Iranian Journal of Applied Animal Science

Relationship between Phenotypic Sexual Characters and Semen Characteristics in Four Strains of Cocks in Northern Nigeria

Research Article

A.A. Ibrahim[1*], N.K. Alade[2], J. Aliyu[2] and A.I. Muhammad[1]

[1]Department of Animal Science, Federal University, Dutse. P.M.B. 7156, Dutse, Jigawa State, Nigeria
[2]Department of Animal Science, University of Maiduguri. P.M.B. 1069. Maiduguri, Borno State, Nigeria

Received on: 8 Jul 2013
Revised on: 10 Aug 2013
Accepted on: 15 Aug 2013
Online Published on: Sep 2014

*Correspondence E-mail: talk2aai@yahoo.com

Online version is available on: www.ijas.ir

ABSTRACT

A study was carried out to evaluate the secondary sexual characteristics of four strains of cocks, comprising of two (2) exotics; Bovan Nera Black (BNB) and Isa Brown (ISB), one (1) improved local strain, Shika Brown (SB) and one (1) unimproved local strain, normal feathered cock (NFC). A total of 64 birds (16 for each strain) at 36, 38, 40 and 42 weeks were used for the study. The result indicated that shank length, comb length, comb width, wattle length and wattle width were all significantly ($P<0.001$) affected by strains, with the exotic strains being superior to the local cocks. Age × strain interactions were also found to be significant. Phenotypic correlations between the secondary sexual characters were found to be significantly high and positive. The correlation between the secondary sexual characters and semen characteristics showed that shank length, wattle length and width, comb length and width had a positive correlation with semen volume (r=0.123, 0.335, 0.195 and 0.408 and 0.348 $P<0.01$), total sperm count (r=0.202, 0.300, 0.188, 0.403 and 0.320 $P<0.05$) and normal sperm (r=0.175, 0.143, 0.026, 0.155 and 0.065 $P<0.05$) respectively. Shank length has a positive correlation with sperm motility (0.010) and dead sperm (0.026), but a negative correlation with live spermatozoa. The result of this study shows a considerable similarity among the strains of cocks with respect to secondary sexual traits. Therefore, it may be inferred from this study that length of shank, comb and wattle are good predictors of semen attributes in male chickens. Selecting cocks with larger shank length, comb and wattle size can improve the semen quality and subsequently, results to higher fertility.

KEY WORDS comb, local strains, poultry, semen characteristics, wattle.

INTRODUCTION

Intensive poultry production has been identified as one of the means of attaining sufficiency in the supply of animal protein in the diet of an average Nigerian. This had led to importation of commercial birds bred in developed countries of Europe and America by international breeding companies to enfranchised companies locally from whom many farmers purchase their chicks (Oluyemi, 1978). With changes in the taste and commercialization of the poultry industry in Nigeria, there has been mass raising of exotic chicken breeds (Orheruata *et al.* 2004). However, genotype × environment interaction, which tends to lower performance of these birds in a tropical environment calls for the need to continuously evaluate the performance of these birds with a view to recommending appropriate breed or strain to our local farmers (Ojedapo *et al.* 2006).

Poor reproductive performance is an important problem in poultry and certain types of infertility found in various animal populations may be due to genetic causes. This type of lowered reproduction becomes increasingly important in the male as the use of artificial insemination extends to more species. Any information either genetic or physiological in nature, which might help correct this problem, should be met with prompt attention.

Phenotypic variability is the observable physical variation present in a population and includes both genotypic and environmental components (Ogah *et al.* 2011), while genetic variability is the component of variation that is due to the genetic differences among individuals within a population (Pakzadeh *et al.* 2007). El Sahn (2007b) reported that ornamental traits such as comb and wattle length were good indicators of semen quality in males. The secondary sexual traits, namely comb and wattle measurements, showed positive phenotypic correlations with most semen physical traits. Whereas, the genetic correlations between comb and wattle measurements with semen traits were mostly positive, which can be used as indicators for high semen physical traits in cocks (Gebriel *et al.* 2009), which indicates the importance of relationship between phenotype traits and fertility, and that can be a reliable indicator to facilitate the identification and removal of sub fertile males from the breeder flock (McGary *et al.* 2002).

However, the assessment of semen quality characteristics of poultry birds gives an excellent indicator of their reproductive potential and has been reported to be a major determinant of fertility and subsequent hatchability of eggs (Peters *et al.* 2004). This experiment was therefore designed to determine the secondary sexual characters, physical semen characteristics of cocks and phenotypic correlations between each secondary sexual character and semen physical characteristics in order to predict cocks fertility.

MATERIALS AND METHODS

Experimental site

The study was conducted at the Kano university of science and technology, teaching and research farm, Wudil, Nigeria. This site is situated on latitude 12˚ 58ˈN, longitude 8˚ 25ˈE and altitude 457 m above sea level (Olofin, 2007). The range of annual temperature and relative humidity is about 38-43 ˚C and 40-51% respectively. It has a mean annual rainfall range of 850-870 mm from May-October with a peak in August.

Experimental stock and management

A total of sixty four (64) cocks made up of 16 each of indigenous cocks (normal feathered), Shika Brown (improved local), Bovan Nera Black and Isa Brown strains were used for the study. The normal feathered cocks were purchased from local households at first week of hatching, the Shika Brown were purchased from NAPRI while the Bovan Nera Black and Isa Brown strains were purchased from reputable hatcheries. The birds were all certified free of diseases and quarantined in an isolation unit of the university poultry farm for a period of two weeks of adaptation. During this period, the cocks were dewormed using piperazine dihydrochloride 100%, vaccinated against Newcastle disease and preventive doses of anticocidiostat (amprolium) was also given.

At the end of the adaptation period, cocks were logged individually in battery cages. They were maintained on commercial breeders mash containing 18% crude protein and 2800 kcal ME/kg of feed. Feed and water were provided *ad libitum* and a standard poultry husbandry practice as obtained in the university farm was observed.

Data collection

Secondary sexual characters determination

The secondary sexual characters measured individually were shank length, comb length, comb width, wattle length and wattle width. Comb length and wattle length were measured as the maximum horizontal distance between the front and the rear of the comb or wattle. Comb width was measured as the maximum vertical distance from the higher peak of the comb to the base and the wattle width as maximum vertical distance from the base to the distal end of wattle. All these measures were obtained in cm, using calliper/tape and recorded individually for cocks at 36, 38, 40 and 42 weeks of age.

Semen collection

During semen collection, cocks were pulled out of cage and allowed to rest calmly before the semen collection begins. Semen collection was performed by abdominal massage (Hafez, 1987). Briefly, semen was obtained by gently massaging (stroking) the back with the palm of the hand. The abdomen was massaged towards the tail with the other hand. Two people were involved in performing the semen collection, one holding the cock by the thigh and the other massaging and collecting the semen. Semen was collected with aid of a sterile test tube and labelled according to genotype and age. Immediately after collection, each ejaculate was evaluated for colour, volume, motility, concentration, pH, live-dead ratio and sperm morphological abnormalities.

Semen volume from each of the sire strain was measured in mL, using graduated centrifuge tubes. The pH of the semen was determined using a pH meter. For semen motility, a sample of semen was dropped on a microscope slide under a cover slip foe estimating the fraction of the population that was motile (Zemjanis, 1970). Sperm concentrations were determined under a microscope with a haemocytometer after dilution to 1:1000 with 2% NaCl (Hafez, 1987). The fresh semen sample was diluted and stored in 10% buffered formal saline for morphological studies of the acrosome, mid-piece, and sperm tail. Routine cytological specimens were obtained from the preserved samples, stained with eosin-nigrosin and observed under a phase microscope at a magnification of x 1000 to evaluate sperm abnormalities (Sekoni *et al.* 1981), and to estimate live / dead and abnormal/normal cell count. The total sperm counts (TSC) were determined by multiplying the sperm concentration by semen volume (Hafez, 1987).

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) using the general linear model (GLM) and correlation analysis (Steel and Torrie, 1980). The treatment means were tested for significant differences by Duncan's multiple rang test (Duncan, 1955). The model used was:

$$Y_{ijk}= \mu + S_i + G_j + (GA)_{ij} + e_{ijk}$$

Where:

Y_{ijk}: observation of individual with i^{th} genotype of j^{th} age.

μ: overall mean.

G_j: effect due to genotype (i=1,...,4).

S_i: effect due to age.

$(GA)_{ij}$: the effect of interaction between i^{th} genotype of j^{th} age.

e_{ijk}: experimental error.

RESULTS AND DISCUSSION

The results of the secondary sexual characters of cocks as affected by strain, age and their interaction are presented in Table 1. The results revealed that there were highly significant differences (P<0.001) in shank length between the four strains of cocks. Though the shank length of Bovan Nera Black, Isa Brown and Shika Brown (11.62±0.14 cm, 11.36±0.15 cm and 11.53±0.26 cm respectively) were similar, they were longer than the local cock (10.44±0.16 cm). The differences in shank length among the strains could be due to differences in their body weight, since Missou *et al.* (2003) reported that there were relationship between shank length and live weight. Similarly, Yeasmin *et al.* (1998) and Yeasmin *et al.* (2003) reported that birds with shank length of 6 cm or below were considered as dwarf while those with shank length above 6 cm were considered as normal size. Shank length did not differ significantly among the age groups but there existed a significant interaction of age and strain effect. A particular attention should therefore be paid to age differences while establishing differences in shank length among different strains of cocks.

The two exotics presented similar comb length with the Shika brown which was significantly longer (P<0.001) than that of the local cocks. The strain effect on comb length found in this study is contrary to the report of Galal (2007).

The significantly longer comb length in the exotic strains in the present study is an indication of better fertility, since according to the report of Mc Gary *et al*. (2003), males with larger comb tend to have higher fertility. Mc Gary *et al.* (2003) also provided evidence that secondary sexual characters such as comb length and wattle length might be useful to predict fertility and semen quality in broiler cock. Age had a significant (P<0.01) effect on comb length. The highest value was recorded at the age of 42 weeks (12.69±0.44 cm), indicating that comb length increases with age. The combined effect of age and strain was also significant. Strain differences in comb lengths are therefore related to age.

Highly significant differences (P<0.001) between strains were observed for the comb width. The two exotics and the Shika Brown were similar but significantly higher than the local cocks. The highest comb width was recorded in the Bovan Nera Black (7.69±0.17 cm), closely followed by Isa Brown (7.63±0.23 cm) and Shika Brown (7.12±0.09 cm) while local cocks showed the lowest values (4.77±0.21 cm). The increased comb width in exotic strain and Shika Brown suggest the existence of better sperm characteristics since comb width is associated with semen production (Burrows and Titus, 1939).

Zeller (1971) reported that comb and wattle growth were androgen-dependent and McGary *et al.* (2003) described a relationship between the secondary sexual characters and fertility in domestic fowls. Within a given strain, male roosters with larger combs may therefore likely have higher fertility.

Moreover, Galal (2007) referred that breeding females crouch more frequently and subsequently mate more frequently with males possessing- larger comb and wattle, suggesting also that they may have higher fertility. These research findings establish better fertility potentials of exotic and Shika Brown cocks compared with the locals. Although, comb length did not differ significantly among the age groups, the age × strain interaction effect was significant. Therefore, the cocks' age must be taken into account when strains are evaluated for differences in comb width.

From Table 1, it is clear that all the secondary sexual characters followed similar pattern. A highly significant variation (P<0.001) among the strains with respect to wattle length existed, with the exotic strain being superior to the local cock. The differences in average values in wattle length for Bovan Nera Black, Isa brown, Shika Brown and the local cocks (7.03±0.14 cm, 6.91±0.22 cm, 6.46±0.11 cm and 5.26±0.09 cm respectively), suggest breed differences.

More so, Anderson (1994) reported that the degree of development of the secondary sexual characters could affect the reproductive potentials of an individual cock.

Table 1 Least squares means (LSM±SE) of secondary sexual characters of cocks

Main effects	Body weight	Shank L (cm)	Wattle L (cm)	Wattle W (cm)	Comb L (cm)	Comb W(cm)
Overall mean	2.21±0.45	12.14±2.09	6.41±0.91	5.92±0.84	12.14±2.09	6.80±1.40
Stain	***	***	***	***	***	***
BNB	2.40±0.06^{b}	11.62±0.14^{a}	7.03±0.14^{a}	6.23±0.15^{a}	13.82±0.24^{a}	7.69±0.17^{a}
ISB	2.58±0.04^{a}	11.36±0.15^{a}	6.91±0.22^{a}	6.47±0.15^{a}	13.14±0.36^{ab}	7.63±0.23^{a}
SB	2.32±0.05^{b}	11.53±0.26^{a}	6.46±0.11^{a}	6.13±0.11^{a}	12.47±0.20^{b}	7.12±0.09^{a}
NFC	1.55±0.07^{c}	10.44±0.16^{b}	5.26±0.09^{b}	4.87±0.13^{b}	9.12±0.22^{c}	4.77±0.21^{b}
Age (weeks)	NS	NS	NS	NS	**	NS
36	2.19±0.13	11.09±0.22	6.37±0.20	5.84±0.20	12.05±0.54^{b}	6.59±0.34
38	2.27±0.13	11.25±0.21	6.54±0.27	6.00±0.21	11.87±0.57^{b}	6.74±0.41
40	2.19±0.10	11.22±0.24	6.33±0.18	5.74±0.21	11.94±0.55^{b}	6.77±0.35
42	2.18±0.09	11.39±0.21	6.42±0.26	6.11±0.23	12.69±0.44^{a}	7.09±0.32
Age × strain	NS	*	*	*	*	*
36 × BNB	2.26±0.11^{abc}	11.75±0.32^{ab}	7.27±0.29^{a}	6.23±0.31^{abcd}	14.67±0.42^{a}	7.60±0.37^{a}
ISB	2.75±0.11^{a}	11.50±0.32^{ab}	6.55±0.29^{ab}	5.97±0.31^{abcd}	11.75±0.42^{de}	6.85±0.37^{ab}
SB	2.35±0.11^{ab}	10.75±0.32^{ab}	6.37±0.29^{ab}	6.33±0.31^{abc}	12.83±0.42^{abcd}	7.13±0.37^{ab}
NFC	1.40±0.11^{e}	10.37±0.32^{b}	5.27±0.29^{b}	4.83±0.31^{cd}	8.95±0.42^{f}	4.55±0.37^{c}
38 × BNB	2.54±0.11^{ab}	11.50±0.32^{ab}	6.57±0.29^{ab}	6.10±0.31^{abcd}	12.75±0.42^{abcd}	7.30±0.37^{a}
ISB	2.65±0.11^{ab}	11.87±0.32^{ab}	7.75±0.29^{ab}	7.00±0.31^{a}	14.00±0.42^{abc}	8.25±0.37^{a}
SB	2.49±0.11^{ab}	11.37±0.32^{ab}	6.55±0.29^{b}	6.07±0.31^{abcd}	12.13±0.42bcde	6.80±0.37^{ab}
NFC	1.40±0.11^{e}	10.25±0.32^{b}	5.30±0.29^{a}	4.83±0.31^{cd}	8.63±0.42^{f}	4.63±0.37^{c}
40 × BNB	2.48±0.10^{ab}	11.51±0.30^{ab}	7.11±0.27^{ab}	6.03±0.28^{abcd}	14.15±0.38^{ab}	7.91±0.37^{a}
ISB	2.45±0.11^{ab}	11.00±0.32^{ab}	6.47±0.29^{ab}	6.33±0.31^{abc}	12.93±0.42^{abcd}	7.50±0.37^{a}
SB	2.28±0.11^{abc}	12.13±0.32^{a}	6.47±0.29^{ab}	6.05±0.31^{abcd}	11.90±0.42^{cde}	7.17±0.37^{ab}
NFC	2.16±0.11^{de}	10.25±0.32^{b}	5.27±0.29^{b}	4.63±0.31^{d}	8.73±0.42^{f}	4.63±0.37^{c}
42 × BNB	2.28±0.13^{abc}	12.00±0.40^{ab}	7.13±0.37^{a}	6.55±0.31^{abc}	13.48±0.52^{abcd}	7.62±0.46^{a}
ISB	2.44±0.11^{ab}	11.05±0.32^{ab}	6.87±0.29^{a}	6.57±0.31^{ab}	13.90±0.42^{abcd}	7.90±0.37^{a}
SB	2.17±0.11^{bcd}	11.87±0.32^{ab}	6.43±0.29^{ab}	6.05±0.31^{abcd}	13.05±0.42^{abcd}	7.38±0.37^{a}
NFC	1.78±0.11^{cde}	10.87±0.32^{ab}	5.17±0.29^{b}	5.20±0.31^{bcd}	10.18±0.42^{ef}	5.27±0.37^{bc}

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
BNB: Bovan Nera black; ISB: Isa Brown; SB: Shika Brown and NFC: normal feathered cock.
*: (P<0.05); **: (P<0.01) and ***: (P<0.001).

However it was evident that there were no statistical differences in wattle length of cocks among different age groups, but there was significant age strain interaction effect with the highest wattle length of (7.75±0.09 cm) obtained at the age 38 weeks in Isa Brown cock and the lowest (5.17±0.29 cm) at 42 weeks in local cock. This may be as a result of differences in body weights since Orheruata *et al.* (2004) reported that wattle size is related to body weight and body measurements in exotic chickens.

Regarding wattle width, a highly significant difference (P<0.001) was observed among the strains. Although, all the exotic strains and the improved local were similar, they had higher values compared to the local strains. The average mean values recorded for wattle width for the four strains (Bovan Nera Black, Isa Brown, Shika Brown and local cocks) were 6.23 ± 0.15 cm, 6.47 ± 0.15 cm, 6.13 ± 0.11 cm and 4.87 ± 0.13 cm respectively. These values are higher than the values reported by El Sahn (2007a) in Bandarah cocks and Gebriel *et al.* (2009) in Norfa cocks. The exotic and the improved local excelled the local due to the fact that they represent improved cock flocks and are superior in body weight (Orheruata *et al.* 2004) and sperm production characteristics (McGary *et al.* 2003). Age effect did not have any significant effect on the wattle width though age and the strain interaction effect was significant; an indication that the strain differences depend on age. The result presented in Table 2 showed that secondary sexual characters were found to have high and positive correlations among themselves. Significantly high positive correlation was recorded between the performance traits. Shank length had high positive correlations with wattle length (r=0.541, P<0.001), wattle width (r=0.486, P<0.001), comb length (r=0.543, P<0.001) and comb width (r=0.510, P<0.001). Wattle length was positively correlated with width (r=0.789, P<0.001), comb length (r=0.847, P<0.001) and comb width (r=0.789, P<0.001). Similarly, wattle width was positively correlated with comb length (r=0.743, P<0.001) and comb width (r=0.732, P<0.001). Also, there was a significant positive correlation between comb length and comb width (r=0.890, P<0.001).

The positive and significant correlation between the live performance traits implies that improvement in one trait would have a positive influence on the others. Wattle and comb have therefore been recommended as selection traits for quantitative traits in chickens, Abdellatif, (1999). More so, Galal (2007) reported that any selection for the important economic trait that alters secondary sexual characters (comb, wattle and shank sizes) may result in lower fertility and reduced libido as they are considered as means of heat dissipation. The correlations between the secondary sexual characters and semen characteristics are shown in Table 3. It was observed that shank length, wattle length and width, comb length and width had positive correlation with semen volume (r=0.123, 0.335, 0.195 and 0.408 and 0.348 P<0.01), total sperm count (r=0.202, 0.300, 0.188, 0.403 and 0.320 P<0.05) and normal sperm (r=0.175, 0.143, 0.026, 0.155 and 0.065 P<0.05). Shank length has a positive correlation with sperm motility (0.010) and dead sperm (0.026), but a negative correlation with live sperm. Wattle width shows a positive correlation with motility (0.078) and live sperm (0.035) but a negative correlation with dead sperm. Also, wattle length shows a positive correlation with live sperm (r=0.064) and a negatively with dead sperm. Comb length and width were positively correlated with live sperm (r=0.087 and 0.109) but negatively with motility (r=-0.118 and -0.171) and dead sperm (r=-0.087 and -0.109).

independently of those controlling sperm motility, while long legs enhanced the releasing of additional heat along with main pathways of comb and wattles.

The results of this study however indicated that improving these secondary sexual characteristics may have a negative effect on semen pH and concentration. According to Zeller (1971) comb and wattle growth depends on the androgen (male reproductive hormone) levels, which have been shown to correlate with a male health status in Red Jungle fowl. Generally, it was reported (Dourgham, 1980; Hossari, 1980; Andersson, 1994; El sayiad *et al.* 1994; Abdellatif, 1999) that the degree of development of the secondary sexual characters could affect the reproductive potentials of an individual cock. Therefore, according to Galal (2007) any selection for important economic traits such as growth, fertility, hatchability and egg production that alters secondary sexual characters (comb, wattle and the positive and significant correlations between some secondary

Table 2 Phenotypic correlation coefficients between the secondary sexual characters

Traits	Shank length	Wattle length	Wattle width	Comb length	Comb width
Shank length		-	-	-	-
Wattle length	0.541***	-	-	-	-
Wattle width	0.486***	0.789***			-
Comb length	0.543***	0.847***	0.743***		-
Comb width	0.510***	0.789***	0.732***	0.890***	-

*** (P<0.001).

Table 3 Phenotypic correlation coefficients between secondary sexual characters and semen characteristics of four (4) strains of cocks

Traits	Volume	pH	Motility	Conc.	MNS	MAS	TSC	Live ratio	Dead ratio	Colour
Shank length (cm)	0.123	-0.017	0.010	-0.097	0.175	-0.191	0.202	-0.026	0.026	0.049
Wattle length (cm)	0.335**	-0.121	-0.078	-0.299*	0.143	-0.228	0.300*	0.064	-0.064	0.222
Wattle width (cm)	0.195	-0.120	0.078	-0.319*	0.126	-0.084	0.188	0.035	-0.035	0.246*
Comb length (cm)	0.408**	-0.150	-0.118	-0.264*	0.155	-0.209	0.403**	0.087	-0.087	0.265*
Comb width (cm)	0.348**	-0.182	-0.171	-0.330	0.065	-0.122	0.320*	0.109	-0.109	0.316**

Volume: semen volume; pH: semen pH; motility: semen motility; Conc: semen concentration; MNS: morphologically normal sperm; MAS: morphologically abnormal sperm; TSC: Total sperm count and Colour: semen colour.
* (P<0.05) and ** (P<0.01).

sexual characters and semen characteristics in chickens have been established by different authors. McGary *et al.* (2003) found that male broiler breeders with larger comb within specific strain were likely to have higher fertility as a significant positive correlation was found between strains and their individual fertility level.

Chickens with larger combs may reliably indicate roosters with greater semen production (Burrows and Titus, 1939), higher androgen levels, increased mating activity (Ligon *et al.* 1990) and good semen quality (Gebriel *et al.* 2009).

McGary *et al.* (2003) also provided evidence that secondary sexual characters namely, comb length and wattle length might be useful to predict fertility and semen quality in cocks. However, Galal *et al.* (2002) indicated that genes that govern length of shank tends to be linked with genes controlling ejaculate volume and sperm concentration but shank sizes) may result in lower fertility and reduced libido.

CONCLUSION

The outcome results of the present study showed the similarity of the exotic strains and the local cocks. Although it compares favourably with that of the Shika Brown, the local cocks may can compete favourably in any genetic improvement and breed development programme. When evaluating strains of cocks for fertility study, there is a need to take cognisance of age, because of the strain age interaction effect on some of the fertility traits. It may be inferred from this study that length of shank, comb, and wattle are good predictors of semen attributes in male chickens. Selecting cocks with larger shank length, comb and wattle size can improve the semen quality and subsequently, results to higher fertility.

ACKNOWLEDGEMENT

We express our profound gratitude to the staff of the small ruminant unit of the farm and also the staff of the Animal Science Department, Kano University of Science and technology, Wudil.

REFERENCES

Abdellatif M.A. (1999). Inheritance of comb and wattle lengths and its indicator to select cockerels in a population of Dandarawi chickens. *Assult J. Agric. Sci.* **30,** 123-131.

Andersson M. (1994). Sexual Selection. Princeton University Press, Princeton, N.J., USA.

Burrows W.H. and Titus H.W. (1939). Some observation on the semen production of the male fowl. *Poult. Sci.* **18,** 8-10.

Dourgham S.A. (1980). Genetic differences between two stains in fayoumi chickens with special reference to heterosis. MS Thesis, Ain. Shams university Cairo, Egypt.

Duncan D.R. (1955). Multiple range and multiple F-Test. *Biometrics.* **11,** 1-42.

El Sahn A.A. (2007a). Use of phenotypic traits to predict cocks fertility, 1. The secondary sexual trait and the skeletal conformation. *Egypt Poult. Sci.* **27,** 521-536.

El Sahn A.A. (2007b). Use of phenotypic traits to predict cock fertility, 2. The ornamental and non-ornamental traits. *Egypt Poult. Sci.* **27,** 1085-1097.

El Sayiad G.H., Hassari M.A., Yamani K.A., Sabri H.M. and Abdel-warith A. (1994). A genetical study on Egyptian fayoumi fowl. *Egypt Poult. Sci.* **14,** 285-315.

Galal A., Shemeis A.R. and Fathi M.M. (2002). Indexes to improve semen quality of naked neck cocks. *Egypt Poult. Sci.* **22,** 1143-1157.

Galal M. (2007). Predicting semen attributes of naked and normally feathered male chickens from live performance traits. *J. Poult. Sci.* **6(1),** 36-42.

Gebriel G.M., Kalamah M.A., El Fiky A.A. and Ali A.F.A. (2009). Some factors affecting semen quality traits in Norfa cocks. *Egypt Poult. Sci.* **29,** 677-693.

Hafez E.S.E. (1987). Reproductive Farm Animals. Philadelphic P.A, USA, Lea and Febiger.

Hossari M.A. (1980). Review on the improvement of fayoumi fowl with particular reference to a flock at fayoumi research station. *Agric. Res. Rev.* **58,** 171-190.

Ligon J.D., Thomhill R., Zuk M. and Johnson C. (1990). Male competition, ornamentation, and the role of testosterone in sexual selection in the red jungle fowl. *Anim. Behav*. **40,** 367-373.

McGary S., Estevez I., Bakst M.R. and Pollock D.L. (2003). Phenotypic traits as reliable indicators of fertility in male broiler breeders. *Poult. Sci*. **81,** 102-111.

Missou A., Dieng A., Horst P., Zarate V.A., Nesseim T. and Tchedre K. (2003). Effect of dwarf and frizzle genes on the performance of layers under Senegalese conditions. *Trop. Anim. Health Prod*. **35,** 373-380.

Ogah D.M., Momoh O.M. and Dim N.I. (2011). Application of canonical discriminant analysis for assessment of genetic variation in Muscovy duck ecotypes in Nigeria. *Egypt Poult. Sci.* **31,** 429-436.

Ojedapo L.O., Akinnokun O., Adedeji T.A., Olayeni T.B., Ige A.O. and Aman S.R. (2006). Short-term laying performance of three strain of commercial chicken in derived Savannah environment of Nigeria. Pp. 234-237 in Proc. 11th Animal Science Ass. Nigeria (ASAN). New challenge in Animal Production, The Way Forward. I.A.R and T., Ibadan, Nigeria.

Olofin E.A. (2007). Some aspect of physical geography of the Kano region and related human resources. Departmental lecture note series. Geography Department. BUK Kano, Nigeria.

Oluyemi J.A. (1978). A comparison of five laying commercial strains of fowl in a tropical environment. *Nigerian J. Genet.* **2,** 91-96.

Orheruata M.A., Okpeku M. and Imiunorin I.G. (2004). Phenotypic and body measurement characteristics in native and some exotic chickens in Edo State. Pp. 17-21 in Proc. 29th Ann. Conf. Soc. Anim. Prod. Nigeria.

Pakzadeh B., Safari P. and Honarnejad R. (2007) Assessment of Genetic Variation in Peanut (*Arachis hypogaea*) Cultivars using Canonical Discriminant Analysis.Hort

Peters S.O., Omidije E.A., Ikeobi C.O.N., Ozoje M.O. and Adebambo O.A. (2004). Effect of naked neck, and frizzle gene on egg traits, fertility and hatchability in local chicken. Pp 262-264 in Proc. 9th Ann. Conf. of Anim. Sci. Assoc. Nig., Nigeria. Ebonyi State Univ., Abakaliki, Nigeria.

Sekoni V.O., Gustaffson B.K. and Mather E.C. (1981). Influence of wet fixation, staining technique and storage time on bull's sperm morphology. *Nord. Vet. Med.* **33,** 161-166.

Steel R.G.D. and Torrie J.H. (1980). Principles and Procedures of Statistics. A Biometrical Approach. McCrawhill Book Co., New York.

Yeasmin T. and Howlider M.A.R. (1998). Comparative physical features, egg production and egg quality characteristics of normal and dwarf indigenous (Deshi) hens of Bangladesh. *J. Appl. Anim. Res.* **13,** 191-196.

Yeasmin T., Howlider M.A.R. and Ahammad M.U. (2003). Effect of introgressing dwarf gene from Bangladeshi indigenous to exotic breeds on egg production. *Int. J. Poult. Sci.* **2,** 264-266.

Zeller F.J. (1971). The effect of testosterone and dihydrotestosterone in the comb testes and pituitary gland of the male fowl. *J. Reprod. fertile*. **25,** 125-127.

Zemjanis R. (1970). Diagnostic and Therapeutic Techniques in Animal Reproduction. Williams and Wilkins Co. Baltimore, MD.