Egg production and quality assessment of Nigerian indigenous chicken genotypes and their crosses with Marshall

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Abstract

This study focused on investigating the reproductive performance of Nigerian indigenous chickens and their crosses with Marshall. The genotypes were normal-feathered (Nn), frizzle-feathered (Ff) and naked neck (Na) chickens, while the crossbreds with Marshall (M) breed were MNn, MFf and MNa respectively (Marshall being the sire while the indigenous are dams). Data were taken on; weekly egg production, weight at first egg and age at first egg. Genotype significantly ($P < 0.05$) influenced egg production traits. Egg weight ranged from 23.71 ± 1.06 g to 26.13 ± 0.94 g for indigenous purebreds and 39.75 ± 0.75 g to 48.06 ± 0.57 g for crossbreds. Age at first egg were 165.63 ± 0.61 days (Nn), 170.60 ± 0.75 days (Na) and 173.57 ± 0.52 days (Ff), 188.71 ± 1.67 days (MNn), 187.50 ± 3.16 days (MNa) and 185.25 ± 5.44 days (MFf). Also, genotype significantly ($P < 0.05$) influenced egg quality traits. Heritability for first egg production traits were 0.37 (Nm), 0.16 (Na) and 0.66 (Fz) while heritability estimates for egg quality trait (haugh unit) were 0.14, 0.07 and 0.08 for Nm, Na and Fz birds, respectively. The crossbreds performed better than the indigenous purebreds in egg production traits. The Nigerian indigenous chicken can therefore be improved upon for better egg production traits using the Marshall breed.

Keywords: Genotypes, Nigerian indigenous chicken, crossbreds and egg quality

Introduction

Poultry products are among the most valuable sources of animal protein available for human consumption and they offer means of meeting the animal protein deficiency gap in Nigeria and many African countries (Akinokun, 1990; Padhi, 2016). In most of these countries, demand for eggs and poultry meat far outweighs supply, as evidenced by steep rises in the prices of these products (Akinokun, 1990). The poultry sub-sector is ranked best among the fastest growing livestock and animal industry in the world (Belova *et al.*, 2012). Poultry birds have been widely reported to possess high degree of efficiency of feed utilisation with little or no socio-religious taboo in their consumption. Poultry meat and egg production accounts for more than

30% of all animal protein (Permin and Perderson, 2000). The International Food Policy Research Institute (IFPRI, 2000) estimated that by the year 2015, poultry will account for 40% of animal protein. Several surveys on local chicken population and production have been carried out and reported from many parts of the world, particularly in African countries. Reports from Indonesia indicated that local chickens contributed 53% of poultry production (Bambang, 2008) while in India, between 70 and 75% of poultry production comes from local chicken populations and provides 18-20% of about 30,000 million eggs annually (Padhi, 2016; Branckaert *et al.*, 2000). In Africa, rural poultry is believed to be a viable and a promising alternative source of income for rural

households (Sonaiya, 1990, Alabi *et al.*, 2006). The chicken industry in Nigeria is dominated by two distinct categories of stock namely; improved (exotic) and unimproved indigenous stock. The total population of domestic chickens (improved and unimproved) in Nigeria was estimated to be 180 million (Sahel, 2015). The population of indigenous chickens has preponderance of adaptability genes to the detriment of productive genes. These may be partly due to the fact that the birds have not been subjected to adequate genetic selection for increased productivity (Ibe, 1998) but more to natural selection by the adverse environmental conditions.

Several researches have been conducted towards the effective genetic improvement of local chickens by many researchers across the different ecological zones of the country, such as the performance characterisation (Adebambo *et al.*, 1999) and the genetic differences in the performance (Ikeobi *et al.*, 1996). The current productivity levels of local chickens are low, considering their potentials because of poor management. Adaptability of exotic breeds under the climatic condition of Nigeria is also a major problem, as a result of genotype by environment interaction. They experience considerable loss of fitness when compared with improved indigenous counterparts that are well-adapted and are characterised by higher disease resistance capacity (Oluyemi and Roberts, 1988; Permin, 2008). The production of exotic poultry species is unaffordable to many Nigerians, owing to high foreign exchange implication of importing grand-parents stocks (Ibe, 1990). Meanwhile, the indigenous chickens are characterised with low production despite the fact that they are better-adapted and cheaper to raise. It is therefore necessary that a balance between these

extremes be attained through cross breeding. This experiment was therefore carried out to assess the egg production and quality traits, the correlations among egg quality traits and the heritability of egg production of normal-feathered, frizzle feathered and naked neck local chickens and their crosses with Marshall.

Materials and Methods

Experimental Site

The breeding unit of the poultry pen of the Teaching and research farm (TREFARD) of the Federal University of Agriculture, Abeokuta, Ogun State was used for this experiment.

Experimental birds

30 pullets from the breeding pen were inseminated to produce day-old chicks of different genotypes containing pure genotypes of normal-feathered chicks, naked neck chicks, and frizzle-feathered chicks. Semen from Marshall Cocks was used to inseminate pure genotypes of frizzle-feathered, normal-feathered and naked neck pullets to produce dihybrids (F1) with 50% Marshall blood and 50% local blood. Records of the sire and dam noted and written on the eggs before taken to the hatchery. After 19 days in the incubator, the eggs were individually placed in partitioned trays before taken to the hatcher, so that each chick can be identified with its sire and dam. All the chicks are from a single hatch. These chicks grew to become pullets and cockerels. At 20 weeks of age pullets were separated from cockerels into battery cages. Pullets obtained were fewer in number than cockerels especially for the frizzled feathered and naked neck genotypes and their crosses with Marshall. These pullet of local chicken genotypes, 16 normal-feathered (Nn), 7 frizzle-feathered (Ff), 10 naked neck (Na), and pullets of their

crosses with Marshal (ie 17 MNn, 4 MFf and 8 MNa) were evaluated for egg production.

Data collection

The data on age at first egg, weight at first egg and weight of first egg were collected for each bird in each genotype. Number and weight of eggs laid subsequently were noted weekly.

At eight weeks and twelve weeks in lay, eggs laid by pullets were sampled for egg quality traits. Egg quality parameters which include external parameters (egg weight, egg length, egg width, egg shape index and shell thickness) and internal parameters (yolk weight, albumen height, yolk height, albumen weight, and incidence of blood spot) were determined for each genotype. The data was classified according to their genotypes.

Egg weight was measured to the nearest grammes using a sensitive weighing scale (Gulfex Medical and Scientific Electronic Balance, JT502N). Egg height and width were measured using a vernier caliper to. Albumen height was measured using a spherometer. This was achieved by breaking out a freshly-laid egg into a clean slide placed on a flat surface. The spherometer was then placed in the slide directly on top of the broken out egg. The spherometer was screwed so that its pointed tip touched the top of the albumen; the reading was then taken in millimeter. The yolk was removed from the albumen with a clean plastic spoon and placed on a clean slide to measure the albumen weight and the yolk weight apart. The shell thickness was measured using a micrometer screw gauge.

$$\text{Egg shape index} = \frac{\text{Egg Width}}{\text{Egg Length}}$$

$$\text{HU} = 100 \log_{10} (h - 1.7w^{0.37} + 7.6)$$

Where HU = Haugh unit

h = observed height of the albumen in millimeters

w = weight of egg in grams

Statistical Analyses

Least square means, heritability, genetic and phenotypic correlation analyses were carried out using SAS (2002) software. Means were separated using Duncan's Multiple Range Test (DMRT) (2002).

Results and discussion

The effects of genotype on egg production traits are presented in Table 1. Genotype significantly ($P < 0.01$) affected the age of pullets at lay. The pure indigenous genotypes came to lay earlier than their crossbred counterparts. Nn started laying at the age of 165.63 ± 0.61 days. This agrees with the 165 ± 3.7 days reported by Adedokun and Sonaiya (2001) for chickens in the rain forest zone in Nigeria. Nn started at 170.6 ± 0.75 days while Ff started at 173.75 ± 0.52 days. Among the dihybrids, MFf started laying at the age of 185.25 ± 5.44 days followed by MNa at 187.50 ± 3.167 days and MNn at 188.71 ± 1.67 days, respectively. The present findings differs from the reports of Nwosu (1979) and Omeje and Nwosu (1984), who recorded 133 ± 1.11 days and 157.80 ± 3.21 days, respectively as the age of first lay for Nigerian local chickens. They are also not in agreement with those from Akinokun (1990) and Oleforuh-Okoleh (2011) who reported that age at sexual maturity ranged from 159.47 ± 1.97 to 168.47 ± 1.90 days for local chickens in Nigeria. However, reports from this experiment fall within the range of 153 to 206 days reported in literature for unimproved local chickens in Nigeria (Akinokun, 1990; Adedokun and Sonaiya, 2001; Momoh, 2005). Dihybrid pullets significantly ($P < 0.05$) weighed higher than pure local chicken genotypes at point of lay with 2107.35 ± 55.06 g, 2075.00 ± 165.2 g and 2053.13 ± 73.56 g recorded for normal,

frizzle and naked neck respectively. Average values of 1640.00 ± 78.81 g, 1365.00 ± 40.74 g and 1298.57 ± 37.19 g were obtained for Na, Nn and Ff respectively. The results were expected because the Marshall breed used in the experiment had been well developed for high body weight (www.candmpoultry.com).

The weights of first eggs in dihybrids were significantly $P < 0.001$ higher than those of the pure genotypes. Dihybrid normal had the highest egg weight of 48.06 ± 0.57 g followed by dihybrid naked neck and frizzle with 45.13 ± 1.80 g and 39.75 ± 0.75 g respectively. Among the pure genotypes,

pure normal had the highest egg weight followed by pure naked neck and then pure frizzle of 26.13 ± 0.94 g, 24.10 ± 0.57 g, 23.71 ± 1.06 g respectively. This is low when compared with 34.29 g reported by Agu *et al.*, (2012) and 30.62 g reported by Oleforuh-Okoleh (2011) but falls within the range of 25.97 g reported by Omeje and Nwosu (1984). In this experiment, the dihybrids exhibited the trait of egg production inherent in their exotic sire. Their performance over the pure indigenous genotype is consistent with the results obtained by Omeje and Nwosu (1983), where heterosis in the egg weight of crossbreds was shown.

Table 1: Least Square Means $\pm$ Standard Errors for Egg Production Traits

Genotype	N	Weight at first egg (g)	Weight of first egg (g)	Age at first egg (days)
Pure Normal	16	1365.00 ± 40.74^c	26.13 ± 0.94^d	165.63 ± 0.62^c
Pure Naked neck	10	1640.00 ± 78.81^b	24.10 ± 0.57^d	170.60 ± 0.75^{bc}
Pure frizzle	7	1298.57 ± 37.19^c	23.71 ± 1.06^d	173.57 ± 0.52^b
Di Normal	17	2107.35 ± 55.06^a	48.06 ± 0.57^a	188.71 ± 1.67^a
Di Naked neck	8	2053.13 ± 73.56^a	45.13 ± 1.30^b	187.50 ± 3.16^a
Di Frizzle	4	2075.00 ± 165.20^a	39.75 ± 0.75^c	185.25 ± 5.44^a

^{abcd} Means with the same superscript are not significantly different ($P > 0.05$).

The means of weekly egg production were not significantly ($P > 0.05$) different as presented in Table 2. The non-significant difference observed among the genotypes in egg production shows that the three Nigerian chicken genotypes are not distinct

from one another in number of eggs produced. This agrees with an earlier conclusion reached by Adedokun and Sonaiya (2001) that Nigerian local chickens are not significantly different in egg production.

Table 2: Least Mean square $\pm$ Standard errors of Weekly Egg Production as affected by Genotype

Age in lay (wk)	Pure Normal	Pure Naked neck	Pure Frizzle	Di-Normal	Di-Naked neck	Di-Frizzle
1	1.64 ± 0.69	1.67 ± 1.05	1.80 ± 1.11	0.63 ± 0.43	2.33 ± 1.05	2.33 ± 1.20
2	2.36 ± 0.72	1.83 ± 0.87	2.40 ± 0.68	3.44 ± 0.56	2.83 ± 0.94	3.66 ± 1.85
3	2.64 ± 0.72	3.00 ± 1.00	3.40 ± 0.40	3.75 ± 0.60	4.50 ± 0.34	5.67 ± 0.00
4	3.64 ± 0.73	4.33 ± 0.33	4.60 ± 0.24	3.69 ± 0.45	4.33 ± 0.33	5.00 ± 0.57
5	4.09 ± 0.48	4.33 ± 0.33	3.40 ± 0.51	4.13 ± 0.52	3.83 ± 0.87	4.67 ± 0.67
6	3.73 ± 0.49	4.50 ± 0.43	3.60 ± 0.24	4.31 ± 0.38	4.67 ± 0.49	3.36 ± 0.67
7	4.55 ± 0.41	3.67 ± 0.21	3.60 ± 0.60	4.56 ± 0.30	3.50 ± 0.56	3.33 ± 0.33
8	4.45 ± 0.41	3.83 ± 0.48	4.40 ± 0.60	4.31 ± 0.33	4.67 ± 0.67	4.00 ± 0.57
9	4.18 ± 0.30	4.00 ± 0.68	4.00 ± 0.55	4.25 ± 0.30	4.50 ± 0.56	5.33 ± 0.33
10	4.64 ± 0.41	3.83 ± 0.48	4.40 ± 0.59	4.69 ± 0.37	4.83 ± 0.95	4.33 ± 0.33
11	4.36 ± 0.49	3.83 ± 0.48	3.60 ± 0.24	4.56 ± 0.22	5.00 ± 0.45	4.00 ± 0.00
12	4.18 ± 0.42	3.67 ± 0.49	3.80 ± 0.49	5.31 ± 0.25	4.17 ± 0.70	4.33 ± 0.67
13	4.82 ± 0.30	4.00 ± 0.39	4.40 ± 0.24	4.81 ± 0.21	5.17 ± 0.40	5.00 ± 0.57

The effect of genotype on egg quality traits is presented in Table 3. Genotype significantly ($P<0.05$) affected most of the egg quality traits under consideration. Nn and MNn had the highest values for almost all the traits examined followed by Na and MNa. The lowest performance coming from Ff and MFF for all traits under consideration.

Egg shape index ranged from 77.36 ± 0.44 to 80.16 ± 0.76 in this study, and it is higher in dihybrids than purebreds. These values are lower than 0.83 ± 0.04 reported by Ikeobi *et al.* (1999) for Nigerian local chickens, but are closely similar to the values of 0.79 reported by Ukachukwu and Akpan (2007), 0.76 to 0.78 reported by Momoh *et al.*

(2010) and 77.36 ± 0.36 reported by Haunshi *et al.* (2011) for Aseel chicken from India.

The Haugh units ranged from 89.40 in Ff to 96.33 in Na, this shows that Naked neck birds (pure and crossbred) have higher albumen quality than other genotypes studied. These values are however, higher than 61.85 reported by Ikeobi *et al.* (1999) and 77.9 to 79.1 reported by Momoh *et al.* (2010) for some Nigerian indigenous birds. Parmer *et al.* (2008) and Niranjan *et al.* (2008) also reported ranges of 62.58 to 90.00 and 74.60 to 79.42 respectively for some indigenous backyard poultry in India. The higher values of Haugh unit obtained in this study indicate the superior quality of the albumen in the genotypes studied.

Table 3: Least Square Means $\pm$ Standard Errors for Egg quality traits

Genotype	N	Egg wt (g)	Egg ht (cm)	Egg width (cm)	Shell (mm)	Int wt(g)	Alb ht (cm)	Alb wt (g)	Yolk ht(mm)	Yolk wt(g)	HU	ESI
Pure Normal	30	59.68 $\pm$ 1.15 ^a	5.42 $\pm$ 0.05	4.18 $\pm$ 0.04 ^b	0.38 $\pm$ 0.01	51.92 $\pm$ 1.13 ^a	8.84 $\pm$ 0.24 ^a	35.58 $\pm$ 0.24 ^a	15.57 $\pm$ 0.18 ^a	16.37 $\pm$ 0.30 ^{ab}	93.68 $\pm$ 1.12 ^a	77.36 $\pm$ 0.44 ^b
Pure Naked neck	11	51.41 $\pm$ 2.10 ^b	5.61 $\pm$ 0.10	4.48 $\pm$ 0.06 ^a	0.39 $\pm$ 0.02	44.94 $\pm$ 1.98 ^b	9.05 $\pm$ 0.65 ^a	30.91 $\pm$ 1.60 ^b	16.50 $\pm$ 0.32 ^a	14.00 $\pm$ 0.41 ^a	96.33 $\pm$ 2.58 ^a	79.85 $\pm$ 0.92 ^{ab}
Pure Frizzle	9	45.95 $\pm$ 1.48 ^c	5.53 $\pm$ 0.07	4.30 $\pm$ 0.08 ^{ab}	0.41 $\pm$ 0.01	39.45 $\pm$ 1.35 ^c	7.75 $\pm$ 0.57 ^{ab}	25.11 $\pm$ 0.83 ^b	15.78 $\pm$ 0.49 ^a	14.16 $\pm$ 0.65 ^a	91.46 $\pm$ 2.75 ^{ab}	77.69 $\pm$ 0.99 ^{bc}
Di Normal	18	57.46 $\pm$ 1.73 ^a	5.56 $\pm$ 0.09	4.47 $\pm$ 0.08 ^a	0.42 $\pm$ 0.01	50.09 $\pm$ 1.70 ^{ab}	8.64 $\pm$ 0.32 ^a	33.19 $\pm$ 0.97 ^{ab}	15.92 $\pm$ 0.24 ^a	16.73 $\pm$ 0.82 ^a	93.21 $\pm$ 1.47 ^a	79.62 $\pm$ 0.87 ^{ab}
Di Naked neck	12	51.90 $\pm$ 1.27 ^b	5.56 $\pm$ 0.08	4.45 $\pm$ 0.07 ^a	0.41 $\pm$ 0.01	44.96 $\pm$ 1.06 ^b	8.87 $\pm$ 0.33 ^a	30.17 $\pm$ 0.68 ^b	16.00 $\pm$ 0.41 ^a	14.74 $\pm$ 0.47 ^{ab}	95.67 $\pm$ 1.75 ^a	80.16 $\pm$ 0.76 ^a
Di Frizzle	6	43.61 $\pm$ 1.67 ^c	5.27 $\pm$ 0.14	4.13 $\pm$ 0.11 ^b	0.39 $\pm$ 0.02	37.48 $\pm$ 1.38 ^c	6.68 $\pm$ 0.49 ^b	24.70 $\pm$ 1.08 ^c	14.42 $\pm$ 0.58 ^a	12.91 $\pm$ 0.85 ^b	89.40 $\pm$ 2.07 ^b	78.37 $\pm$ 0.88 ^{ab}

^{a-c} Means with the same letters within the same column are not significantly different ($P>0.05$).

The heritability estimates, phenotypic and genetic correlations are as shown in Tables 4-9. Heritability estimates for weight at first egg, weight of first egg and age at first egg are different within each genotype and from one genotype to another. Pure naked neck genotype had the highest heritability estimate of 0.84 for weight at first egg while frizzle feathered and normal feathered genotypes had 0.54 and 0.20 respectively. Naked neck also had the highest estimate of 0.93 for age at first egg while frizzle feathered and normal feathered genotypes had 0.27 and 0.85 respectively. Frizzle

feathered genotype had the highest estimate of 0.66 for weight of first egg while normal feathered and naked neck had 0.37 and 0.16 respectively. The high heritability estimates obtained for egg production traits showed that more of additive gene component is active and expressed in the chicken genotypes rather than the dominant or epistatic gene component. This implies that more improvement can be achieved in our indigenous chicken genotypes through continuous selection for egg production (Adeleke *et al.*, 2011).

Table 4: Heritability estimates, Genetic and Phenotypic Correlation for Egg Production Trait of Pure Normal Chicken

	Weight at first egg	Weight of first egg	Age at first egg	±MSE
Weight at first egg	0.20	0.19	-0.08	±0.25
Weight of first egg	0.19	0.37	-0.25	±0.25
Age at first egg	-0.08	-0.25	0.85	±0.25

Heritability in bold, phenotypic correlation above diagonal and genetic correlation below diagonal

Table 5: Heritability estimates, Genetic and Phenotypic Correlation for Egg Production Trait of Pure Naked neck Chicken

	Weight at first egg	Weight of first egg	Age at first egg	±MSE
Weight at first egg	0.84	0.55	-0.20	±0.31
Weight of first egg	0.55	0.16	-0.36	±0.31
Age at first egg	-0.21	-0.38	0.93	±0.31

Heritability in bold, phenotypic correlation above diagonal and genetic correlation below diagonal

Table 6: Heritability estimates, Genetic and Phenotypic Correlation for Egg Production Trait of Pure Frizzle Chicken

	Weight at first egg	Weight of first egg	Age at first egg	±MSE
Weight at first egg	0.54	-0.42	-0.14	±0.37
Weight of first egg	-0.42	0.66	0.73	±0.37
Age at first egg	-0.14	-0.73	0.27	±0.37

Heritability in bold, phenotypic correlation above diagonal and genetic correlation below diagonal

Genetic and phenotypic correlations of egg production traits were not significant ($P>0.05$) for all the genotypes. Genetic and phenotypic correlations between weight at first egg and age at first egg were negative for all genotypes except dihybrid frizzle. Correlations between weight at first egg and weight of first egg are positive for pure normal, pure naked neck and dihybrid frizzled while those of pure frizzle, dihybrid normal and dihybrid naked neck were negative. Age at first egg had correlation coefficients ranging from -0.02 in dihybrid naked neck to -0.73 in pure frizzle with weight of first egg. Generally, the genetic correlations observed in this study were almost the same as the phenotypic

correlations. Negative genetic correlations among these egg production traits imply that as one trait is increasing the other is decreasing. This suggests that the gene controlling one is opposed to the other, as selection for one trait will lead to reduction in the other traits. However, crossbreeding will yield better results as additive gene is at work.

In conclusion the heritability estimates in this study suggest that additive genetic variance will bring about fast response to selection in local chicken for egg production. Pure normal and naked neck genotypes can compete with hybrids when continuous selection is carried out for egg production.

Table 7: Genetic and Phenotypic Correlation for Egg Production Trait of Dihybrid Normal Chicken

	Weight at first egg	Weight of first egg	Age at first egg	±MSE
Weight at first egg	--	-0.11	-0.44	±0.24
Weight of first egg	-0.26	--	-0.30	±0.24
Age at first egg	0.06	-0.39	--	±0.24

Phenotypic correlation above diagonal and genetic correlation below diagonal

Table 8: Genetic and Phenotypic Correlation for Egg Production Trait of Dihybrid Naked neck Chicken

	Weight at first egg	Weight of first egg	Age at first egg	±MSE
Weight at first egg	--	-0.11	-0.47	±0.31
Weight of first egg	-0.13	--	-0.02	±0.31
Age at first egg	-0.58	-0.02	--	±0.31

Phenotypic correlation above diagonal and genetic correlation below diagonal

Table 9: Genetic and Phenotypic Correlation for Egg Production Trait of Dihybrid Frizzle Chicken

	Weight at first egg	Weight of first egg	Age at first egg	±MSE
Weight at first egg	--	0.11	0.65	±0.37
Weight of first egg	0.12	--	-0.55	±0.37
Age at first egg	0.72	-0.61	--	±0.37

Phenotypic correlation above diagonal and genetic correlation below diagonal

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