Nigerian J. Anim. Sci. 2021, 23 (2): 100-113

Evaluation of egg production and egg quality traits of Noiler chickens

[1]Dogara, M. U., [2]Kalla, D. J. U., [2]Mancha, Y. P. and [3]Shuaibu, A.

[1]Department of Animal Science, Faculty of Agriculture, Federal University of Lafia, Nasarawa State, Nigeria; [2]Department of Animal Production Faculty of Agriculture and Agricultural Technology, Abubakar Tafawa Balewa University, Bauchi, Nigeria; [3]Department of Animal Science Faculty of Agriculture, Federal University of Kashere, Gombe State, Nigeria

***Corresponding Author**: u.muhammad48@gmail.com; **Phone Number**: +2347065021802*

***Target Audience**: Poultry breeders, Physiologists and poultry farmers*

Abstract

The study was conducted to evaluate the egg production performance and egg quality traits of Noiler chickens. A total of 135 adult Noiler hens were used for the study out of which 63 were black, 52 brown and 20 spotted. Specifically, laying characteristics, egg production and egg quality traits were assessed. Data generated were subjected to analysis of variance and the relationship among the parameters observed was estimated using Pearson's correlation analysis. The laying characteristics showed significant (P<0.01, P0.05) difference in age at sexual maturity (ASM), body weight at first egg (BFE), average egg number per hen (Ave. En/Hen), hen housed production (HHP) and hen day production (HDP). On the other hand, plumage colour and period on hen day production rate indicated considerable changes (P<0.01) on normal eggs and period (weeks) of production, also egg weight, egg density, shell thickness, egg surface area, albumen length, width, depth, weight and percent, yolk length, width, weight and percent and Haugh unit revealed considerable changes. The correlation coefficients among the egg quality traits and laying characteristics were in generally low and non-significant which showed that they cannot indicate each other.

***Keywords:** Noiler chicken, egg production, egg quality traits, plumage colour*

Description of Problem

The need to produce more animal protein in the country has become increasingly urgent in view of the ever-rising population. Population growth has surpassed food production and at the moment it is estimated that about one quarter of the population are already facing chronic food insecurity. The human population in Nigeria is projected to grow at an annual rate of 2-5% to the year 2025 (1). Poultry products have been recommended to bridge protein gap because of short generation interval, high rate of productivity, quick turnover rate, higher feed efficiency of poultry (2). Poultry eggs constitute one of the most valuable sources of animal protein recommended for human consumption (3).

Adequate information on growth potentials of existing commercial layers in the country is essential to poultry farmers so as to guide or assist in the choice of stock. However, because these birds vary in production indices, it is therefore imperative to assess them as a measure of their performance in the environment (4). Most commercial laying birds are bred in developed countries of Europe and America by International breeding companies and supplied to enfranchised companies locally from whom many farmers purchase their chicks (5). However, genotype x

environment interaction continues to lower the performance of these birds as against what is obtained in their native countries. Egg number and egg weight are important performance indices in the economies of poultry production and play a significant role in determining the net final income of egg producers (3).

In Nigeria, the local chickens are widely distributed in the rural areas, where they are kept by the natives, principally as a source of protein and income. (6) noted that the local chicken has unique adaptive features which predispose it to adapt to the local environment better than the exotic types. (3) suggested that genetic improvement of Nigerian indigenous chickens can help to alleviate the problems of animal protein shortage especially in the rural areas. The Nigerian indigenous chickens are suitable for the development of layer strains for the tropical environment (7). Earlier attempts to improve the performance of indigenous chickens started in the late 1930's (8) in which there was the introduction of the village poultry improvement scheme which was based on cockerel exchange. These attempts were made in the past to improve the productivity of the indigenous chicken due to its potential as a source of meat to significantly reduce the gap of animal protein deficiency in the society (9). Noiler bird is a natural cross breeding process of layers, broilers with the local birds carried out by Amo Farm Sieberer hatchery Limited. Noiler is a dual purpose breed of chicken bred to survive on low quality feedstuff to provide good quality meat and egg for small holders to address the challenges of food insecurity and financial dependency among rural populace, especially women (10). In Nigeria, efforts have been made towards the development of indigenous chicken breeds with improved meat and egg production. These efforts result in the creation or development of FUNNAB-alpha breed by Federal University of Agriculture Abeokuta (11). However, there is little information on egg production performance and egg quality traits of Noiler chicken. This study was therefore carried out to evaluate the laying characteristics, egg production and egg quality traits.

Materials and Methods

Location of the study

The experiment was conducted at the poultry unit of Bauchi State Agricultural Development Programme (BSADP). Bauchi State is located between latitudes 9^{o} 3′ and 12^{o} 3′ North, longitudes 8^{o} 50′ and 11^{o} East and is elevated 537 meters above sea level. It has a land area of 49,119 km^2 representing 5.3% of Nigeria's total land mass. The climate is characterized by two well defined seasons; the rainy season (May to October) and the dry season (November to April). The mean annual rainfall was 905.33 mm and ranges between 700 to 1250 mm while that of the temperature was 11-41 ^{o}C. The average hour of sunshine per month was 300. The state has a highest relative humidity 65.5 % in month of August and 16.5% in February (12; 13). The vegetation of the state is Sahelo-Sudan in the north and guinea savannah in the central and western zones (Institute of Agricultural Research/Bauchi State Agricultural Development Program (14).

Experimental birds

A total of 136 Noiler chickens were used for this study, out of which, 63 were black, 52 brown and 20 spotted. They were purchased from Poultry Center of Bauchi State Agricultural Development Program (BSADP) and raised on deep litter system for a period of 10 weeks (from 8-18 weeks of age). Prior to the onset of laying, the birds were transferred to battery cage (height = 42

cm, length = 31 cm, and width = 37 cm).

Experimental diets

The experimental birds were fed with grower ration (Crude Protein = 14 %, Fat = 7 %, Crude fiber = 10 %, Calcium = 1.0 % and Available Phosphorous = 0.35 %) from 8 to 18 weeks of age which was later change to layer mash before the commencement of laying (CP = 16.5 %, Fat = 5 %, Crude fiber = 10 %, Calcium = 3.50 % and Available Phosphorous = 0.40 %). Throughout the experimental period (12 weeks), water is supplied ad-libitum.

Data collection

Egg production traits

Eggs were collected twice in a day (morning and evening). A total of 3645, 2860 and 1100 eggs were collected from black, brown and spotted plumage respectively and 1039, 858 and 330 eggs were used for egg quality traits assessment for black, brown and spotted plumage respectively. Both hen day egg production (HDP) and hen housed production (HHP) were observed, and calculated using the following formulas;

$$\text{HDP} = \frac{Total\ number\ of\ eggs\ produced\ in\ a\ day}{Total\ number\ of\ hens\ present} \times 100$$

$$\text{HHP} = \frac{Total\ number\ of\ eggs\ produced\ in\ a\ day}{Total\ number\ of\ hens\ at\ begining\ of\ laying} \times 100$$

Egg quality traits

Motor vehicle was used to transport eggs from BSADP to University Laboratory (20 min drive). About twenty-three (23) eggs quality traits were measured in Animal Production Laboratory of Abubakar Tafawa Balewa University, Bauchi. These includes: egg weight, egg circumference, egg density, egg length, egg width, shell weight, shell thickness, shell percent, egg shape index, egg surface area, albumen length, albumen width, albumen depth, albumen weight, albumen percent, yolk length, yolk width, yolk depth, yolk weight, yolk index, yolk percent, yolk colour and Haugh unit. Weights of egg, shell, yolk and albumen were determined using electronic scale (accuracy of 0.01 g) ; egg length, circumference and width were measured using digital Vernier caliper; albumen and yolk lengths, widths and depths were obtained also using digital vernier caliper (0.01mm accuracy); shell thickness was recorded using digital micrometer screw gauge (0.01mm accuracy), while egg density, egg shape index, egg surface area, shell percentage, yolk percentage, yolk index, albumen percentage and Haugh unit were estimated using the following formulas (15):

$$Egg\ density = \frac{Egg\ weight\ (g)}{Egg\ volume(cm3)}$$

$$\textit{Egg shape index (\%)} = \frac{Egg\ width\ (mm)}{Egg\ length\ (mm)} \times 100$$

$$\textit{Egg surface area } (cm^2) = 3.9782 \times egg\ weight^{0.70}$$

$$\textit{Shell Percentage (\%)} = \frac{Shell\ weight\ (g)}{Egg\ weight\ (g)} \times 100$$

$$\textit{Yolk Percentage (\%)} = \frac{Yolk\ weight\ (g)}{Egg\ weight\ (g)} \times 100$$

$$\textit{Yolk Index (\%)} = \frac{Yolk\ height\ (mm)}{Yolk\ height\ (mm)} \times 100$$

$$\textit{Albumen Percentage} = \frac{Albumen\ weight\ (g)}{Egg\ weight\ (g)} \times 100$$

$$HU = 100 \log (h + 1.7\ W^{0.37} - 7.6)$$

Where:
h = albumen height (mm)
W = Egg weight (g).

Data analysis

The data generated were subjected to analysis of variance (ANOVA) using the

General Linear Procedure (GLM) of SPSS, version 22 (16). Significantly different means were compared using the Least Significant Difference (LSD). The models utilized were as follow:

$\mathbf{Y_i = U + G_i + e_i}$

$\mathbf{Y_{ij} = U + G_i + M_j + e_{ij}}$

$\mathbf{Y}_i$ = Observation on independent variables (production and egg quality parameters)

$\mathbf{Y}_{ij}$ = Observation on independent variables (hen day egg production rate)

U = Overall mean

$\mathbf{G}_i$ = Effect of i^{th} genotype (1, 2, 3)

$\mathbf{M}_j$ = Effect of j^{th} month (1, 2, 3)

$\mathbf{e}_i$ = Random error term (production and egg quality parameters)

$\mathbf{e}_{ij}$ = Random error term (hen day egg production rate)

Results

Laying characteristics, egg production performance and egg quality traits (both external and internal egg parameters) are presented in Tables 1, 2 and 3, respectively. There was significant effect of plumage colour on age at sexual maturity (ASM) and average egg number per hen (Ave. EN/Hen), body weight at first egg (BFE), hen housed and hen day productions (HHP and HDP) (Table 1). Spotted Noiler chicken had the highest for Ave. EN/Hen, HHP and HDP while the least values were recorded in Brown (62.28±1.66, 74.14 % and 66.31 % vs. 55.71±1.93, 66.43 % and 63.59 %). Black strains were heavier at first egg than spotted and brown chicken (2.27±0.03 kg vs. 2.17±0.05 kg and 2.02±0.04 kg) while for ASM, the result for spotted chickens was better compared to other genotypes (Brown and Black). Non-significant effect of strain on egg weight, clutch length and size and pause length was however observed. Average normal, soft shell and shell-less eggs produced are shown in the Table 2. Strain had no effect on egg type (normal, soft shell and shell-less egg). Significant effect of period (week) on normal ($P<0.001$) and shell-less ($P<0.05$) eggs was observed. Week 28-32 had the highest for normal eggs produced by Noiler chicken while the least value was recorded in week 18-22 (88.45±4.16 vs. 30.64±4.16). For shell-less eggs, the latter week had the highest than the former (1.21±0.11 vs. 0.04±0.11). However, non-significant effect of period (week) on soft shell egg was evident.

The mean egg parameters (internal and external egg quality traits) according to strain are presented in Table 3. Significant influence of genotype (strain) on egg density, shell thickness, albumen depth, albumen weight, albumen percent, yolk length, yolk width, yolk weight, yolk percent and Haugh unit ($P<0.001$), albumen length and albumen width ($P<0.01$), egg weight and surface area ($P<0.05$) was observed. Black strains had the heaviest eggs (55.32±0.27 g), with higher density (52.61±0.21 g/cm^3), shell thickness (0.36±0.04 mm), egg surface area (65.98±0.23 cm^2), albumen depth (5.61±0.86 mm), albumen weight (34.47±0.22 g) albumen percent (62.44±0.34 %) Haugh unit (74.36±0.64), yolk length (38.21±0.10 mm), yolk width (36.40±0.01 mm), yolk weight (15.28±0.83 g) and yolk percent (27.75±0.17 %), while the least was observed in spotted [for egg weight (54.05±0.60 g), egg density (50.14±0.58 g/cm$^{3)}$, shell thickness (0.32±0.02 mm), egg surface area (64.89±0.49 cm$^{2)}$, albumen depth (4.90±0.18 mm), albumen weight (32.03±0.35 g), albumen percent (59.45±0.51 %) and Haugh unit (68.55±1.37)] and brown [for yolk length (37.53±0.11 mm), yolk width (35.92±0.09 mm), yolk weight (14.70±0.98 g) and yolk percent (26.54±0.23 %)]. For albumen length and width, spotted strain of Noiler chickens had higher values than black (77.33±0.74 and 62.30±0.24 mm vs 74.47±0.41 and 60.75±0.28 mm). However,

non-significant effect of strain on egg circumference, egg length, egg width, shell weight, shell percent, egg shape index, yolk depth, yolk index and yolk colour was observed. Phenotypic correlation coefficients among the egg measurements are presented in Table 4. Most of the coefficients observed were low and non-significant except between albumen weight and egg weight (0.644), egg length and egg weight (0.943), egg width and egg weight (0.857), albumen weight and egg density (0.712) and egg length and egg density (0.704) in which higher values were recorded. Correlation coefficients of laying performance of Noiler chickens are presented in Table 5. Most of the relationships among the traits observed (laying performance) were low and non-significant except between clutch length and size and, average egg number and age at first lay where high, significant and negative values were recorded (-0.715 and -0.737, respectively).

Table 1: Effect of plumage colour on laying characteristics of Noiler chicken

Parameters	Overall mean ± SEM	Black	Brown	Spotted	LOS
ASM (days)	169.50±0.88	171.39±1.32^{b}	168.55±1.46^{a}	165.67±1.60^{a}	*
BWFE (kg)	2.16±0.02	2.27±0.03^{a}	2.02±0.04^{b}	2.17±0.05^{a}	***
Ave. EN/Hen	56.70±1.00	55.90±1.26^{b}	55.71±1.93^{b}	62.28±1.66^{a}	*
EWFL (g)	46.35±0.77	47.91±1.21	45.45±1.08	46.35±2.26	NS
CL	7.35±0.29	7.24±0.43	7.80±0.50	6.44±0.57	NS
PL (days)	1.46±0.11	1.40±0.06	1.65±0.26	1.16±0.07	NS
CS	11.79±0.86	12.18±1.00	10.92±1.65	12.92±1.82	NS
HHP (%)	65.01	63.59^{b}	63.13^{c}	66.31^{a}	***
HDP (%)	69.08	66.66^{b}	66.43^{c}	74.14^{a}	***

ASM = Age at sexual maturity, BWFE = Body weight at first egg, Ave. En/Hen = Average egg number per hen, EWFL = Egg weight at first lay, CL = Clutch length, PL = Pause length, CS = Clutch size, HHP = Hen housed production and HDP = Hen day production. LOS = Level of significance, * = P<0.05, *** = P<0.001 and NS = Non-significant

Table 2: Effect of plumage colour and period (week) on egg production of Noiler chicken (%)

Factor	Normal egg	Soft shell egg	Shell-less egg
Overall mean	68.24±2.40	0.18±0.06	0.14±0.06
Strain	NS	NS	NS
Black	65.23±4.16	0.08±0.10	0.07±0.11
Brown	65.60±4.16	0.03±0.10	0.05±0.11
Spotted	73.88±4.16	0.02±0.10	0.03±0.11
Week	***	NS	*
18-22	30.64±4.16^{b}	0.31±0.10	1.21±0.11^{c}
23-27	85.67±4.16^{a}	0.16±0.10	0.38±0.11^{ab}
28-32	88.45±4.16^{a}	0.08±0.10	0.04±0.11^{a}

* = P<0.05, *** = P<0.001 and NS = Non-significant

Table 3: Effect of plumage colour on external and internal egg quality traits of Noiler chicken

Parameters	Overall Mean±S.E	Black	Brown	Spotted	LOS
EWt (g)	55.08±0.21	55.32±0.27^{a}	55.20±0.39^{ab}	54.05±0.60^{c}	*
EC (mm)	137.94±0.29	138.75±0.43	139.37±0.56	132.02±0.39	NS
ED (g/cm^3)	52.02±0.21	52.61±0.21^{a}	52.03±0.41^{a}	50.14±0.58^{b}	***
EL (mm)	52.80±0.12	52.65±0.14	53.02±0.24	52.847±0.04	NS
EW (mm)	38.66±0.06	38.54±0.08	38.83±0.01	38.51±0.01	NS
SW (g)	5.21±0.25	5.24±0.03	5.19±0.48	5.16±0.46	NS
ST (mm)	0.35±0.02	0.36±0.04^{a}	0.34±0.03^{b}	0.32±0.02^{c}	***
SP (%)	9.50±0.46	9.51±0.64	9.44±0.86	9.60±0.09	NS
ESI	73.25±0.11	73.27±0.13	73.34±0.20	73.00±0.28	NS
ESA (cm^2)	65.77±0.18	65.98±0.23^{a}	65.86±0.32^{a}	64.89±0.49^{b}	*
AL (mm)	75.51±0.33	74.47±0.41^{c}	76.32±0.64^{bc}	77.33±0.74^{a}	**
AW (mm)	61.44±0.24	60.75±0.28^{c}	61.93±0.45^{bc}	62.30±0.24^{a}	**
ADt (mm)	5.40±0.63	5.61±0.86^{a}	5.35±0.13^{a}	4.90±0.18^{b}	***
AWt (g)	34.04±0.16	34.47±0.22^{a}	34.30±0.29^{a}	32.03±0.35^{b}	***
AP (%)	61.88±0.23	62.44±0.34^{a}	62.16±0.35^{a}	59.45±0.51^{b}	***
YL (mm)	37.85±0.07	38.21±0.10^{a}	37.53±0.11^{b}	37.61±0.12^{b}	***
YW (mm)	36.21±0.07	36.40±0.01^{a}	35.92±0.09^{b}	36.12±0.13^{b}	***
YD (mm)	1.49±0.06	1.54±0.07	1.46±0.10	1.45±0.15	NS
YWt (g)	14.99±0.57	15.28±0.83^{a}	14.70±0.98^{b}	14.77±0.11^{b}	***
YI	42.59±0.69	42.19±0.18	44.07±1.86	40.36±0.46	NS
YP (%)	27.27±0.13	27.75±0.17^{a}	26.54±0.23^{b}	27.44±0.27^{a}	***
YC	7.13±0.32	7.14±0.42	7.09±0.62	7.18±0.32	NS
HU	72.66±0.49	74.36±0.64^{a}	72.12±0.83^{a}	68.55±1.37^{b}	***

EWt = Egg weight, EC = Egg circumference, ED = Egg density, EL = Egg length, EW = Egg width, SW = Shell weight, SP = Shell percentage, ESI = Egg shape index, ESA = Egg surface area, AL = Albumen length, AL = Albumen length, AW = Albumen width, ADt = Albumen depth, AWt = Albumen weight, AP = Albumen percentage, YL = Yolk length, YW = Yolk width, YD = Yolk depth, YWt = Yolk weight, YI = Yolk index, YP = Yolk percentage, YC = Yolk colour and HU = Haugh unit. LOS = Level of significance, * = P<0.05, ** = P<0.01, *** = P<0.001 and NS = Non-significant

Table 4: Phenotypic correlation among the egg measurement (overall) in Noiler chicken

Parameters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
E Wt (1)	1	0.024^{ns}	0.827**	-0.007^{ns}	0.107^{ns}	0.255**	0.644**	0.253**	0.316*	0.249**	0.432**	0.027^{ns}	0.347**	0.046^{ns}	0.943**	0.857*	0.098*
E C (2)		1	0.015^{ns}	0.007^{ns}	-0.035^{ns}	0.029^{ns}	0.034^{ns}	-0.045^{ns}	-0.045^{ns}	0.029^{ns}	0.029^{ns}	0.034^{ns}	-0.006^{ns}	-0.045^{ns}	0.023^{ns}	0.013^{ns}	0.019^{ns}
E D (3)			1	-0.014^{ns}	0.156*	0.249**	0.712**	0.297**	0.324*	0.350**	0.502**	-0.026^{ns}	0.327**	0.038^{ns}	0.763**	0.704*	0.125**
A L (4)				1	0.594*	-0.455**	-0.072^{ns}	-0.207**	-0.031^{ns}	-0.426*	-0.125**	-0.085*	0.191**	0.044^{ns}	0.034^{ns}	-0.019^{ns}	-0.486**
A W (5)					1	-0.392**	0.149**	0.047^{ns}	0.100*	-0.303*	-0.014^{ns}	-0.033^{ns}	-0.174**	-0.042^{ns}	0.118**	0.105*	-0.439**
A Dt (6)						1	10.363*	0.239**	0.141*	0.499**	0.322**	-0.012^{ns}	0.091*	-0.013^{ns}	0.207**	0.252*	0.971**
A Wt (7)							1	0.284**	0.254*	0.316**	0.412**	-0.025^{ns}	0.255**	0.000^{ns}	0.565**	0.581*	0.270**
Y L (8)								1	0.587*	0.392**	0.472**	-0.026^{ns}	0.098*	-0.130**	0.196**	0.174*	0.208**
Y W (9)									1	0.205**	0.376**	0.026^{ns}	0.188**	0.040^{ns}	0.256**	0.220*	0.099*
Y D (10)										1	0.563**	-0.002^{ns}	0.003^{ns}	-0.094*	0.173**	0.180*	0.479**
Y Wt (11)											1	-0.077^{ns}	0.177**	-0.107*	0.377**	0.378*	0.265**
Y C (12)												1	-0.024^{ns}	0.090*	0.006^{ns}	0.031^{ns}	-0.004^{ns}
S Wt (13)													1	0.234**	0.351**	0.269*	0.026^{ns}
S T (14)														1	0.020^{ns}	-0.051^{ns}	-0.021^{ns}
E L (15)															1	0.817*	0.052^{ns}
E W (16)																1	0.110**
H U (17)																	1

Ewt = Egg weight, EC = Egg circumference, ED = Egg density, EL = Egg length, EW = Egg width, SW = Shell weight, SP = Shell percentage, ESI = Egg shape index, ESA = Egg surface area, AL = Albumen length, AL = Albumen length, AW = Albumen width, AD = Albumen depth, AWt = Albumen weight, AP = Albumen percentage, YL = Yolk length, YW = Yolk width, YD = Yolk depth, YWt = Yolk weight, YI = Yolk index, YP = Yolk percentage, YC = Yolk colour and HU = Haugh unit.

** = P<0.01, * = P<0.05 and ns = non-significant

Table 5: Phenotypic correlation of laying characteristics in Noiler chicken

	1	2	3	4	5	6	7
BWFL (1)	1	-0.054^{ns}	0.033^{ns}	0.102^{ns}	-0.206*	-0.091^{ns}	-0.090^{ns}
EWFL (2)		1	-0.172^{ns}	-0.168^{ns}	0.068^{ns}	0.031^{ns}	0.0286**
Ave. En/Hen (3)			1	-0.296**	0.444**	-0.146**	-0.737**
CL (4)				1	-0.715**	-0.075^{ns}	-0.063^{ns}
CS (5)					1	-0.101^{ns}	-0.113^{ns}
PL (6)						1	-0.062^{ns}
Age (7)							1

BWFL = Body weight at firs lay, EWFL = Egg weight at first lay, Ave. En/Hen = Average egg number per hen, CL = Clutch length, CS = Clutch size and PL = Pause length. ** = P<0.01, * = P<0.05 and ns = non-significant

Discussion

The mean age at sexual maturity (169.50 days) recorded in the current study is similar to those reported by (17) among Dandarawiy (170.3 days), Mandarah (167.7 days), Gimmizah (170.9 days) and dominant black chickens (161 days) (18). Similarly, earlier reports of (19) in Kampung strain (171.4 days) buttress the present findings. Lower maturity periods of 130±1.8 days was observed by (20) in noiler chicken and also 135, 133, 132, 134 and 143 days (for Bovan Brown, Isa Sussex, Moravian Breed and Moravia BSL chickens, respectively) were however reported (21). The mean body weight at first egg (BWE) observed in the present study was similar to value (2355.1 g) obtained by (20) in noiler chickens and superior to the value obtained by (18) in Fulani ecotype and dominant black x Fulani ecotype cross (1.44 kg). The average clutch size recorded in the present study is closer to the results reported by (18) and (22) among chickens sampled in North Central (11 eggs per clutch) and North Western (10.4 eggs per clutch) parts of Nigeria, but higher than respective values of 6, 8.75, 8.50 eggs (19; 23; 24). The mean hen day production (HDP) observed in the present study is similar to the value of 71.80 % reported by (25) among birds managed in aviary and lower value (55.6±7.1 %) in noiler chicken as observed by (26). Higher values of 91.30, 92.20 and 78.80 % for conventional and enriched cages and deep litter system, respectively were however reported (26). The average egg number per hen and hen day production recorded in the current observation was higher than 42 and 53.1 %, respectively as reported by (18).

The effect of plumage colour observed on age at sexual maturity and body weight at first egg agree with the findings of (17) and (27) in Egyptian (Dandarawy, Alexandria, Bahig, Bandarah, Gimmizah, Golden Montazah, Mandarah, Norfa and Silver Montazah) and Nigerian local (light and heavy ecotypes) strains of chickens, respectively. In their studies, the authors observed significant variation on body weight at first egg, weight of first egg, annual egg number and average clutch length. The work of (28) in Nigerian local strains (Fulani and Tiv ecotypes) and (29) among exotic commercial layers (Isa brown, Babcock and Brown Leghorn), respectively showed that genotype had great effect on laying performance of chickens. The authors concluded that the variation observed in egg production traits is chiefly genetics under full intensive system of management. The non-significant influence of plumage colour observed on egg weight at first lay contradicts the finding of (30) who reported marked variation in exotic layer breeds of chicken (Isa Brown, Babcock and Brown

Leghorn). The fact that plumage colour had no effect on clutch length of Noiler chickens contradicts the works of (31) and (32) who detected a significant influence of genotype on clutch size and length in different breeds of chickens and related this to variation in the genetic structure of the experimental birds. Similarly, (33) reported varied clutch length in two strains of French and Taiwan chickens (normal feather type and heterozygous naked neck). The highly significant difference observed on hen day and hen housed productions indicated that the different plumage colours of Noiler chickens used in the present study performed variedly in terms of egg production. This corroborates the work of (34) among Bovan and Lohman brown commercial layer hens and that of (35) in white and brown chickens. The authors attributed this varied performance (egg production) to genetic dissimilarities among the studied genotypes.

The average normal eggs recorded in the current observation are closer to the respective values of 69.4, 73.2 and 67.9 % as reported by (21) in Bovan sperwer, Bovan brown and Dekalb white chickens. However, (36) reported higher mean of 85.96 %. The percentage soft-shell eggs observed in the present study is lower than the value recorded by (37) and (36) (0.24 and 1.24 %, respectively), while for average shell-less eggs, value of 0.14±0.06 % observed is closer to 0.18 % reported by (36).

The fact that genotype and period had effect on egg production performance as observed in the present report agrees with the work of (34) who noticed that Bovan Brown layer chicken produces higher number eggs compared to Lohman brown at three months of laying. Season wise, the former breed performed better than the latter and concluded that this breed of chicken (Bovan Nera Black) is more adaptable to tropical weather condition. Similarly, several investigators (38; 39; 40; 35) proved that breed had great effect on performance of layer chickens and correlated this fact to genetic diversity of birds and genotype by environmental interaction.

The averages of egg quality traits observed in the current study confirm the findings of (41) who recorded the overall mean values of 57.24 g, 6.74 mm, 37.04 g, 64.67 %, 14.23g, 77.67, 5.96 g, 10.43 % and 6.74 mm for egg weight, albumen depth, albumen weight, albumen percent, yolk weight, Haugh unit, shell weight, yolk percent and albumen depth, respectively among Isa brown and White Leghorn chickens. Similarly, (42) reported mean values of 54.23 g, 5.33 g, 17.77 g, 31.3 g, 54.50 mm, 41.63 mm and 17.87 mm for egg weight, shell weight, yolk weight, albumen weight, egg length and yolk depth, respectively in local strains of chickens native to India. (43) also reported respective values of 57.33 g, 6.80 g, 11.33 %, 0.38 mm, 77.13 and 66.0 mm for egg weight, shell weight, shell percent, shell thickness, egg shape index and egg length. The considerable effect of plumage colour observed on most egg characteristics corroborates the work of (44) who noticed a significant variation on most egg quality traits among black, barred and brown noiler chickens. More so, (45) also reported significant difference on egg morphometries of frizzy feather, gold, silver, chamois and silky chickens. The authors attributed these differences to varied genetic structure of the studied genotype. In a similar study, (46) favoured Oravka chicken over Rhode Island Red on most egg quality traits recorded. (41) also made similar assertion. The non-significant variation observed in some egg measurements (egg circumference, length and width, shell thickness and percent) contradicts the findings of several authors (45; 46; 47) working on different strains of

local chickens. The correlation coefficients observed in this study were mostly low and non-significant which agrees with the work of some investigators (48; 49) who reported poor relationship among most egg characteristics of local chicken strains. (50) and (43) also made similar observation in helmeted guinea fowl, while (51) in Japanese quail. These results could be attributed to absence of pleiotropic gene action and genetic linkage among egg measurements. On the contrary, the reports of (52), (53), (54) and (55) on Isa layer breeders, Belgian breeders, Tswana chickens and Iraqi strains of local hens, respectively indicated higher, positive and significant coefficients on some egg quality traits. The relationships observed among laying characteristics of Noiler chickens were mostly low and non-significant. This corroborates the work (56) and (57) in Sinai chickens and some strains of Japanese quail (black and white types). The work of (58) on broiler breeder also proved that the relationships among laying characteristics were low and insignificant.

Conclusion and Applications

1. The findings revealed that spotted plumage colour had better value of age at sexual maturity (ASM), average egg number per hen (Ave. EN/Hen), hen housed and day productions (HHP and HDP). Black plumage had the highest value for most egg quality traits and body weight at first egg (BWFE).
2. The effect of plumage colour was not significant on egg weight at first lay, pause length, clutch size and clutch length.
3. The genetic variation that existed in ASM, Ave. EN/Hen, HHP, HDP and egg quality traits of black, brown and spotted plumage colour is important in effective selection for egg and meat yield. Spotted plumage showed better result for ASM, Ave. EN/Hen, HHP and HDP than black and brown plumage.
4. Black plumage had better egg quality characteristics and BWFE than brown and spotted plumage.

References

1. Adebambo, O.A. (1999). Improving the potentials of Nigerian livestock genetic resources in the new millennium. In: Genetics and food security in Nigeria in the twenty – first Century. Genetics Society of Nigeria, Pp: 175-186.
2. Ojedapo, L.O., Akinokun, O., Adedeji, T.A., Olayeni, T.B., Ameen, S.A., Ige, A.O. and Amao, S.R. (2008). Evaluation of growth traits and short-term laying performance of three strains of chicken in Derived Savannah Zone of Nigeria. *International Journal of Poultry Science.* 7(1): 92-96.
3. Olawoyin, O. O. (2006). Evaluation of performance and adaptability of the local Nigerian and exotic Harco cockerels in the humid tropical zone. *Tropical Journal of Animal Science*, 9 (1): 63-71.
4. Piper, L. R. and Latter, B. D. H. (1974). Proceedings of the Australian Society of Animal Production, 10: 8. SAS, 1990. Statistical Analysis system. Users guide. Statistical Analysis Institute Inc. Cary. North Carolina.
5. Oluyemi, J.A and Roberts, F.A. (1979). Poultry Production in warm climates. 1st ed. Macmillan Press, Nigeria. Pp.76.
6. Egahi, J. O., Dim, N. I., Momoh, O. M and Gwaza, D. S. (2010). Variations in Qualitative Traits in the Nigerian Local Chicken. *International Journal of Poultry Science* 9(10): 978-979. ISSN 1682-8356.

7. Adekunle, M. A., Sunday, O. P., Michael, O. O., Christian, O. N., Adeyemi, M. B. and Olufunmilayo, A. A. (2012). Effect of crossbreeding on fertility, hatchability and embryonic mortality of Nigerian local chickens. *Tropical Animal Health Production* 44: 505–510.
8. Otechere, E. O., Adeoye, A. T., Gefu, J. O. and Adewuti, A. A. (1990). Preliminary Observations on Village Poultry Production in North Central Nigeria. In: *Proceedings of an Intermz and Oruzl Workshop* Sonaiya (E.d.) Rural Poultry Development in Africa. Ile Ife Nigeria. Pp196-200.
9. Ojedapo, L.O. (2013). Evaluation of Body Weight and Other Linear Parameters of Marshall Broiler for Repeatability Estimates. *International Journal of Applied Agriculture and Apiculture*, 9: 1-2.
10. Amo Farm. (2018). Annex 10-Noiler breed promoted by Amo Farm retrieved from https://blog.lifango.org. retrieved 20/05/2018.
11. Adebambo, O.A. (2015). From PEAL project to in Nigeria. Paper presented at the First ACGG Nigeria Innovation Platform meeting Ibadan, Nigeria, 20-22 July. Retrieved May 15th, 2018, from https://cgspace.cgiar.org/bitstream/handle/10568/72670/acgg pearl nigeria a jul2015.pdf?sequence=1
12. Anonymous (2011). Bauchi State - ‘‘Home of peace and hospitality’’. Retrieved May 23th, 2018 from: http://www.cometonigeria.com/region/north-east/bauchi-state/
13. Ngu, G.T., Etchu, K.A., Butswat, I.S.R and Woogeng, I.N. (2014). Semen and microbial characteristics of two breeds of turkey in an arid tropical environment of Bauchi State, Nigeria. *African Journal of Microbiology Research*, 8(21): 2174-2182. DOI:10.5897/AJMR 2013.5906.
14. IAR/BSADP (1996). Diagnostic survey on Agriculture in Bauchi State, Executive Summary, BSADP (Bauchi State Agricultural Development Program), Bauchi, 180 P.
15. Hanusová, E., Hrnčár, C., Hanus A. and Oravcová, M. (2015). Effect of breed on some parameters of egg quality in laying hens. *Acta fytotechnica et zootechnica,* **18**(1): 20-24.
16. SPSS (2014). SPSS Statistics for windows, version 24.0 Armonk, NY. IBM Corp.
17. Kosba, M. A. and Abd El-Halim, H. A. H. (2008). Evaluation of the Egyptian local strains of chicken. *Egypt poultry science*, 28: 1239-1251.
18. Sola-Ojo, F. E and Ayorinde, K. L. (2011). Evaluation of reproductive performance and egg Quality traits in progenies of Dominant black strain crossed with Fulani ecotype chicken. *Journal of Agricultural science*, 3(1): 1916-6760.
19. Engku, Azahan (1983). Laying patterns and egg production of indigenous Kampung chickens. MARDI *Res. Bull* 11, 3: 291-298.
20. Bamidele, O., Sonaiya, E.B., Adebambo, O.A. and Dessie, T. (2020). On-station performance evaluation of improved tropically adapted chicken breeds for small holder poultry production systems in Nigeria. *Tropical Animal Health and Production*. 52:1541-1548.
21. Tumova, E., Chodora, D. and Unlifova, L. (2017). Age related changes in laying pattern and egg weight of different laying hen genotypes. *Animal Reproduction Science*, 183 (17): 21 - 26.
22. Atteh J.P. (1990). Rural Poultry Production in western middle belt region of Nigeria. In: Sonaiya E.B. (ed.) Rural Poultry in Africa. Proceedings of an International workshop held at the Obafemi Awolowo University, Ile-Ife, Nigeria. 13-16 November 1989. Thelia

Publishers, Nigeria. Pp 211-220.
23. Kolawole, O. (2015). The local chickens of Nigeria. A Review. Retrieved from researchgate. DOI: 10.13140/RG,2.1.3766.4164
24. Dafwang I.I (1990). A survey of rural poultry production in Lafia Area in the middle belt region of Nigeria. In: Sonaiya E.B. (ed.) Rural Poultry in Africa. Proceedings of an International workshop held at the Obafemi Awolowo University, Ile-Ife, Nigeria. 13-16 November 1989. Thelia Publishers, Nigeria. Pp 221-235.
25. Saleh, B. (2017). Effect of varying dietary energy and protein levels on the reproductive performance of FUNAAB-Alpha chicken. A Ph. D. Thesis, Abubakar Tafawa Balewa University Bauchi.
26. Englmaierova, M., Tumova E., Charvatova V. and Skrivah, M. (2014). Effect of laying hens housing system on laying performance, egg quality characteristics and egg microbial contamination. *Czech Journal of Animal Science*, 59(4): 261-272.
27. Ogbu, C. C., Joseph, T. J. and Nwoso, C. C. (2015). Comparative egg production performance of Domestic chicken genotypes reared in two housing plans and feeding regimes. *Global Journal of Biology, Agriculture and Health Sciences*, 4(1):257-262.
28. Gwaza, D. S., Ukwu, H. U., Ochefu, J. and Gbor, V. (2018). Genotype by environmental interaction effects on laying characteristics of Lohman brown and Sub-humid Tropic of Nigeria. *Journal of genetics and genetic Engineering*, 2(1):25-35.
29. Silversides, F. G., Korver, D. R. and Budgell, K. L. (2016). Effect of strain on layer and age at photostimulation on egg production, egg quality and bone strength. *Poultry Science*, 85: 1136-1144.
30. Gwaza, D. S., Dim, N. I. and Momoh, O. M. (2016). Genetic improvement of egg production traits by direct and indirect selection of egg traits in Nigerian local chickens. *Advancement in genetic Engineering*, 5:148, doi 10.4172/2169-.0111.1000148.
31. Iqba, A., Akram, M., Sahota, A. W., Javed, K., Hussain, J., Sarfraz, Z. and Mehmood, S. (2012). Laying characteristics and egg geometry of four varieties of indigenous Assel chicken in Pakistan. *The Journal of Animal and Plant Science*, 22(4):848-852.
32. Assefa, S., Melesse, A. and Banerjee S. (2018). Egg production and linear body measurement traits of local and three exotic chicken genotypes reared under two agroecological zones. *International Journal of Ecology and Eco solution*, 5(2):18-23.
33. Chen, C. F., Huang, N. Z., Gourichon, D., Lee, Y. P., Tixier, B. M. and Bordast, A. (2008). Effect of introducing the naked neck gene in a line selected for low residual feed consumption on performance in temperate or subtropical environments. *Poultry Science*, 87: 1320 - 1327.
34. Yakubu, A., Salako, A. E. and Ige, A. O. (2007). Effects of genotype and housing system on the laying performance of chickens in different season in the Semi-humid Tropics. *International Journal of Poultry Science*, 6(6): 434-439.
35. Stojcic, M. D., Peric, L., Milosevic, N. and Rodic, V. (2012). Effect of genotype and
housing system on egg production, egg quality and welfare of the hens. *Journal of food Agriculture and Environment*, 10(4): 848-852.
36. Van Eck, J. H. H., Davelaar, F. G., Thea, A. M., Den, H. P., Nel, V. K., Kouwenhoven, B. and Guldie, F. H. M. (1976). Dropped egg production, soft shelled and shell-less eggs associated

with appearance of precipitins to adenovious in flocks of laying fowls. *Avian Pathology*, 5(4): 261-272.

37. Wolc A, Arango J, Settar P, O'Sullivan NP, Olori VE, White IM, Hill WG, Dekkers JC. (2012). Genetic parameters of eggs defects and egg quality in layer chickens. *Poult Sci.* 91 (6):1292-8. Doi:10.3382/ps.2011-02130. PMID:22582285.
38. Li, F., Xu, L. M., Shan, A. S., Hu, J. W., Zhang, Y. Y. and Li, Y. H. (2011). Effect of daily feed intake in laying period on laying performance, egg quality and egg composition of genetically fat and lean lines of chickens. *British Poultry Science*, 52(2):163-168.
39. Khawaja, T., Hassan Khan, S., Mukhtar, N., Asghar Ali, M., Ahmed, T. and Abdul Ghafar, A. (2012). Comparative study of growth performance, egg production, egg characteristics and haemato-biochemical parameters of Desi, Fayoumi and Rhode Island Red chickens. *Journal of Applied Animal Research*, 4(4):273-283.
40. Oguntunji, A. O. and Salako, A. E. (2012). Effects of genotype and season on the productive performance of commercial egg type chickens in the derived Savanna zone in Nigeria. *Nigerian Journal of Animal Production*, 39(2):153-158.
41. Scott, T. A. and Silversides, F. G. (2000). The effect of storage and strain of hen on egg quality. *Poultry Science*. 91: 1725 - 1729.
42. Niranjan, M., Sharma, R. P., Rajkumar, U., Chatterjee, R. N., Reddy, B. L. and Battacharya, T. K. (2008). Egg quality traits in chicken varieties developed for backyard poultry farming in India. Vol. 20 Article # 189. Retrieved July 4, 2019 from http://www.Irrd.org/Irrd20/12/nira20189.htm.
43. Hagan, J. K., Adjei, I. A. and Baah, A. (2013). Effect of extended period of storage and strain of layer on quality of chicken eggs. *Journal of Science and Technology* 33(2):1-11
44. Dudusola, I.O., Bashiru, H.A. and Adeleke, O.E.(2020). Effect of laying age and plumage colour on internal and external quality characteristics of noiler chicken eggs. *Slovakia Journal of Animal Science*. 53(4):192-198.
45. Bartlimiej, K. and Zenon, B. (2014). Assessment of egg quality and hatch results of two show hen breeds raised for fancy. *Journal of Central European Agriculture* 15(4), P. 1-11
46. Emilia, H., Cyril, H., Hanus, A. and Marta, O. (2015). Effects of breed on some parameters of egg quality laying hens. Acta fytotechnica et Zootechnica; 20-24.
47. Alsobayel, A. A. and Albadry, M. A. (2011). Effect of storage period and strain of layers on internal and external quality characteristics of eggs marketed in Riyadh area. *Journal of the Society of Agricultural Sciences*, 10:41-45.
48. Okwonko, J. C. (2014). Genetic correlation between egg quality traits. *Scientific Journal of Biological Sciences*, 3(6): 69-72.
49. Ebegbulen, V. and Dauda, A. (2017). Phenotypic correlation and regression among some external and internal egg quality parameters of Nigerian guinea fowl genotypel. *Journal of Scientific and Engineering Research*, 4(5): 220-229.
50. Fajemilehin, S. O. K., Odubola, O. O., Fagbuaro, S. S. and Akinyemi M. O. (2009). Phenotypic correlation between some external and internal egg quality traits in the Nigerian helmeted guinea fowl. *Applied tropical agriculture*, 14(1& 2):102-108.
51. Alkan, S., Galic, A., Karsi, T. and Karabag, K. (2015). Effects of egg weight on egg quality traits in Partridge.

*Journal of applied Animal Research,*43 (4):450-456.

52. Olawuni, S. O. and Ogunlade J. T. (2008). Phenotypic correlations between some external and internal egg quality traits in the exotic Isa brown layer breeder. *Asian Journal of Poultry Science*, 2(1): 30-35.
53. Moula, N., Antonine, M. N., Decoypere, E., Farnir, F., Mertens, K., De baerdemaeker, J. and Leroy, P. (2009). Comparative study of egg quality traits in two Belgian local breeds and two commercial lines of chickens. *Arch. Gefluselk.* 74(3):450-456.
54. Kgwatalala, P. M., Molapisi, M., Thutwa, K., Sekgopi, B., Selemoge, T. P. and Nsoso, S. J. (2016). Egg quality characteristics and phenotypic correaltions among egg quality traits in the naked neck,normal and dwarf strains of Tswana chickens raised under intensive management system. *International Journal of Environment and Agricultural Research.* 2(8): 96-105.
55. Hermiz, H.N., Abas K.A., Al-Khatib T.R.A., Amin Sh. M., Hamad D.A. and Denha H.P. (2012). Effect of strain and storage period on egg quality characteristics of local Iraqi laying hens. *Research Opinions in animal and veterinary Sciences*. 2(1): 98-101.
56. Sakunthaladevi, K., Ramesh, B. G. and Prakash, M. G. (2011). Genetic analysis of production, reproduction and clutch traits in Japanese quails. *Journal of Veterinary and Animal Science,* 7(3): 126 - 132.
57. Soltan, M.E., Farang, S.A., and Enab, A.A. (2018). Realized correlated selection response for feed efficiency of egg production under different feeding regimens in Sinai chickens. *Journal of Agriculture and Veterinary Science,* 11(12):53-59.
58. Farooq, M., Ali, M., Durrani, F. R., Chand, N., Sarbiland, K. and Riaz, A. (2003). Egg production performance and prediction of standard limits for traits of economic importance in broiler breeders. *International Journal of Poultry Science,* 2(4):275-279.