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Short Term Egg Quality and Pecking Behaviour of Three Strains of Chickens in A Tropical Environment

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ABSTRACT

This experiment was conducted to compare the egg quality characteristics and pecking behaviour of three layer strains namely FUNAAB-Alpha, ISA-Brown and Bovan-Nera. The number of birds used for the study was 60 pullets per strain. The 60 pullets per strain were replicated into 3 and randomly assigned into pens. The following parameters were monitored: egg weight, egg number, pecking and brooding behaviours. A total of 196 eggs were used for the egg quality study. A completely randomized design was used to analyze the data collected Coefficient of correlations among 16 egg quality parameters of each strain was computed. Principal component. analysis was used to reduce the 16 egg quality parameters of each strain into a small number of latent and orthogonal variables with minimal loss of information. The frequencies of feather pecking, head pecking and egg eating among the three strains of chickens were not statistically significant ($p>0.05$). Coefficient of correlations among the egg quality traits were mostly positive and significant ($p<0.05, 0.01$). Principal component analysis yielded five components each in ISA Brown and Bovan-Nera and six components in FUNAAB-Alpha. The principal components accounted for 70.49%, 66.79% and 68.26% of the total variance in FUNAA B-Alpha, ISA Brown and Bovan-Nera respectively. Principal component analysis could be used by poultry breeders to select group of egg quality variables instead of isolated traits.

Keywords: Strains, Chickens, Egg Quality and Pecking Behaviour.

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INTRODUCTION

The word "Poultry" comes from the middle English "Pultrie." From old French poultrie, from pouletier, poultry dealer, from poulet pullet the word " Pullet" itself comes from middle English pullus, a young fowl, young animal or chicken. The word "fowl" is of Germanic origin (CF. old English fugol, German Vogel, Danish Fugl) (https:/en.m.Wikipedia.org/wiki/poultry).

"Poultry" is a term used for any kind of domesticated bird, captive-raised for its utility and traditionally. The word has been used to refer to wild fowl (Galliformes) and water fowl (Anseriformes) but not to cage birds such as song birds and parrots.

"Poultry" can be defined as domestic fowls, including chickens, turkeys, geese and ducks, raised for the production of meat or eggs and the word is also used for the flesh of these birds used as food (https:/en.mwikipedia.org/wiki/poultry).

Poultry comes fourth among sources of animal protein for human consumption in Nigeria and contributes about 27% of the national meat production (FAO, 2010 cited by Yusuf et al, 2017). Although, poultry plays important role in the economy of Nigeria, a lot of socio- economic and climate factors militates against it. "Vices" are bad habits developed by Birds (KCSE ONLINE 2017). Habit in layers chickens can be cause by discomfort, poor management or/ and by unrest due to strange condition of weather. (Clauer, (2017) states that poultry farmers should learn to recognize when layers type chicken are not comfortable and contented.

Deuter, et al, (2015) defined "Vice" as evil or immoral behaviour, in somebody's character. Agritech. Enau. Ac. in (2006) was of the opinion that vice in layers type chicken is a condition in which layers attack their pen mate and eat its flesh, which may impose deep wounds and heavy mortality. Layers may exhibit certain vices (bad habits) which are inimical to egg production agritech. tnau. Ac .in (2006).

Copper, *et al* (2003) states that vice tend to be more common in some breed of layers type chicken than others and may have genetic predisposition. Coppers, *et al* (2003) also states that poultry farmer must remain alert to prevent vice in layers type chicken as it has no direct treatment. Nepel, (2017) states that it occur in any production system including free-range system. Clauer (2017) states that vice in layers type chicken is a costly and vicious habit that poultry producers cannot afford to ignore. 1t may occur at any age among all breeds, strains and ses of layers, Hassan, (2005) reported highest incidence of vice habit such as cannibalism, feather pecking, egg eating in isa brown layers (40%) followed by white leghorn (30%), Black Harco (27%) and shika brown (3%)

in that order. Ellen, et al, (2008) point out that selection strategies aimed reducing vices in layer type chicken should therefore consider both the direct effect of an individual on its own experience with litter stimulated ground pecking, cannibalism and reduced the chance of vice habit in later life.

Jacquie (2015) reported that pecking behaviours can occur among birds of any age and breeds which can affect egg production and egg quality. The author further reported that pecking behaviours is more common among floor-raised layer chickens than cage raised chicken.

The two most popular commercial layer strains among poultry farmers in southern Nigeria are Bovan Nera and ISA-brown. ISA, (2010) reported that ISA-Brown strain is not easily effected by diseases due to its genotypic effects. This motivates poultry farmers to choose ISA-brown layer chickens for high productivity and profitability. ISA-brown age at commencement of egg production is 140 days to 150 days and produces 350 eggs per year. The body weight of ISA-brown at 90 weeks of age is 2000g. It is suitable for variety of management system, lay fast, increased egg weight and feed efficiency (ISA, 2010).

FUNAAB-Alpha is a commercial strain of layer chicken at Federal University of Agriculture Abeokuta. FUNAAB-Alpha breed average age at commencement of egg production is 119 days to 133 days. It produces 200 to 240 eggs per year. The body weight at first egg is 1900g. It has an average fertility and hatchability of 60% and 55% respectively. The mortality of Alpha breed at laying stage is 3.5% (Adebambo, 2017). Adebambo (2017) described Alpha breed as an excellent layer that lays large number of eggs, quick mating, excellent foragers with spritely characters that do not go broody often. These performance will enable the commercial egg producers to select the best strain of layer chickens that had egg quality and non aggressive behaviour which will help the commercial producers to enhance productivity and efficiency.

Thus ,the aim of this study was to ascertain the internal and external egg quality and determine the pecking behaviours of three commercial strains in a tropical environment.

MATERIALS AND METHODS

Experimental Location

The study was carried out in the poultry unit of the Teaching and Research Farm, Department of Animal Science, Delta State University, Asaba Campus. The farm is located on

longitude 60 49E of the Greenwich Meridian and latitude 60 14N of the equator with animal rainfall of 1800mm to 3500mm between the period of April to October.

The Poultry House and Its Preparation

The poultry house and the environment were kept in good sanitary condition with the interior properly swept, washed, disinfected and allowed to stand for two weeks. This was to allow the strong odour of the disinfectant to thin out for the good health of the pullets. Thereafter, fresh litter of wood shaving was spread on the floor of the pens which act as absorbent for the feacal droppings the shavings changed when necessary. The entire house was provided with electricity.

Management of the Experimental Birds

A total of one hundred and eighty (180) layer chickens were used for the experiment. Sixty (60) layers in each strains was used, FUNAAB-Alpha, Bovan-nera and ISA-Brown. The pullets were seventeen weeks of age on arrival. The layers were assigned into three replicates each with 20 layers chickens per replicate.

Data Collection

Data were collected on the External egg quality which include: Egg weight, Egg volume, Egg width, Egg shape index, Egg surface area, Egg shell weight and shell thickness and internal egg quality which include: albumen weight and yolk, Albumen height, yolk height, Albumen maximum diameter, Albumen minimum diameter, yolk weight , egg circumference , haugh unit and monitoring their pecking behaviours.

Egg weight at different periods: A sensitive Digital balance (Beam balance) weighing up to the nearest 0.1 gram. Was used to determine the weight of the eggs.

Egg volume: Egg volume milliliters was determined used 1000 ml measuring cylinder was filled with a known volume of clean water (400ml) then slant and gently drop the egg into the cylinder. The water displacement was taken as the volume of the egg in ml.

Egg length: A vernier caliper was used to determine the maximum length of the egg from tip the (Apex) of the egg to the base of the egg and the length recorded in (cm).

Egg width: With the same vernier caliper the maximum width of the egg in (cm) was determined. Egg circumference was determined using twine to measure both the vertical and horizontal length of the egg. The average value was recorded as the circumference of the egg.

Horizontal length + vertical length

2= cm

Shell thickness was determined after drying the shell. Micro –meter screwguage was used to determined the thickness of the Apex (tip), middle and base of the egg shell.

Shell thickness as shown below:

Apex (egg shape index) + middle + base (mm)

3

Egg surface area was determined with the formular.

Egg surface Area = Ks LB

Where: Ks = (3.155-0.0136L+0.0715B)

Where: B = the breath of egg

Where L = Length of egg.

Haugh unit: The Haugh unit was determined with the formular below:

Haugh unit = 100xlog (Albumen height + 7.57-1.7 X egg weight = 0.37) = 100x Log (Alht + 7.57 – 1.7 x egg weight 0.37)

Pecking Behaviour: Through monitoring of the pecking behaviour of the three strains of layer type of chickens.

Data Analysis

Descriptive statistics such as mean, standard deviation and correlation coefficient of variation was used to summarize the data. The data was subjected to one way analysis of variance in a completely randomized designs and significant means separated using Duncan multiple range test (Duncan, 1955). Principal component analysis (PCA) was used to reduce the dimension of egg quality parameters to core components that define egg quality in each of the three strains of layer chickens. Procedures used to Analysis principal components Analysis were the Pearson's coefficient of correlation among egg quality traits; the appropriateness of the data to principal component analysis was tested using Kaiser Meyer Olkin (KMO) and finally Data was analysed using one way analysis of variance in a completely randomized design.

RESULTS

Mean value of Pecking behaviour at 3 hours per day per replicate and broodiness of FUNAAB-Alpha, ISA-brown and Bovan-nera layer chickens

The results in show no significant (P>0.05) difference among the three strains in feather pecking, head pecking and egg eating. However, significant (P<0.05) differences were observed among the three strains on beak pecking and broodiness. FUNAAB-Alpha and Bovan-nera recorded higher frequency of beak pecking and broodiness than ISA-Brown.

Mean value of Pecking behaviour at 3 hours per day per replicate and broodiness of FUNAAB-Alpha, ISA-brown and Bovan-nera layer chickens

Treatments	Feather pecking	Head pecking	Egg eating	Beak pecking	Broodiness
ALPHA	0.64 ± 0.12	0.78 ± 0.14	0.39 ± 0.17	0.89 ± 0.65^{a}	0.86 ±0.03^{a}
ISA brown	0.75 ± 0.08	0.56 ± 0.1	0.28 ± 0.15	0.47 ± 0.05^{b}	0.14 ± 0.14^{b}
Bovan nera	0.75 ± 0.17	0.88 ± 0.09	0.17 ± 0.08	0.89 ± 0.11^{a}	0.85 ± 0.05^{a}

a,b,c: Means within row are not significantly (P< 0.05) different

Egg quality characteristics of three strains of layer chickens for 16 weeks

Egg quality characteristics of the three strains of layer chicken. Significant (P<0.05) differences were observed among the three strains of layer chickens on most of the egg quality parameters. Bovan-nera had the higher mean value of egg weight (49.70 ± 0.43), egg length (3.89 ± 0.02) and egg width (2.73 ± 0.02) followed by ISA-brown for egg width (2.68 ± 0.01). The least was FUNAAB-Alpha for egg width (2.51 ± 0.02). ISA-brown and Alpha layers were not significantly (P>0.05) difference in egg length. Alpha had higher mean yolk diameter (4.15 ± 0.02) and yolk weight (13.40 ± 0.15) compared to ISA-brown (4.05 ± 0.02, 12.72 ± 0.15) and Bovan-nera (4.07 ± 0.02, 12.83 ± 0.12). The result on Alpha, ISA-brown and Bovan-nera mean value for egg volume, yolk height, albumen height, egg surface area, shell weight, shell thickness and haugh unit had a significant (P<0.05) difference. Bovan-nera (50.19 ± 0.55) was significantly higher compared to ISA-brown (48.97 ± 0.55) and Alpha (45.29 ± 0.55). ISA-brown (1.65 ± 0.02) and Bovan-nera (1.66 ± 0.02) had a similar mean value on yolk height followed by FUNAAB Alpha (1.59 ± 0.02). Bovan-nera (0.90 ± 0.01) had significantly (P>0.05) higher albumen height followed by ISA-

brown 0.88 ± 0.01 and FUNAAB Alpha (0.85 ± 0.01) in that order. ISA-brown (31.70 ± 0.01) and Bovan-nera (32.34 ± 0.25) had a similar mean value for egg surface area followed by Alpha (29.70 ± 0.25). The shell weight result also shows that Bovan-nera (5.53 ± 0.05) significantly (P<0.05) had higher in shell weight followed by FUNAAB Alpha (4.65 ± 0.00) and ISA-brown (3.57 ± 0.05). The shell thickness results also shows that ISA brown (0.34 ± 0.00) significantly (P<0.05) had higher shell thickness followed by Bovan-nera (0.33 ± 0.01) and Alpha (0.31 ± 0.00). The haugh unit results also shows that Bovan-nera (95.31 ± 0.28) significantly (P< 0.05) had higher haugh unit mean value followed by ISA brown (94.47 ± 0.04) and Alpha (94.13 ± 0.39) which has similar mean value.

Egg quality characteristics of three strains of layer chickens for 16 weeks

Parameters	**FUNAAB-Alpha**	**ISA-brown**	**Bovan-nera**
Egg weight (g)	49.70 ± 0.43^{c}	54.19 ± 0.44^{b}	55.69 ± 0.39^{a}
Egg length (mm)	3.81 ± 0.02^{b}	3.81 ± 0.30^{b}	3.89 ± 0.02^{a}
Egg width (cm)	2.51 ± 0.02^{c}	2.68 ± 0.01^{b}	2.73 ± 0.02^{a}
Egg volume (ml)	45.29 ± 0.55^{b}	48.97 ± 0.55^{a}	50.19 ± 0.55^{a}
Yolk height (cm)	1.59 ± 0.02^{b}	1.65 ± 0.02^{a}	1.66 ± 0.02^{a}
Yolk Diameter (cm)	4.15 ± 0.02^{a}	4.05 ± 0.02^{b}	4.07 ± 0.02^{b}
Yolk weight (g)	13.46 ± 0.15^{a}	12.72 ± 0.15^{b}	12.83 ± 0.12^{b}
Albumen weight (g)	29.48 ± 0.35^{c}	33.92 ± 0.34^{b}	34.94 ± 0.32^{a}
Albumen height (cm)	0.85 ± 0.01^{c}	0.88 ± 0.01^{b}	0.90 ± 0.01^{a}
Max albumen diameter (cm)	6.61 ± 0.08^{c}	6.66 ± 0.06^{a}	6.63 ± 0.07^{ab}
Min albumen diameter (cm)	7.27 ± 0.07^{c}	7.35 ± 0.09^{a}	7.31 ± 0.07^{ab}
Egg circumference(cm)	14.19 ± 0.05^{c}	14.61 ± 0.04^{ab}	14.73 ± 0.07^{ab}
Egg surface area(cm)	29.70 ± 0.25^{b}	31.70 ± 0.24^{a}	32.34 ± 0.25^{a}
Shell weight (g)	4.65 ± 0.00^{b}	3.57 ± 0.05^{c}	5.53 ± 0.06^{a}
Shell thickness(cm)	0.31 ± 0.00^{c}	0.34 ± 0.00^{a}	0.33 ± 0.01^{b}
Haugh unit (cm)	94.13 ± 0.39^{b}	94.47 ± 0.04^{ab}	95.31 ± 0.28^{a}

a,b,c: Means within row are not significantly (P > 0.05) different superscript letters are significantly (P<0.05) different

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Correlation coefficient among egg quality traits of FUNAAB-Alpha Layer Chickens

The phenotypic correlation among egg quality characteristics of FUNAAB-Alpha layers (strain 1) are presented in Table 4.8. A total of 120 correlation were calculated, out of which 45 were significant (P<0.05, 0.01). Only 11 out of the 120 correlations were negative. All the negative correlations were not significant (P> 0.05). Among the significant correlation coefficient, only 21 have values ≥ 0.30. The correlations coefficient between albumen weight and egg circumference (0.77) was the highest, followed by Albumen weight and egg surface area (0.71). Other correlation coefficients with high positive values were egg weight and albumen weight (0.65), egg weight and egg length (0.59), egg weight and egg circumference (0.59), egg weight and egg width (0.49), egg surface area and egg circumference (0.65) and haugh unit and albumen height (0.62).

Correlation coefficient among egg quality traits of FUNAAB-Alpha Layer Chickens

Parameters	Egg weight	Egg length	Egg width	Egg volume	Yolk height	Yolk dia	Yolk weight	Albumen weight	Albumen height	Alb. Max dia	Alb min d	Egg circumference	Egg surface area	Shells weight	Shell height	Haugh unit
Egg weight	1.00															
Egg length	0.56**	1.00														
Egg width	0.49**	0.07	1.00													
Egg volume	0.33**	0.26**	0.13	1.00												
Yolk Height	0.35**	0.25**	0.14	0.27**	1.00											
Yolk Diameter	0.24**	0.17	0.21*	0.04	0.16	1.00										
Yolk weight	0.40**	0.30**	0.26**	0.11	0.04	0.46**	1.00									
Albumen weight	0.65**	0.51**	0.49**	0.22*	0.27**	0.13	0.05	1.00								
Albumen height	0.21*	0.13	0.23*	0.12	0.03	-0.01	-0.05	0.30	1.00							
Albumen max Diameter	0.03	0.12	0.10	0.14	0.18	0.11	0.04	0.11	0.18	1.00						
Albumen Min Diameter	0.13	0.14	-0.01	0.10	0.03	0.18	0.09	0.15	0.08	0.18	1.00					
Egg circumference	0.59**	0.49**	0.35**	0.25**	0.19*	0.21*	0.22*	0.77**	0.24*	0.14	0.29**	1.00				
Egg surface area	0.59**	0.46**	0.61**	0.07	0.25**	0.28**	0.23*	0.71**	0.24**	0.15	0.17	0.65**	1.00			
Shell weight	0.05	0.16	0.08	0.10	0.05	-0.17	0.05	0.14	0.19*	0.09	-0.12	0.18	0.16	1.00		
Shell thickness	0.07	0.06	0.01	0.06	0.18	-0.13	0.18	0.15	0.01	0.01	-0.05	-0.01	0.06	-0.003	1.00	
Haugh unit	0.09	0.04	0.17	0.09	-0.12	0.09	0.05	0.20	0.62**	0.25**	0.01	0.18	0.17	0.14	-0.08	1.00

Note * = P < 0.05, ** = P < 0.05

Correlation coefficient among egg quality traits of ISA BROWN Layer Chickens

This presents the coefficient of phenotypic correlations among egg quality characteristics of ISA brown layer chickens. The number of correlation coefficient calculated was 120. Out of this number, 50 correlations were significant (P< 0.05, 0.01). The number of negative correlations was 33, of which 2 were significant (P < 0.05, 00.01). The highest correlation was egg weight and egg width (0.74) followed closely by the correlation coefficient between egg surface are and egg circumference (0.73).

Correlation co-efficient among egg quality traits of Bovan-nera layer chicken

Table 4.10 present the phenotypic correlations among egg quality traits of Bovan-nera layers. The total number of correlations calculated were 120, out of which 30 were significant (P<0.05, 0.01). Among the significant correlations only 30 had values ≥ 0.03. The number of negative correlations was 44 and the number of negative correlation that were significant was 13. The highest coefficient of correlations was between Albumen maximum diameter and Albumen weight (0.88), followed by the egg weight and egg width (0.66).

Correlation coefficient among egg quality traits of ISA BROWN Layer Chickens

Parameters	Egg weight	Egg length	Egg width	Egg volume	Yolk height	Yolk dia	Yolk weight	Albumen weight	Albumen height	Alb. Max dia	Alb min d	Egg circ	Egg surface area	Shells weight	Shell height	Haugh unit
Egg weight	1.00															
Egg length	0.388**	1.00														
Egg width	0.74	0.12	1.00													
Egg volume	0.62	0.37**	0.52**	1.00												
Yolk Height	0.38	0.20	0.28**	0.21*	1.00											
Yolk Diameter	0.08	-0.09	0.17*	0.03	-0.29**	1.00										
Yolk weight	0.411**	0.23**	0.47**	0.32**	-0.07	0.52**	1.00									
Albumen weight	047**	0.16	0.36**	0.39**	0.20*	-0.17	-0.05	1.00								
Albumen height	0.27**	0.07	0.30	0.27**	-0.05	0.02	0.29**	0.28**	1.00							
Albumen max Diameter	-0.13	0.01	-0.18	-0.14	-0.08	0.08	-0.08	-0.09	-0.10	1.00						
Albumen Min Diameter	0.07	-0.22*	0.10	-0.05	0.14	-0.02	-0.07	0.19*	-0.08	-0.01	1.00					
Egg circumference	0.59**	0.23	-0.57**	0.49**	0.11	0.09	0.42**	0.56**	0.40**	0.23	0.17	1.00				
Egg surface area	0.60	0.29**	0.59**	0.50**	0.28**	0.10	0.37**	0.55**	0.40**	-0.09	0.05	0.73**	1.00			
Shell weight	0.41	0.07	0.37**	0.34**	0.09	-0.06	0.19*	0.51*	0.31**	-0.01	0.06	0.56**	0.57*	1.00		

Shell thickness	0.17	0.05	-0.01	0.01	0.03	-0.02	-0.03	0.04	-0.10	-0.002	-0.07	0.01	0.06	-0.02	1.00	
Haugh unit	0.04	0.002	0.09	0.12	-0.07	0.10	0.20*	0.09	0.61**	-0.04	-0.10	0.18	0.15	0.07	-0.13	1.00

Note * = P < 0.05, ** = P < 0.05

Correlation co-efficient among egg quality traits of Bovan nera layer chicken

Parameters	Egg weight	Egg length	Egg width	Egg volume	Yolk height	Yolk dia	Yolk weight	Albumen weight	Albumen height	Alb. Max dia	Alb min d	Egg circ	Egg surface area	Shells weight	Shell height	Haugh unit
Egg weight	1.00															
Egg length	0.46**	1.00														
Egg width	0.66**	0.33**	1.00													
Egg volume	0.31**	0.26**	0.43**	1.00												
Yolk Height	0.26**	0.15	0.24**	0.03	1.00											
Yolk Diameter	0.12	-0.01	0.06	0.03	-0.04	1.00										
Yolk weight	0.26**	0.20*	0.27**	0.29*	-0.06	0.08	1.00									
Albumen weight	0.44**	0.32**	0.40**	0.29**	0.05	-0.04	10.20*	1.00								
Albumen height	-0.26**	-0.20**	-0.19*	-0.19*	0.04	-0.05	-0.23	-0.91**	1.00							
Albumen max Diameter	0.26**	0.22**	0.22*	-0.22**	-0.08	0.06	0.29**	0.88**	-0.97**	1.00						
Albumen Min Diameter	-0.03	-0.03	-0.04	-0.09	0.03	0.10	-0.03	-0.39**	0.43**	-0.39**	1.00					
Egg circumference	0.51**	0.38*	0.57	0.46**	-0.15	-0.10	0.37	0.59**	-0.33**	0.35**	-0.06	1.00				
Egg surface area	0.51**	0.41**	0.55**	0.47**	0.05	-0.10	0.27	0.52**	-0.27**	0.29**	0.02	0.64**	1.00			
Shell weight	0.32**	0.13	0.39**	0.30**	-0.05	-0.07	0.41	0.08	0.09	-0.02	0.15	0.39**	0.38**	1.00		
Shell thickness	0.02	0.06	0.03	0.002	0.01	0.06	-0.06	-0.28**	0.35**	-0.29**	0.16	-0.12	0.05	0.09	1.00	
Haugh unit	-0.04	-0.09	-0.004	-0.03	0.09	-0.01	-0.04	0.13	-0.001	-0.01	-0.08	-0.08	-0.09	-0.06	-0.002	1.00

Note * = P < 0.05, ** = P < 0.05

Eigen values, total variance, factor and factor loadings after varimax rotation together with communalities of egg quality of Bovan Nera

The summary of the PCA showing the component of extracted after uarimax rotation, eigen values, percentage of total variance and communalities of egg quality characteristics of Bovan nera. The communalities ranged from 0.32 to 0.95. Five PCA was extracted after varimax rotation. PC1 was highly associated with Albumen max diameter, Albumen weight and negatively cumulated with Albumen height and Albumen, minimum diameter. PC2 was associated with egg weight, egg length, egg width, egg surface area, egg circumference and yolk height. PC3 was associated with shell weight, yolk weight and egg volume. PC4 was specially associated with haugh unit while PC5 was heavily with yolk diameter.

Eigen values, total variance, factor and factor loadings after varimax rotation together with communalities of egg quality of Bovan Nera

Parameters	PC1	PC2	PC3	PC4	PC5	Communalities
Egg weight	0.09	0.77	0.24	0.08	0.05	0.67
Egg length	0.10	0.69	0.01	-0.09	0.06	0.49
Egg width	0.02	0.69	0.40	0.22	0.07	0.69
Egg volume	0.11	0.32	0.56	0.19	0.02	0.46
Yolk Height	-0.17	0.52	-0.34	0.39	-0.08	0.57
Yolk Diameter	-0.03	-0.02	0.02	.0.03	0.95	0.90
Yolk weight	0.16	0.08	0.72	0.01	0.18	0.58
Albumen weight	0.84	0.47	0.14	-0.01	-0.02	0.94
Albumen height	0.94	-0.22	-0.04	0.05	-0.10	0.95
Albumen max Diameter	0.91	0.23	0.11	-0.09	0.14	0.92
Albumen Min Diameter	-0.60	0.15	0.03	-0.43	0.14	0.58
Egg circumference	0.26	0.60	0.47	0.04	-0.18	0.69
Egg surface area	0.16	0.64	0.44	-0.04	-0.15	0.65
Shell weight	-0.19	0.18	0.78	-0.12	-0.16	0.71
Shell thickness	-0.50	0.17	-0.01	-0.10	0.19	0.32
Haugh unit	0.06	0.10	0.07	0.88	0.07	0.79
Eigen values	4.89	2.47	1.41	1.12	1.04	
% of variance	30.56	15.42	8.78	6.99	6.51	

Discussion

Effect of Strains (Alpha, ISA-brown and Bovan-nera) The value of Bovan-nera in this study fall within the range of Kabir *et al, (*2013) (1.876kg – 1.98kg) but lower than the value (1.887kg – 1.978kg) recorded for Isa-Brown.Mean egg weight obtained in this study (49.70g) Alpha, (54.19g) Isa-Brown and (55.69g) Bovan-nera was higher than those of Ukwu *et al., (*2017) in Isa Brown Ahmadu, (2016) in Shikabrown, Momoh *et al.,* (2010) Bobbo *et al.,* (2013) and Abeke *et al;* (2008). The value is however lower than that obtained by Kabir *et al.,* (2015) in Isa-brown, Olawumi, (2014) for Isa-brown (62.97g) and Boven-nera (61.10g). At 55 weeks.

Mean egg weight of Alpha and Isa-brown in this present study is within the range obtained by (Ahmadu, 2016) (48.6-50g) and (54.39g) Orunmuyi, (2007) from Shika brown.The result of Bovan-nera falls within the value obtained by (Raji *et al* (2009 and Kabir *et al.,* (2013) in Isa-brown and Bovan-nera (54.26g – 58.06g). The heavier the egg produced by Bovan-nera and Isa-brown is probably due to the favourable weather condition and gene effect on production (Merat, 1990). Mean egg length ranged from (3.81cm-3.89cm) in this study is lower compared to that of Kabir *et al;* (2014) in Isa-brown and Bovan-nera black (5.44cm – 5.61cm), Ahmadu, (2016) in Shikabrown, Ukwu *et al.,* (2017) in Isa-brown (5.09cm), Bobbo *et al.,* (2013) 5.15cm and Yakubu *et al.,* (2008) in Nigeria naked neck fizzle. Egg length is a good estimator of egg weight Obike *et al.,* (2012). This indicates that egg wright can be improved phenotypically through selection. Mean egg width ranged (2.51cm – 2.73cm) in the present study does not agree with the report of Kabir *et al.,* (2014), Ukwu *et al.,* (2017), Bobbo *et al,* (2013) who reported (2.86cm – 3.86cm) in Isa-brown and Bovan-nera black respectively. Mean yolk of Alpha (1.59cm), Isa-brown (1.65cm) and Bovan nera (1.66cm) in this study is higher than that obtained by Ukwu *et al.,* (2007). The result obtained in this study agreed with that of Bobbo *et al.,* (2013) in fizzle layers. But the result contrast the value obtained by Oyeagu, (2014) (1.7cm – 1.89cm) in Nera black and (1.74cm – 1.88cm) in Shaver black. The mean yolk diameter is study for the three strains (4.15cm) Alpha, (4.05cm) Isa-brown and (4.07cm). Bovan Nera were higher than the value (2.99 – 3.2) Nera black (2.30cm – 3.04) Shaver brown hen Oyeagu, (2015). Mean yolk weight recorded in this study is (12.72g – 13.46g) within the range of Kabir *et al* (2014) (12.26g – 15.6g). Albumen weight for Alpha in this study (29.49cm) agreed with that of Ahmadu (2016) and the value of Isa Brown and Bovan Nera fall within the range of reported by Zhang *et al.,* (2005), Shafey, (2002) and Kabir *et al.* (2014). Albumen height in this study range from 0.85-0.9cm. This value is higher than that of Ukwu *et al.,* (2017). (5.10)

Albumen Diameter and Albumen length in this present study were within the range of (5.74 – 8.33) Oyeagu, (2015) in Nera Black and Shaver Black.Egg circumference for the three strains Alpha, ISA-brown and Bovan-nera (14.19cm, 14.61cm and 14.73cm) respectively fall within the range (14.62 – 15.53) recorded by Ukwu *et al.,* (2017). The value fall below that recorded by Ukwu *et al.,* (2017) in Isa Brown. The circumference obtained in this study were lower than the value (16.39cm) reported by Eronu *et al* (2004) for Shikka Brown layer. Shell weight is comparable with Bobbo *et al;* (2013), Ukwu, Kabir *et al.,* (2014) higher than Ahmadu (2017) contrast Oyeagu 2015 (7.84cm – 8.68cm), Abdullai *et al.,* (2008). Shell thickness did not show significant difference among three strains studied. Egg thickness shell are desirable to withstand externally applied force, thus preventing breakage of egg and this is an economical

indictor for commercial poultry producer and consumer Bobbo *et al.*, (2013). The result obtained in this study is higher than value obtained by Oyeagu, (2014) it fall within the range (0.32cm – 0.36cm) reported by Ukwu *et al.*, (2017). Similarly, it is an indication that the research was conducted on chicken with good quality fresh eggs and free from infectious diseases. Haugh Unit and yolk index are the indictor of internal egg quality Isikwenu, *et al.*, (1999). The higher the haugh unit, the more the desirable the egg quality.

Phenotypic correlation and principal component Analysis

The value of Kaiser-Meyer-Olkin measure of sampling adequacy obtained for FUNAAB-Alpha (0.719), ISA-Brown (0.766) and Bovan-nera (0.732), suggests that correlations between the variable were adequate. This showed clearly that the sample sizes were okay to apply PCA Kasier, (1960). The results of Bartlett's test for sphericity of the three layer strains of chicken were significant ($P<0.001$) this confirming that part PCA was appropriate for the egg quality data. The result of the present study showed high communalities, it gave additional credence to the authenticity of the principals component analysis. Wuenseh (2012) observed that communalities represents the quantity of the variable that is accounted for by the components (as long as the loading are correlations between variables and components and the component are orthogonal, a variable communality is the coefficient of determination of the variable predicted from the components). So many high communalities have been observed by so many researchers on egg quality (Udeh & Ogbu, 2011, Ukwu *et al.*, 2017, Bobbo *et al* 2013). The low contribution of albumen maximum diameter, shell weight, shell thickness, egg volume, haugh unit and yolk weight of egg trait of FUNAAB Alpha layer, Haugh unit, shell thickness, albumen minimum diameter and egg length of egg traits of ISA Brown layer chicken and egg width, haugh unit, egg length traits of Bovan-nera layer chicken to their PC1 respectively are not too surprising as the traits equally had lowest relationship with egg weight. These are obvious indication of their poorness in explaining the total variation in the egg traits of strain 1, 2 and 3 layer chickens. In the egg qualities of the three layer strains, PC1 had the highest share of the total variance and correlated highly with egg weight, egg length, egg width, albumen weight, egg circumference and egg surface egg in FUNAAB-Alpha (Strain 1), egg weight, egg width, egg volume, albumen weight, egg circumference, egg surface area and shell weight in ISA-brown (strain 2) and albumen weight, albumen height and albumen maximum diameter in Bovan-nera (strain 3), egg length, egg width, yolk weight and yolk weight which is similar to the observation made in FUNAAB-Alpha and ISA-brown with regards to PC1. Therefore PC1 can be referred to as egg weight and its components in FUNAAB-Alpha and ISA-brown and egg albumen traits in Bovan-nera, it is observed that PC1

of quality parameters of Chikka brown was a good estimater of egg weight. PC 2, PC 3, PC 4, PC5 and PC6 would be referred to as general egg quality in FUNAAB-Alpha and PC 2, PC3, PC4 and PC5 as general egg quality traits in Bovan-nera, PC2 represent egg weight and its components and PC3, PC4 and PC5 referred to as general egg quality trait. The differences observed in the principal components factor scores of the three strains indicates that they have different features of their egg quality traits. The egg quality traits in the same principal component might be controlled by the same set of genes Goto *et al.*, (2014). The positive and significant (P<0.05, 0.01) relationship between egg weight and egg measurements which imply that egg weight can be predicted from the egg measurements. Bobbo *et al.,* (2013) the positive are significant (P<0.05, 0.01) between albumen weight. Significant positive correlations between Albumen weight and egg circumference, albumen weight and egg surface area, egg weight and albumen weight, egg weight and egg length, egg weight and egg circumference, egg weight and egg surface area, egg weight and egg width, egg surface are and egg circumference and haugh unit and albumen height in FUNAAB-Alpha are in agreement with Yakubu *et al.,* (2008). Similarly the positive and significant (P<0.05, 0.01) correlations between egg weight and egg length, egg width, egg volume, yolk height and yolk weight obtained in FUNAAB-Alpha, ISA-brown layers are in agreement with the reports of Bobbo *et al.,* (2013) and Yakubu *et al.,* (2008). the obtained in FUNAAB-Alpha and ISA-brown layer chicken in the study between egg weight and egg length, egg weight and egg width, egg weight and egg volume, egg weight and yolk height, egg weight and yolk weight are in harmony with (Bobbo *et al.*, 2013 and Yakubu 2008). Furthermore, the resultrecorded In this study in Bovan-nera layer chicken between albumen maximum diameter and albumen weight, egg weight and egg width, albumen weight and egg circumference, egg width and egg surface area are in consonance with the finding of (Olawumi and Ogunlade, 2007). Negative correlation value observed between Albumen height and egg weight, egg length and albumen height, egg width and albumen height, egg volume and albumen height in Bovan-nera layer chicken concurs with (Bobbo *et al*., 2013). Similarly the negative correlation obtained between albumen minimum diameter and haugh unit, egg weight, yolk weight and shell weight is comparable with (Yakubu *et al.*, 2008 and Raji *et al.*, 2009). They reported non-significant but negatively correlated value (Table 4.10). Significant positive correlation between egg length and egg value, egg length and egg surface area, egg width and egg surface area, egg width and egg circumference, egg length and egg circumference, in all the three strains of layer chickens compares favourably with (Shafey *et al.*, 2002 and Bobbo *et al.*, 2013). The good relationship existing between egg weight and egg traits could be useful in selection programme.

CONCLUSION AND RECOMMENDATION

Conclusion

The following conclusions are drawn from this study.

i. Egg quality characteristics of the three strains of layer chickens, significantly ($P<0.05$) difference was observed among the three strains of layer chickens. Bovan-nera had the highest mean value than ISA-Brown, FUNAAB-Alpha the least

ii. Bovan Nera and FUNAAB Alpha had the highest mean value of beak pecking and broodiness than ISA Brown.

iii. In view of the genetic variability recorded in egg quality characteristics, Bovan-nera is recommended for its good egg characteristics (quality).

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