Research Article

Comparative Reproductive Traits among three Plumage Varieties of Noiler Cocks

Paul Oludare Adetunji* **and Safiriyu Idowu Ola**

Department of Animal Sciences, Obafemi Awolowo University, 220005, Ile-Ife, Osun State, Nigeria.

Abstract | This study was carried out to evaluate the reproductive performance of three plumage varieties of Noiler cocks, with a view to helping both the farmers and breeders in selecting the best performing variety for rearing and further genetic improvement. Eighteen cockerels of three plumage colours (brown, black and barred) were divided into 2 replicates with 3 birds per replicate. The study lasted for 38 weeks (Feb.-Nov., 2019). Data were taken on the onset of puberty parameters (age at first sperm cell and puberty) from 16-22 weeks of age, semen quality parameters (semen volume, semen concentration, sperm output, sperm motility and sperm abnormalities) from 26-52 weeks of age and sexual ornaments' morphometry (Comb Length-CL, Comb Height-CH, Wattle Length-WL, Wattle Height-WH and Inter Pubic Distance-IPD) from 16-24 weeks of age. Data on onset of puberty and semen quality parameters were subjected to Analysis of Covariance (ANCOVA) with body weight at puberty as a covariate while morphometry measurements were subjected to Spearman correlation analysis. The result showed that the plumage colour influenced ($p<0.05$) the onset of puberty in the cockerels with lower age at puberty, 155.29±2.41 days and 160.09±2.41 days recorded in brown and black cockerels, respectively compared to their barred counterpart, 167.23±2.41 days. Black cocks had the highest ($p<0.05$) semen volume (0.84±0.03ml) and sperm output ($3.47±0.13×10^9$/ejaculate) among the varieties. The CL and CH positively and significantly ($p<0.05$) correlated with semen quality parameters ($r = 0.34$ to 0.76), negatively related to the onset of puberty ($r = -0.28$ to -0.50) in brown and black cocks and IPD positively correlated with semen volume ($r = 0.19$ to 0.38) in all the cocks. It was concluded that all the three plumage varieties of Noiler cocks in this study produced semen of acceptable quality and volume and thus could be used for reproductive purposes. The CL, CH and IPD may be used to predict onset of puberty and some semen quality characteristics in the tested varieties of Noiler cocks.

Editor | Muhammad Abubakar, National Veterinary Laboratories, Park Road, Islamabad, Pakistan.
Received | June 03, 2020; **Accepted** | July 05, 2020; **Published** | July 15, 2020
***Correspondence** | Paul Oludare Adetunji, Department of Animal Sciences, Obafemi Awolowo University, 220005, Ile-Ife, Osun State, Nigeria;
Email: adetunjioludare@gmail.com
Citation | Adetunji, P.O. and S.I. Ola. 2020. Comparative reproductive traits among three plumage varieties of noiler cocks. *Veterinary Sciences: Research and Reviews*, 6(2): 88-95.
DOI | http://dx.doi.org/10.17582/journal.vsrr/2020/6.2.88.95
Keywords | Noiler chicken, Plumage effect, Semen quality

Introduction

Good semen quality is very important in poultry production. Approximately 30% of the infertility problems in breeding farms are related to the males (Khaki et al., 2009; Barkhordari et al., 2013). Therefore, the importance of semen quality analyses cannot be overemphasized in order to ascertain the reproductive ability of any cock. Several factors affect semen production in chickens, such as breed, strain, diseases, age, time of collection, plumage colour, body weight and degree of development of the secondary sexual

characters (Zuk et al., 1995). Waseem et al. (2017) reported differences in the semen characteristics of brown, black and white plumage colours of Pakistani naked neck cocks and concluded that the cocks with black plumage colour performed better than the brown and white plumage cocks.

Researchers have reported both positive and negative relationships between semen quality parameters and secondary sexual ornaments such as comb and wattle which are generally believed to be good predictors of semen quality (McGary et al., 2002; El-Sahn, 2007; Galal, 2007; Udeh, 2011). In the rural areas where most of the farmers reside, facilities for microscopic evaluation of semen are not readily available. Therefore, simple, reliable and indirect methods for in vivo estimation of semen qualities based are needed by poultry farmers.

Noiler is a dual-purpose (meat and egg) breed of chicken recently developed by Amo Farms in Nigeria. Noiler chickens come in various plumage colours of which black, brown and barred are the prominent ones. The birds have good and attractive body conformation indicative of good production potentials. Noiler chicken is now a common feature in the backyard and rural poultry production in Nigeria and they are used indiscriminately to breed local hens for possible upgrade. Given the known plumage influence on productive performance in other breeds, it becomes imperative that Noiler chickens be evaluated against plumage variety backdrop. The objectives of this present study are to: evaluate the onset of puberty, semen quality characteristics and relationship between sexual ornaments and semen parameters among three plumage varieties of Noiler cocks.

Materials and Methods

Location

The study was carried out between February and November, 2019 with Noiler chicken maintained at a commercial poultry farm located at Koola Village, Modakeke within Ile-Ife region. Laboratory analyses were carried out in Animal Reproduction Laboratory, Department of Animal Sciences, Obafemi Awolowo University, Ile-Ife, Nigeria. Ile-Ife is located in the South-Western part of Nigeria, and geographically between longitude 7^0 28`N and $7^0$ 45`N and latitude 4^0 30`E and $4^0$ 34`E and at altitude of 286m above the sea level (Google earth finder, 2019). Ecologically it falls within warm and humid tropical forest zone.

Experimental design/Animal management

Eighteen (18) cockerels comprising equal numbers of three plumage colours (brown, black and barred) at the 14th week of age were housed individually in battery cages and acclimatized for two weeks. Each plumage variety was divided into two replicates with 3 birds per replicate. They were fed commercial grower diet containing 15% CP, 2600 Kcal/kg. Quality water was provided *ad-libitum* and New Castle disease vaccine and other medications were administered when necessary following the standard poultry practice management.

Data collection

Onset of puberty: From 16th week of age, cockerels were individually assessed on a weekly basis for onset of puberty by examining preputial fluid collected after sexual massaging which was smeared on a glass slide and viewed under the microscope at ×400 for the presence of sperm cells. The first day when sperm cell was sighted in the preputial fluid of each cock was recorded. Pubertal age for a group was regarded as the period when sperm cells have been sighted in the preputial fluids of at least 50% of the cocks (Ewuola and Egbunike 2010).

Semen quality characteristics: A graduated 5ml plain collection tube was used for the semen collection. Cockerels were trained by sexual massaging during the time when onset of puberty was being checked. Semen collection was performed once every two weeks (after pubertal age was established) between the hours of 9.00-11.00am. Semen was collected for 26 weeks between 26th – 52nd weeks of age. Semen volume was read directly from the transparent graduated collection bottle, while sperm motility was evaluated immediately after collection through the aid of portable Handycope microscrope® (Freedom and Challenge Inc., South Korea). Other semen parameters (semen concentration, sperm output and sperm morphology) were later assessed in the laboratory.

- **Mass motility:** This was done immediately on the farm after semen collection. This was done by charging freshly collected semen on the glass slide and viewed with the aid of a Handycope Microscope (Freedom and Challenge Inc., South Korea). Different five fields of the microscope views were considered; a subjective percentage was

recorded and the average percentage of motility calculated.

- **Sperm concentration:** The sperm concentration was determined using Neubauer haemocytometer following the procedure of Hafez and Hafez (2000).
- **Sperm output:** This is the number of sperm cells contained in the whole of the ejaculate volume. It was expressed in billions of sperm cells/ejaculate (x10^9/ejaculate). The sperm output was calculated using the formula: Sperm output = sperm concentration x volume of ejaculate (Zaneveld and Polaskoski, 1977).
- **Sperm abnormalities:** Sperm morphology was evaluated by eosin-nigrosin mixture staining procedure (Jager et al., 1985; Fujita, 1975).

Sexual ornaments' morphometric

Linear measurements of secondary sexual characters were taken on individual bird with the aid of a measuring tape following the procedure of FAO (2012). The sexual ornaments measured were: Comb Length (CL), Comb Height (CH), Wattle Length (WL) and Wattle Height (WH). Also, the distance between the two pubic bones was measured and recorded as Inter-Pubic Distance (IPD). All measurements were taken fortnightly between 16 and 24 weeks of age.

- **Comb length:** This was measured as the horizontal distance between the first and the last finger of the comb.
- **Comb height:** This was taken as the maximum vertical distance from the highest peak of the comb to the base of the comb.
- **Wattle length:** It was measured as the maximum horizontal distance between the front and the rear of the wattle.
- **Wattle height:** This was measured as the maximum vertical distance from the base to the distal end of the wattle.
- **Inter pubic distance:** This was measured as the distance between the two small bones around the vent area (Tuber ischii) as described by Wright et al. (2012).

Statistical analysis

Data obtained for onset of puberty and semen quality parameters were subjected to Analysis of Covariance (ANCOVA) with weight at puberty as covariate using General Linear Model Procedure (PROC GLM) of SAS, 2002. Sexual ornaments' data were subjected to Spearman correlation using Procedure Correlation (PROC CORR) of the same version of SAS. A significant difference in the means of the plumage varieties was separated at 5% significance level by Duncan Multiple Range Test (DMRT).

Results

The result presented in Table 1 shows the onset of puberty of the three plumage varieties of the male Noiler chickens. The lowest pubertal age of 155.29 days was obtained in the brown variety and the highest in the barred variety (167.23 days). Age at first sperm cell was not different among the cock varieties with the values of 147.34, 150.19 and 148.52 days for brown, black and barred varieties, respectively. At 16th week (beginning of experiment), barred cocks (2,579.73g) were heavier than the black (2,341.40g) and brown (2,413.80g) cocks at $p<0.05$. However, for the weight at puberty, there was no appreciable difference ($p>0.05$) between brown (2985.57g) and black (2,881.93g) cocks but both were lower ($p<0.05$) in weights compared to the barred cocks (3,333.00g).

The semen quality parameters of the Noiler cocks are presented in Table 2. There was difference ($p<0.05$) among the three plumage varieties in semen volume with the values of 0.58ml, 0.71ml and 0.84ml recorded for the barred, brown and black cocks, respectively. No significant difference was found in the semen concentration among the cocks which ranged between 4.11-4.36×10^9/ml. For the number of sperm cells per ejaculate, differences ($p<0.05$) were observed among the three varieties with black cocks having the highest value of 3.47x10^9, followed by the brown cocks (2.80x10^9) and barred cocks (2.49x10^9). Mass sperm motility was not different ($p>0.05$) among the cocks with the values of 80.57%, 81.46% and 82.08% obtained for brown, black and barred cocks, respectively. Highest ($p<0.05$) primary sperm abnormalities of 4.84% was recorded in the brown cocks, while that of the black (3.43%) and barred (3.95%) cocks were not influenced ($p>0.05$) by plumage colour. Secondary sperm abnormalities in the brown (7.61%) and barred (7.91%) cocks were not different from each other, but lower ($p<0.05$) than the value of 8.97% recorded in the black cocks. Total sperm abnormality recorded in brown (12.45%) and black (12.35%) cocks were similar but higher ($p<0.05$) than 11.86% recorded in the barred cocks.

Table 1: *Onset of puberty in three plumage colour types of Noiler cocks.*

Parameters	Plumage varieties			Group	p value
	Brown	Black	Barred	SEM	
Weight at 16th week (g)	2,413.80[ab]	2, 341.40[b]	2,579.73[a]	62.19	0.0289
Weight at puberty (g)	2,985.47[b]	2,881.93[b]	3,333.00[a]	69.22	0.0001
Age at first sperm cell (days)	147.34	150.19	148.52	0.84	0.6346
Age at puberty (days)	155.29[b]	160.09[ab]	167.23[a]	2.41	0.0296

[abc] *Means in the same row without common letter are different at p<0.05; SEM: standard error of the mean.*

Table 2: *comparative semen quality characteristics of three plumage types of Noiler cocks (26–52 weeks of age).*

Parameters	Plumage varieties			Group	p value
	Brown	Black	Barred	SEM	
Semen volume (ml)	0.71[b]	0.84[a]	0.58[c]	0.03	<0.0001
Sperm concentration (×10^9/ml)	4.11	4.25	4.38	0.30	0.8191
Sperm output (×10^9/ejaculate)	2.80[b]	3.47[a]	2.49[b]	0.13	0.0002
Sperm motility (%)	80.57	81.46	82.08	0.98	0.5465
Primary sperm abnormality (%)	4.48[a]	3.43[b]	3.95[b]	0.19	0.0006
Secondary sperm abnormality (%)	7.61[b]	8.97[a]	7.91[b]	0.08	0.0038
Total sperm abnormality (%)	12.45[a]	12.35[a]	11.86[b]	0.14	0.0191

[abc] *Means in the same row without common letter are different at p<0.05; SEM: standard error of the mean.*

Table 3: *comparative morphometry of sexual ornaments of three plumage types of Noiler cocks (16–24 weeks of age).*

Parameters	Plumage varieties			Group	p value
	Brown	Black	Barred	SEM	
Comb length (cm)	7.77[a]	7.84[a]	7.42[b]	0.10	0.0076
Comb height (cm)	4.40[a]	4.47[a]	4.00[b]	0.08	0.0001
Wattle length (cm)	3.91[a]	3.56[b]	3.75[a]	0.06	0.0002
Wattle height (cm)	3.54	3.53	3.50	0.07	0.9360
Inter pubic distance (cm)	2.31[b]	2.11[c]	2.47[a]	0.05	0.0001

[abc] *Means in the same row without common letter are different at p<0.05; SEM: standard error of the mean.*

Table 3 shows the sexual ornaments morphometric traits in the three varieties of Noiler cocks. Comb length (7.77cm) and comb height (4.40cm) of the brown cocks were not different from those of the black cocks (7.84cm) and (4.47cm), while that of the barred cocks (7.42cm) and (4.00cm) was lower (p<0.05) than those of the two other varieties. The wattle length of the brown and barred cocks was similar but both were higher than that of black cocks. Cocks of the barred variety had higher (p<0.05) inter pubic distance (2.47cm) followed by the brown cocks (2.31cm) and the black cocks (2.11cm).

Coefficients of correlation among sexual ornaments, onset of puberty and semen quality characteristics is presented in Table 4. Comb Length (CH) and Comb Height (CH) were positively correlated (r = 0.34 to 0.72) with semen volume, semen concentration and sperm motility in the brown variety. In the black cocks, CL, CH, Wattle Length (WL) and Wattle Height (WH) positively correlated (r = 0.16 to 0.76) with the semen parameters except primary sperm abnormality and the relationship between semen volume and WH which was not significant. Also, CL, WL positively correlated (r = 0.22 to 0.54) with sperm concentration and sperm output in the barred cocks. The CL, CH and IPD negatively correlated with age at puberty. Inter Pubic Distance positively correlated with semen volume in all the three varieties with the strongest coefficient of correlation magnitude (r = 0.38) recorded in the black cocks. The CH, WH and IPD were negatively related to primary abnormalities whereas it was not significant with CL and WL.

Table 4: *Phenotypic correlation coefficients among sexual ornaments, onset of puberty and semen quality traits in three plumage varieties of Noiler cocks.*

Sexual Ornaments' morphometry	Reproductive traits						Plumage Varieties
	semen volume	semen conc.	sperm output	sperm motility	primary abnorm.	age at puberty	
Comb Length	0.71***	0.42**	0.38**	0.72***	-0.59***	-0.41**	Brown
	0.76***	0.58***	0.65***	0.75***	-0.41**	-0.52***	Black
	0.36**	0.22*	0.32**	0.54***	0.04†	-0.28**	Barred
Comb Height	0.34**	0.37**	-0.22*	0.45**	-0.64***	-0.33*	Brown
	0.38**	0.47**	0.52***	0.45**	-0.44**	-0.37**	Black
	-0.28*	0.29*	0.17†	-0.21*	-0.25*	-0.41**	Barred
Wattle Length	-0.37**	0.52***	-0.31*	0.52***	-0.45**	0.13*	Brown
	0.67***	0.51***	0.68***	0.47**	-0.13†	-0.36**	Black
	-0.02†	0.51***	0.38**	0.13†	0.15†	-0.29**	Barred
Wattle Height	0.23*	-0.49**	0.72***	-0.12†	-0.76***	0.21*	Brown
	0.13†	0.72***	0.68***	0.16*	-0.37**	0.03†	Black
	-0.11†	-0.42**	-0.46**	-0.03†	-0.46**	0.06†	Barred
Inter Pubic Distance	0.21*	0.03†	0.14†	-0.10†	-0.16†	-0.27*	Brown
	0.38**	-0.55**	-0.57***	-0.39**	-0.67***	-0.12†	Black
	0.19*	-0.22*	0.10†	0.12†	-0.57***	-0.14†	Barred

****p<0.0001 to 0.0009 (Highly significant), **p 0.001 to 0.009 (Very significant) *p 0.01 to 0.05; (Significant), †P>0.05 (Not Significant). Correlation coefficients (r) of 0.10 to 0.30 (low correlation); 0.31 to 0.50 (medium correlation); 0.51 to 1.00 (high correlation). conc.: concentration; abnorm.: abnormality.*

Discussion

Determination of pubertal age trait is very important before selection of breeding cocks. It is of significant agricultural importance (Podisi et al., 2011; Abou-Elewa et al., 2017). The onset of puberty, that is, age at first sperm cell reported in this study is in line with Johnson (1986) who reported that, in chicken, spermatid begin to appear in the seminiferous tubules at about 84 days of age, and by day 140 are usually present in all of the tubules. From this time onward, maturation of the spermatid begins and continues throughout its transportation. However, the pubertal age in this study was higher than 119-133 days reported by Abou-Elewa et al. (2017) for the early, moderate and late maturing Norfa chicken. This difference could be due to the effect of breed/strain as several studies have reported significant effects of breed, strain and plumage varieties on the onset of puberty (Peters et al., 2008; Waseem et al., 2017; Dahloum et al., 2018). The difference in the live weight at the beginning of experiment and at puberty observed in this study was an indication of continuous growth in the chicken and that they were yet to reach their final body weight at 16th week of age.

The higher weight at puberty of the barred variety of cocks, was expected to result in earlier puberty than the brown and the black varieties. But this was not the case as the barred cocks matured later than the lighter brown and black cocks. Barred cocks could possibly be the broiler line of the Noiler breed, similar to what had earlier been reported for the broiler line of FUNAAB Alpha chicken (another Nigerian breed of chicken) in FACD (2018).

Variations in the semen volume among plumage varieties agree with the study of Peters et al. (2008) who observed significant difference in semen volume of seven strains of chickens reared in the humid tropic region of Nigeria. The semen volume of black and brown Noiler breed in this study was higher than the volume reported by Ochai et al. (2018) for FUNAAB Alpha, Isa brown and Bantam cocks. The higher semen volume for the black cocks also agrees with the report of Waseem et al. (2017) who reported higher semen volume in the black plumage colour of Pakistani cocks than their brown and white counterparts. This could be as a result of different genetic backgrounds of the parent stock.

The assessment of semen motility is one of the most used indices of semen quality evaluation (Malik et al., 2013). The semen motility values obtained in this study were higher than the range of 40 - 80% reported by Malik et al. (2013) and Waseem et al.

(2017) as normal for cock semen. However, it agrees with range of 62.55±0.26% - 87.35±10.12% reported by Peters et al. (2008) for seven strains of chickens raised under the same humid tropical part of Nigeria. The high motility values obtained in this study could be as a result of immediate on-farm analysis with the aid of a handycope microscope.

Sperm concentration obtained in this study is higher than the range of $1.76x10^9$/ml – $2.66x10^9$/ml, $1.7x10^9$/ml – $3.5x10^9$/ml and $1.83x10^9$/ml reported for the FUNAAB Alpha (Malik et al., 2013), Leghorn and Bantam (Saleh et al., 2017) chickens, respectively. However, the result is comparable to the range of $3.11±0.42x10^9$/ml – $4.21±1.45x10^9$/ml reported by Peters et al. (2008).

Sperm morphology is one of the essential qualitative characteristics of poultry semen that determines the fertilizing ability of spermatozoa (Siudzinska and Lukaszewicz, 2008). The values obtained in this present study across the three varieties of cocks for total sperm abnormality fell within range (10.16±0.88% - 17.88±0.73%) that has been reported to be normal (Hafez and Hafez, 2000; Peters et al., 2008; Abd-El-Ghany et al., 2011). Although there was significant difference in the percentage primary abnormality among the Noiler types, the values were still much below the 10% maximum acceptable level (Hafez and Hafez, 2000).

The variation, in the average values of Comb Length (CL), Comb Height (CH), Wattle Length (WL) and Inter Pubic Distance (IPD) suggest plumage effects. The difference in the mean sizes of these sexual ornaments support the work of Ibrahim et al. (2014) who also found variations in some morphometry measurements of sexual ornaments of Bovan Nera Black, Isa brown and Shikabrown cocks. Earlier, Anderson (1994), reported that the degree of development of the secondary sexual characters could affect the reproductive potentials of an individual cock.

Ibrahim et al. (2014) provided evidence that secondary sexual characters such as comb length, wattle length, comb height and wattle height might be useful to predict fertility and semen quality in cocks. The positive correlation obtained in the black cocks between sexual ornaments and some semen quality parameters were much higher than those reported by Ibrahim et al. (2014), especially on semen volume. The negative correlations observed with primary sperm abnormality agreed with Galal (2007) who reported similar relationships in Egyptian normal feathered and naked neck chickens. Also, Abd-El Ghany et al. (2011) reported positive correlations of semen quality parameters except for abnormality with sexual ornaments such as comb length, comb height, wattle length and wattle height. The negative correlations among comb and wattle heights with some semen parameters obtained in the barred cocks were similar to the one reported by Ibrahim et al. (2014) and Galal (2007) for D-Nana and D-nana strains of cocks, with coefficient of correlation ranges from -0.15 to -0.73 for sexual ornaments and semen parameters.

Considering the low correlation between semen volume and inter pubic distance in the barred cocks, it can be suggested that, the higher inter pubic distance recorded in this variety of cocks could be as a result of their heavier body weight rather than their reproductive performance, especially semen volume.

It could be deduced that, the nature of the correlation between sexual ornaments with semen quality parameters in domestic chicken is a complex one as various study has reported both positive and negative relationships (Pizzari et al., 2004; Bilcik and Estevez, 2005; Parker et al., 2006; Baczynski, 2008).

Conclusion and Recommendation

All the three plumage varieties of Noiler cocks produced semen of acceptable quantity and quality. They can therefore be suggested for reproductive purposes. Sexual ornaments' morphometry may be used to predict onset of puberty and some semen quality characteristics in any of the three plumage varieties of Noiler cocks tested.

Authors Contribution

This publication is part of Mr. Paul Oludare Adetunji Master's degree thesis supervised by Professor Safiriyu Idowu Ola. Paul Oludare Adetunji conceived the idea, designed, carried out the study and prepared the manuscript for publication, while Professor Safiriyu Idowu Ola supervised the study and proofread the manuscript for publication.

Statement of conflict of interest

The authors have declared no conflict of interest.

References

Abd-El-Ghany, F.A., El-Dein, A., Soliman, M.M., Rezaa. A.M. and El-Sodany, S.M., 2011. Relationships between some body measurements and fertility in males of two local strains of chicken. Egypt. Poult. Sci. 31(II): 331-349.

Abou-Elewa, E.M., Enab. A.A. and Abdou, F.H., 2017. Sexual maturity of male chickens according to early response of semen collection. IOSR J. Agric. Vet. Sci. 10(7): 58-63. https://www.researchgate.net/publication/318735256; https://doi.org/10.9790/2380-1007015863

Anderson, M., 1994. Sexual selection. Princeton Univ. Press, Princeton, N.J., USA.

Baczynski, K., 2008. The effect of sperm mobility phenotype on fertility persistence in layer and broiler hens. College Park (MD) University of Maryland.

Barkhordari, A.H., Ajebali, A., Khalili, M.A. and Noorani, T.A., 2013. Effect of Zinc Oxide nanoparticle on viability of human spermatozoa. Iran J. Reprod. Med., 11: 767-771. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3941329/

Bilcik, B. and Estevez, I., 2005. Impact of male-male competition and morphological traits on mating strategies and reproductive success in broiler breeders. Appl. Anim. Behav. Sci. 92: 307-323. https://www.researchgate.net/publication/7558066; https://doi.org/10.1016/j.applanim.2004.11.007

Dahloum, L., Yakubu, A. and Halbouche, M., 2018. Effects of housing system and plumage colour on egg quality characteristics of indigenous naked-neck chickens. Livest. Res. Rural Dev. Volume 30, Article #206. Retrieved October 6, 2019, from http://www.lrrd.org/lrrd30/12/abdul30206.html.

El-Sahn, A.A., 2007. Use of phenotypic traits to predict cock fertility. The ornamental and non-ornamental traits. Egypt. Poult. Sci. 27: 1085-1097.

Ewuola, E.O. and Egbunike, G.N., 2010. Effects of dietary fumonisin B_1 on the onset of puberty, semen quality, fertility rates and testicular morphology in male rabbits. Reproduction. 139: 439-445. https://doi.org/10.1530/REP-09-0077

FAO, 2012. Phenotypic characterization of animal genetic resources. FAO Anim. Prod. Health Guidelines No. 11. Rome.

Fujita, T., 1975. Abnormal spermatozoa and infertility (man). In scanning electron microscopial atlas of mammalian reproduction. E.S.E. Hafez (ed). Tokyo, Japan, Igaku Shoin. pp. 247-249.

FUNAAB Alpha Chicken Descriptor (FACD). 2018. Descriptor's format for poultry. Fed. Univ. Agric. Abeokuta, Nigeria.

Galal, M., 2007. Predicting semen attributes of naked and normally feathered male chickens from live performance traits. J. Poult. Sci. 6(1): 36-42. https://doi.org/10.3923/ijps.2007.36.42

Google earth finder. 2019. The location of Ile-Ife, Osun State, Nigeria. www.googleearthfinder.com

Hafez, B. and Hafez, E.S.E., 2000. Reproduction in Farm Animals. 7th ed. New York. Lippincott Williams and Wilkins, USA. https://doi.org/10.1002/9781119265306

Ibrahim, A.A., Alade, N.K., Aliyu, J. and Muhammad, A.I., 2014. Relationship between phenotypic sexual characters and semen characteristics in four strains of cocks in Northern Nigeria. Iran. J. Appl. Anim. Sci. 4(3): 603-608.

Jager, S., Kuiken, J. and Kremer, J., 1985. Triple staining of spermatozoa for routine investigation of human semen. Technical aspects. Arch. Androl. 12: 53-58.

Johnson, A.L., 1986. Reproduction in the Male. In "Avian Physiology" (4th ed.). New York: Springer-Verlag, chapter 19: 437.

Khaki, A., Fathiazard, F., Nouri, M., Khaki, A.A., Khamenehhi, H.J. and Hamadeh, M., 2009. Evaluation of androgenic activity of *Allium cepa* on spermatogenesis in the rat. Folia Morphol. 68: 45-51.

Kuster, C.E., Singer, R.S. and Althouse, G.C., 2004. Determining sample size for the morphological assessment of sperm. Theriogenelogy. 61: 691-703. https://doi.org/10.1016/S0093-691X(03)00240-1

Malik, A., Haron, A., Yusoff, R., Nesa, M., Bukar, M. and Kasim, A., 2013. Evaluation of the ejaculate quality of the red jungle fowl, domestic chicken, and bantam chicken in Malaysia. Turk. J. Vet. Anim. Sci. 37: 564-568. https://doi.org/10.3906/vet-1107-26

McGary, S., Estevez, I., Bakst, M.R. and Pollock, D.L., 2002. Phenotypic traits as reliable

indicators of fertility in male broiler breeders. Poult. Sci. 81: 102-111. https://doi.org/10.1093/ps/81.1.102

Ochai, D.E., Kalla, D.J.U., Saleh, B. and Mancha, Y.P., 2018. Testicular morpho-histometry and semen quality of three strains of chickens. Poult. Sci. J., 6(2): 173-179.

Parker, T.H., Thompson, D., Ligon, J.D., Schneider, B. and Byrn, F., 2006. Does red junglefowl comb size predict sperm swimming speed and motility? Ethol. Ecol. Evol. 18: 53-60. https://doi.org/10.1080/08927014.2006.9522726

Peters, S.O., Shoyebo, O.D., Ilori, B.M., Ikeobi, C.O.N. and Adebambo, A.O., 2008. Semen quality traits of seven strain of chickens raised in the humid tropics. Int. J. Poult. Sci. 7(10): 949-953. https://doi.org/10.3923/ijps.2008.949.953

Pizzari, T., Jensen, P. and Cornwallis, C.K., 2004. A novel test of the phenotype-linked fertility hypothesis reveals independent components of fertility. Proc. R. Soc. B. Biol. Sci. 271: 51-58. https://doi.org/10.1098/rspb.2003.2577

Podisi, B.K., Knott, S.A., Dunn, I.C., Law, A.S., Burt, D.W. and Hocking, P.M., 2011. Overlap of quantitative trait loci for early growth rate, and for body weight and age at onset of sexual maturity in chickens. Reproduction. 14(1): 381–389. https://doi.org/10.1530/REP-10-0276

Saleh, B., Mbap, S.T., Kalla, D.J.U., Doma, U.D. and Duwa, H., 2017. Effect of varying levels of dietary energy and protein on reproductive performance of FUNAAB alpha hens. Livest. Res. Rural Dev. Volume 29, Article #57. Retrieved March 6, 2017, from http://www.lrrd.org/lrrd29/3/sale29057.html

SAS, 2002. SAS user's guide. Statistical analysis system institute inc., Cary, North Carolina.

Siudzinska, A. and Lukaszewicsz, E., 2008. Effect of semen extenders and storage time on sperm morphology of four chicken breeds. J. Appl. Poult. Res. 17: 101-108. https://doi.org/10.3382/japr.2007-00048

Udeh, I., Ugwu, S.O.C. and Ogagifo, N.L., 2011. Predicting semen traits of local and exotic cocks using Linear Body Measurements. Asian J. Anim. Sci. 5(4): 268-276. https://doi.org/10.3923/ajas.2011.268.276

Waseem, A., Adnan, J., Amjad, R., Muhammad, A. and Yasir, A.D., 2017. Effect of plumage colour and body weight on the semen quality of naked neck chicken. J. World Poult. Res. 7(3): 129-133.

Wright, D., Rubin, D., Schutz, K., Kerje, S., Kindmark, A., Brandstrom, H., Anderson, L., Pizzari, T. and Per, J., 2012. Onset of sexual maturity in female chickens is genetically linked to loci associated with fecundity and a sexual ornament. Reprod. Domest. Anim. 47: 31-36. https://doi.org/10.1111/j.1439-0531.2011.01963.x

Zaneveld, L.J.D. and Polaskoski, K.L., 1977. Collection and physical examination of the ejaculate. In techniques for human andrology. E.S.E. Hafez (ed.). Amsterdam. pp. 102-108.

Zuk, M., Pompa, S.L. and Johnsen, T.S., 1995. Courtship display, ornaments and female mate choice in captive Red Jungle fowl. Behaviour. 132: 821-836. https://doi.org/10.1163/156853995X00027