the significantly lower ($p<0.05$) spermiogramic parameters of the YENLC.

The mean for semen volume obtained in this study was found to be contrary to the range of 0.34 -0.59 ml reported by Bilcik et al. (2005) on broiler cocks and 0.40-0.73 ml obtained by Peters et al. (2008) on seven different indigenous chickens. This may be due to the fact that the genotypes of the birds used for this study was different from the broiler breeder cocks and the indigenous cocks used in this study. This further substantiated that genotypes affect semen characteristics in cocks. The values for motility were also in variance with the results obtained by Peters et al. (2008), they observed a range of 70% to 87.35% while Tabatabaei et al. (2010) reported the range of 74.5-85.67 for broiler breeder chickens of Iran origin. This could be as a result of different genotypes of chickens observed in the present study. Sperm concentration was however within the range of 3.40-9.70 billion/cc and 4.3 billion sperm/ml reported by Bilcik et al. (2005) and Moya et al. (1996) respectively for broiler cocks. The values obtained was also higher than values of 2.17-3.14 $x10^9$ and 2.26 x 10^9 reported by Tabartabaei et al. (2010) and Bah et al. (2001) respectively for Nigerian local breeder cocks.

The variations in the values obtained in this study for semen quality characteristics of the YENLC and Isa Brown cocks and some of those reported in literatures could be due to the effects of genotypes, MOSM inclusion in the diet, body weight, age and season.

CONCLUSION

It can be concluded from this study that the spermiogramic response of the chickens to dietary inclusion of MOSM are affected by genotypes, YENLC had significantly higher values for semen characteristics but the reverse was the case for spermiogramic parameters where Isa Brown cocks had significantly higher ($p<0.05$) values.

The inclusion of 10% MOSM is recommended for YENLC and 5% inclusion of MOSM for Isa Brown Chickens for optimum reproductive performance.

Conflict of Interest

We hereby declare that there is no conflict of interest in the course of this work

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