Iranian Journal of Applied Animal Science

Genetic Analysis of Egg Quality Traits in Bovan Nera Black Laying Hen under Sparse Egg Production Periods

Research Article

A. Sylvia John-Jaja[1], A.R. Abdullah[1] and C. Samuel Nwokolo[2*]

[1] Department of Animal Science, College of Agriculture, Babcock University, Ilshan Remo, Nigeria
[2] Department of Physics, Faculty of Science, University of Calabar, Calabar, Nigeria

Received on: 23 May 2016
Revised on: 18 Sep 2016
Accepted on: 15 Nov 2016
Online Published on: Mar 2017

*Correspondence E-mail: nwokolosc@stud.unical.edu.ng

Online version is available on: www.ijas.ir

ABSTRACT

The present research was designed to examine the genetic analysis of egg weight, egg yolk weight and egg albumen weight of Bovan Neva Black laying hens at 25, 51 and 72 weeks. For this purpose, thirty birds were selected from the layer flock in the Babcock University Teaching and Research Farm. They were individually housed in separate labeled battery cage. A total of thirty eggs were collected daily from the birds continuously in five days of egg production, at each age of 25, 51 and 72 weeks. The total number of eggs collected at each age were 150. Data collected for egg weight, egg yolk weight and egg albumen weight were used to evaluate the descriptive statistics, influence of age and Pearson correlation coefficient on different age groups. The mean values of the traits revealed a consistent increase in egg weight 55.02-63.29 g, egg yolk weight 13.14-19.39 g and egg albumen weight 35.52-39.21 g by aging. A significant positive genetic correlation was obtained among traits with linear regression equations at different age groups. Restricted maximum likelihood (REML) of Wombat software was used to obtain the repeatability and heritability estimates. From the results, it was revealed that all the traits recorded high estimates of heritability and repeatability while egg weight is more heritable and repeatable than egg yolk weight and egg albumen weight indicating that fewer records would be required to adequately characterize the inherent production ability of each trait as laying age progressed.

KEY WORDS Bovan Nera Black, egg, egg quality traits, heritability, repeatability.

INTRODUCTION

Poultry farming occupies an important place in the economy of Nigeria. It contributes immensely to three major sectors (petroleum, mining, and agriculture) in Nigeria's economy and has evolved from subsistence farming to an extremely profit driven commercial enterprise. Poultry population in Nigeria was put at 114.3 million comprising 82.4 million chickens, 11% of which was commercially raised, and 31.9 million other poultry including pigeons, ducks, guinea fowls and turkey. This could be attributed to high productivity, high feed conversion efficiency, improved fertility, hatchability, growth rate, egg yield and meat quality through genetics and breeding within a short time and without a huge investment when compared with other livestock breeding. Poultry raised for meat and eggs are important sources of edible animal protein. Poultry meat accounts for 30% of global meat consumption. The worldwide average per capital consumption of poultry meat has nearly quadrupled since the 1960's (FAO, 2009). This transformation could be attributed to the wide spread of the necessity of animal protein intake per day of an average Nigerian and estimating genetic parameters especially heritability estimates of internal and external egg quality traits of exotic and local hen thereby improving the egg quality traits considering the economic need to increase edible animal protein so as to match the protein requirement of the teaming population through genetic breeding.

Egg quality traits are those that affect its acceptability by consumers. Thus, to maintain the superiority in the total egg quality, routine genetic and breeding experimentation should be carried out continuously through genetic parameters for a number of chicken traits, particularly the improved commercial breeds so as to select the best performers with respect to important economic traits through concentrating and enhancing the manifestation of the gene controlling these traits.

The improved stock will be conserved and multiplied for productive purposes. In this way, commercial chicken will boost the Nigeria poultry industry, thus providing a buffer against shortages of poultry products. Therefore, the aim of this study was to determine the genetic analysis of egg quality traits in Bovan Nera Black laying hen under sparse egg production periods in the tropics.

MATERIALS AND METHODS

The experimental site, Ilara, is located at the Teaching and Research Farm of Animal Science Department, Babcock University. Ilara is situated between Latitude 6.867 ˚N and Longitude 3.717 ˚E with an altitude of 235.2 meters above sea level in tropical rainforest belt of Nigeria. It has an annual rainfall of 1200 mm, 65% mean relative humidity and 21.40 ˚C mean temperature. The research lasted for 54 weeks.

Day-old pullets were randomly selected and purchased from the base population of Nera Black hens and kept on litter till 18 weeks before they are moved to the battery cage. The chicks were protected from cold during the first four weeks of brooding. During lay, the birds were fed twice daily and water was administered accordingly with feed composed of 16% crude protein, other constituents of their feed includes vitamins, minerals and amino acid. Water was provided. At inception, birds were quarantined separately for 7 days and dewormed. . The birds were routinely vaccinated at various stages of development against diseases such as Newcastle, Gumboro and Coccidiosis. Thirty eggs were collected daily in the morning at 8 a.m., afternoon at 2 p.m. and then the final collection was made in the evening at 6:00 p.m. for five days. One hundred and fifty eggs were collected from three age groups (25, 51 and 72 weeks) and 450 for the overall ages of the birds for egg yolk weight and albumen weight.

Two experimental designs were adopted in the course of this study via completely randomized design (CRD) and visual appraisal. The CRD was used to select healthy layers after quarantine and vaccination while visual appraisal was employed to select a total of thirty layers capable of laying 5-6 eggs weekly; and rest for 1-2 days after monitoring their laying cycle and patterns between 21-24 weeks.

The egg weight was measured using a 0.09 sensitive digital scale. The yolk carefully separated from the albumen and placed in a petri dish for weighing. Simultaneously, the associated albumen is weighed.

The descriptive statistics, linear regression and correlation were obtained using statistical analytical system program (SAS, 1999) while heritability and repeatability estimates for egg quality traits were obtained employing a tool for mixed model analysis in quantitative genetics by restricted maximum likelihood (REML) of as follows:

$$Y_{ijkl} = \mu + age_i + bird_j + bird \times age_k + e_{ijkl}$$

Y_{ijkl}: observation on the i^{th} egg quality traits of the i^{th} birds.
μ: mean of the population.
age_i: random effect of age.
$bird_j$: random effect of bird.
$age_i + bird_j$: random effect of age and bird.
e_{ijkl}: residual effect.

RESULTS AND DISCUSSION

Egg production

The descriptive statistics of egg weight, egg albumen weight and egg yolk weight varied for one age group to another as presented in Tables 1, 2 and 3. This could be attributed to the genetic potential, prevalent environment factor influencing each trait and age of the layers as age is a major factor that determines, to a great extent the growth and physiological development of the traits. The least egg albumen weight value 35.52 g was registered at 25 weeks while at 72 weeks the birds reported a maximum value of 39.21 g.

There was a consistent increase in egg albumen weight as the age of the hen advanced. These values are comparable with the report in the literature. Islam and Dutta (2010) registered 36.10 g at the 48 weeks for Rhode Island Red; Tadesse *et al.* (2015) reported 33.19 g and 34.54 g for Isa Bovan and Brown at 32 weeks; 31.53 g, 31.19 g and 33.18 g for three pure lines of white leghorns respectively at 40 weeks; Rath *et al.* (2015) recorded 35.76 g at 50 weeks for white leghorns.

However, lower values 19.71 g and 23.77 g reported for Onagadori and white leghorns, respectively at 20-34 weeks by Goto *et al.* (2015); Begli *et al.* (2010) reported 22.66 g at 30 weeks for Iranian fowl; 25.14 g at 32 weeks for Koekoek breed by Tadesse *et al.* (2015); Islam and Dutta (2010) recorded 18.51 g at 48 weeks for Fayoumi breed; Khalil *et al.* (2013) reported 24.2 g and 25.6 g for Golden Montazah and white leghorn, respectively at 60 weeks.

Table 1 Descriptive statistics of egg weight

Egg weight (g)	N	Mean	Standard error	Coefficient of variation
Age of bird				
25	150	55.02	0.40	8.83
51	150	62.20	0.47	9.17
72	150	63.29	0.45	8.77

N: number of observation per age group.

Table 2 Descriptive statistics of egg yolk weight

Egg weight (g)	N	Mean	Standard error	Coefficient of variation
Age of bird				
25	150	13.14	0.10	8.95
51	150	15.37	0.41	9.19
72	150	15.97	0.14	18.72

N: number of observation per age group.

Table 3 Descriptive statistics of egg albumen weight

Egg weight (g)	N	Mean	Standard error	Coefficient of variation
Age of bird				
25	150	35.52	0.39	13.52
51	150	36.09	0.47	14.67
72	150	39.21	0.49	16.57

N: number of observation per age group.

Several researchers reported higher values of egg albumen weight. Akintola *et al.* (2011) recorded 45.89 g, 45.42 g, 45.77 g and 45.80 for graded dosage levels of orabolin with 0 ug, 10 ug, 20 ug and 30 ug respectively at 69 weeks. Minelli *et al.* (2007) registered 41.5 g at 28-32 weeks, 42.9 g at 47-50 g and 43.8 g at 70-73 weeks for laying phases of commercial breed. This variation could be attributed to the breed differences, the age of the layers, management procedures and environmental temperature.

An increasing trend was observed for the standard error of egg albumen weight for different age groups. The trait recorded 0.39 g at 25 weeks, 0.47 g at 51 weeks, 0.49 g at 72 weeks with 0.27 g for the overall mean of the birds. These values are in agreement with the report of other researchers. Goto *et al.* (2015) recorded 0.31 g for Onagadori breed and 0.47 g for white leghorns; Sreenivas *et al.* (2013) registered 0.39-0.43 g for different pure lines of white leghorns.

The coefficient of variation for the egg albumen weight ranged between 13.52-16.57% at 25-72 weeks. These values are within the range of 14.2% reported by Mube *et al.* (2014); 15.29% obtained by Begli *et al.* (2010).

The mean egg weight recorded 55.02 g at 25 weeks, 62.20 g at 51 weeks and 63.29 g at 72 weeks with a corresponding mean value of 60.17 g for the overall ages of the hen indicating an increasing trend. These results are similar to 57.78 g recorded by Rath *et al.* (2015) for egg weight at 50 weeks for white leghorns; 48.1-63.9 g registered for single comb, while leghorn at 25-65 weeks reported 50.01-53.89 g obtained for three pure lines and one control lines of white leghorns at 40 weeks by Sreenivas *et al.* (2013); 60.3-62.4 g recorded for white egg lines of Lohmann Tierzucht Gambh at 67-70 weeks andBrown egg line of Lohmann Tierzucht Gambh at 32-36 weeks by Blanco *et al.* (2014); 50.6-55.6 g obtained for white leghorn at 26-54 weeks by Sabri *et al.* (1999a); 45.67-51.33 g reported for white leghorn (IWN line) at 32-56 weeks by Paleja *et al.* (2008); 60.6 g, 60.3 g and 61.1 g registered for ATAK-S commercial layers hybrids at 52 weeks employing incandescent bulb, mini fluorescent and light-emitting diodes by Kamanli *et al.* (2015); 58.0-62.1 g reported for white leghorn at 35-65 weeks by Ledur *et al.* (2002); 62.0-67.3 g observed for commercial layers at 28-73 weeks by Minelli *et al.* (2007); 58.75 g, 60.27 g and 48.8 g obtained for Isu Brown, Bovan Brown and PotchetstroomKoekoek breeds at 32 weeks by Tadesse *et al.* (2015); 51.09-61.04 g observed for Vanavoija male line (PDI) at 32-60 weeks by Padhi *et al.* (2015); 63.9-65.2 g for commercial layers at 60-80 weeks by Molnar *et al.* (2016); 64.78 g, 63.46 g and 47.79 recorded for Isa Brown, Novan Brown, Koekoek respectively under intensive production system and 58.92 g, 59.32 g and 47.53 g reported for Isa Brown, Bovan Brown and Koekoek respectively under village production system by Tadesse *et al.* (2015); 51.9-55.6 g for Isa Brown under graded dosage levels of Ovabolin (0 ug, 10 ug, 20 ug and 30 ug) at 69 weeks by Akintola *et al.* (2011); 61.58 g for white leghorn group and 60.72 g for Rhode Island Red at 38 weeks by Lukanov *et al.* (2015); 56.6 g for young (22-29 weeks) and 68.6 g for old of Lohmann Brown laying hens, 66.4 g for young (36-73 weeks) and 71.6 g for old (64-71 weeks) of Cobb 500 broiler breeders by Tumova and Gous (2012); 53.30 g and 56.72 g for Block Olympia and H and

N Brown Nick breeds respectively between 36-46 weeks by (Ewa *et al.* 2005).

However, lower value 42.87 g was obtained for Iranian fowl at 30 weeks by Begli *et al.* (2010); 34.84 g for Onagadori breed and 41.01 g for white leghorn at 20-34 g for both breed, by Goto *et al.* (2015); 46.80 g and 39.83 g for Cobb 500 of Broiler and Fayoumi breeds at 48 weeks by Islam and Dutta (2010); 44.0 g and 45.7 g for Golden Montazah and white leghorn respectively at 120 weeks by Khalil *et al.* (2013); whereas, Petek *et al.* (2007) reported higher values of 74.11 g, 73.20 g and 69.70 g for commercial brown egg laying hens under effects of non-feed removal molting methods (non-molting control, Barley, and Alfalfa, respectively). The variation could be attributed to the breed differences, the age of the layers and environmental temperature as recommendation by (FAO, 1998).

There was a consistent increase in the standard error of egg weight at different age groups except at 72 weeks. At 25 weeks, 0.40 g was registered, 0.47 g at 51 weeks and 0.45 g at 72 weeks.

These value are similar to the report in the literature. Begli *et al.* (2010) recorded 0.17 g; Khalil *et al.* (2013) registered 0.10-0.14 g for golden monstazah and white leghorn breeds; 0.73-0.74 recorded at 60 and 80 weeks by Molnar *et al.* (2016); 0.10-0.16 g between 32-60 weeks reported by Padhi *et al.* (2015); 0.26 g at 50 weeks for white leghorn by Rath *et al.* (2015); 0.42-0.48 g for three strains of white leghorn recorded by (Sreenivas *et al.* 2013).

At week 25, the birds recorded the least coefficient of variation of egg weight value of 8.83% while at 51 weeks, the birds recorded the maximum value of 9.17% with a corresponding value of 10.81% for total age of the hen. These values are similar to the range of 8.9-9.98% reported by Mube *et al.* (2014) and 11.75% obtained by Begli *et al.* (2010); and 8.34% registered by (Zhang *et al.* 2005). The bird egg yolk weight follows a progressive increase as the age of the hen advanced.

Egg yolk weight recorded 13.14 g, 15.37 g and 19.39 g at 25, 51 and 72 weeks, respectively. These values are in agreement with 16.17 g at 50 weeks for white leghorns as reported by Rath *et al.* (2015); 14.16 g, 14.70 g and 15.58 g, respectively were recorded for three different strain of white leghorn at 40 weeks registered by Sreenivas *et al.* (2013); 14.5 g, 17.0 g and 17.1 g at 28-32 weeks, 47-50 weeks and 70-73 recorded for commercial layers recorded by Minelli *et al.* (2007); 14.88 and 16.40 g at 48 weeks for Fayonmi and Sanali breeds respectively Islam and Dutta (2010); 15.65 g, 15.07 g, 14.82 g and 14.94 g at 69 weeks for Brown laying birds using by Akintola *et al.* (2011); 16.69 g and 16.14 g for Isa brown breed employing intensive and village management system; 15.39 g and 15.97 g for Bovan Brown using intensive and village management system, and 14.54 g and 15.94 g for Koekoek breed employing intensive and village management system at 32 weeks by Tadesse *et al.* (2015).

However, lower values 12.91 g was obtained for Iranian fowl at 30 weeks by Begli *et al.* (2010); 10.38 g for Onagadori breed and 11.61 g for white leghorn at 20-34 weeks by Goto *et al.* (2015); 9.60 g for broiler (Cob 500) and 11.20 g for Rhode Island Red at 48 weeks registered by Islam and Dutta (2010).

The discrepancies could be due to the breed differences, age of the layers, management system and environmental temperature. There was a successive increase in the standard error of egg yolk weight at different age groups that is, 0.10 g at 25 weeks, 0.14 g at 51 weeks and 0.15 g at 72 weeks. These results agree favourably with 0.05 g obtained by Rath *et al.* (2015); 0.12-0.13 g for different pure lines of white leghorns by Sreenivas *et al.* (2013); 0.05 g recorded by Begli *et al.* (2010); and 0.22-0.28 for Onagadori and white leghorn respectively registered by Goto *et al.* (2015). The same trend was observed for coefficient of variation of egg yolk weight that ranged 8.95-9.45% at 25, 52 and 72 weeks. These are similar to the report of 11.2% observed by Mube *et al.* (2014); 10.31% obtained by Begli *et al.* (2010); and 8.99% registered by Zhang *et al.* (2005). The influence of age on egg weight, egg albumen weight and egg yolk weight are appreciable as observable changes resulted from increase in age of the hen from 25-51, 51-72 and 25-72 weeks are presented in Table 4.

The rate of change in egg weight recorded 7.180, 1.090 and 8.272 between 25-51 weeks, 51-72 weeks and 25-75 weeks respectively; egg yolk weight registered rate of change of 2.230, 4.020 and 6.250 between 25-51 weeks, 51-72 weeks and 25-75 weeks respectively; and albumen weight reported 3.690, 3.120 and 0.570 between 25-51 weeks, 51-72 weeks and 25-75 weeks respectively. It could be observed that egg weight recorded the highest influence of age variance at 25-51 weeks and 25-72 weeks and the lowest value of 1.090 at 51-72 weeks compared to egg albumen weight and egg yolk weight at 25-51, 25-72 and 51-72 weeks. This variation indicates that age is major determinant in the growth and development of egg quality traits which tends to influence the external egg quality trait (egg weight) than the internal egg quality traits (egg albumen weight and egg yolk weight) in this study. This is similar to the report of Molnar *et al.* (2016), Abdallah *et al.* (1995), Sabri *et al.* (1999a) that egg weight increased with age and weighted regression analysis of periods indicated a linear increase.

Genetic correlation

Pearson correlation coefficient between egg quality traits at 25, 51 and 72 weeks are presented in Table 5.

Table 4 Regression equation showing the rate of change of egg quality traits at different age groups

Egg quantity traits	N	Age group	Regression equation	Rate of change
	150	25-51	$EW_{51} = 7.180 + EW_{25}$	7.180
Egg weight	150	51-72	$EW_{72} = 1.090 + EW_{51}$	1.090
	150	25-72	$EW_{72} = 8.272 + EW_{25}$	8.272
	150	25-51	$EW_{51} = 2.230 + EW_{25}$	2.230
York Weight	150	51-72	$EW_{72} = 4.020 + EW_{51}$	4.020
	150	25-72	$EW_{72} = 6.250 + EW_{25}$	6.250
	150	25-51	$EW_{51} = 3.690 + EW_{25}$	3.690
Albumen Weight	150	51-72	$EW_{72} = 3.120 + EW_{51}$	3.120
	150	25-72	$EW_{72} = 0.570 + EW_{25}$	0.570

N: number of observation per age group; EW: egg weight; EY: egg yolk weight and EAW: egg albumen weight.

Table 5 Pearson correlation coefficients of egg quality traits

Traits/age	EW	EAW	EYW
25 weeks			
EW	1	0.521**	0.641**
EAW	-	1	0.911**
EYW	-	-	1
51 weeks			
EW	1	0.521**	0.641**
EAW	-	1	0.911**
EYW	-	-	1
72 weeks			
EW	1	0.521**	0.641**
EAW	-	1	0.911**
EYW	-	-	1

EW: egg weight; EAW: egg albumen weight and EYW: Egg yolk weight.
** (P<0.005).

A significant positive and similar high magnitude correlations were recorded between egg weight and egg yolk weight (0.641); egg weight and egg albumen weight (0.521) but egg yolk weight was affected mostly by the weight of the albumen (0.911) for different age groups. This could be attributed to similar variation in the additive variance and presume non-additive genetic plus permanent environment variance on the egg quality traits as a proportion of phenotypic variance at different age groups as age is a major determinant of the growth and development of egg quality traits. Additionally, the significant and positive high correlation between egg weight and the egg components indicates that egg weight can be used to predict egg yolk weight and egg albumen weight with a reasonable level of accuracy and prevision in Bovan Neva Black laying hen. Similar high positive significant correlation of egg weight with yolk weight and albumen weight in Bovan Neva Black laying hens at 25, 51 and 72 weeks recorded in this study have been previously reported in white leghorn and other commercial breeds in literature (Molnar *et al.* 2016; Sreenivas *et al.* 2013; Sharma *et al.* 2002; Jayalaxmi *et al.* 2002).

Hereditability estimates

The genetic potential for the periodic egg production of egg weight, egg albumen, and egg yolk weight varied from one age group to another primarily because of the variation of the genetic response and the inherent transmitting ability of parent traits from one generation to another at each stage of egg production as presented in Table 6. High heritability estimates of 0.783-0.889, 0.426-0.798 and 0.433-0.811 for egg weight, egg yolk weight and egg albumen weight at 25-72 weeks, respectively were obtained indicating higher role of additive genetic variance in phenotypic expression for different age groups. These high estimates generally agreed with the report in the literature. Rath *et al.* (2015) recorded values of 0.443, 0.740 and 0.460 for heritability estimates of egg weight, egg yolk weight and egg albumen weight respectively at 50 weeks for white leghorns using half-sib correlation analysis adopted to multifarious species and evaluated using PROC VAMCOMP of restricted maximum likelihood (REML) method of Statistical Package for Social Sciences. Sabri *et al.* (1999a) registered 0.457 at 26-30 weeks and 0.501 at 50-54 weeks for heritability estimates of egg weight employing white leghorn evaluated using mixed model least-squares and maximum likelihood method. Blanco *et al.* (2014) reported heritability estimates of 0.49 for egg weight at 32-36 weeks for male white egg lines of Lohmann selected leghorn and 0.65 for egg weight at 32-36 weeks for male Brown egg lines of Lohmann Brown breed using mixed procedure of statistical analytical system for a half-sib correlation analyses adopted to multifarious species.

Table 6 Estimates of heritability and repeatability for egg production at different age group

Traits	Weeks	Heritability	Repeatability
Egg Weight	25	0.783±0.01	0.843±0.18
	51	0.889±0.13	0.902±0.13
	72	0.792±0.19	0.880±0.09
York Weight	25	0.798±0.20	0.838±0.07
	51	0.426±0.14	0.666±0.09
	72	0.623±0.09	0.666±0.17
Albumen Weight	25	0.811±0.17	0.846±0.13
	51	0.433±0.08	0.712±0.14
	72	0.787±0.16	0.887±0.11

Begli *et al.* (2010) obtained heritability estimates of 0.45 for egg weight in Iranian fowl at 30 weeks using half-sib correlation analysis adopted to multifarious specie and employing restricted maximum likelihood of ASREML software for the estimation of variance components.

Paleja *et al.* (2008) obtained 0.778 at 28 weeks, 0.682 at 40 weeks and 0.542 at 56 weeks for egg weight using white leghorn breed employing least squares analysis of data with unequal subclass number. Akintola *et al.* (2011) recorded 0.50 for egg weight, 0.32 for egg yolk weight and 0.61 for egg albumen weight at 40-65 weeks for Iranian fowl employing restricted maximum likelihood (REML) procedure using the ASREML 9.0 software package.

However, Sreenivas *et al.* (2013) recorded low to moderate estimates of 0.180-0.255 for egg weight, 0.245-0.322 for egg yolk weight and 0.124-0.214 for egg albumen weight for IWH, IWI and IWK lines of white leghorns at 40 weeks using full-sib correlation method employing mixed model least squares and maximum likelihood compared to the high estimates obtained in this study. This could be attributed to the method of estimation, presumed non-additive genetic plus permanent environmental effects variance, and breed differences. Although egg weight, egg yolk weight and egg albumen recorded high estimates of heritability, observable variation was registered at different age groups. Egg weight was highly heritable at 25, 51 and 72 weeks whereas egg yolk weight and egg albumen weight were highly heritable at 25 and 72 weeks only. This suggested that the genetic potential of egg weight, egg yolk weight and egg albumen weight were well expressed at 25 and 72 weeks which minimized the effects of environmental factors thus enhanced the role of additive genetic variance in the phenotypic expression of these traits compared to report recorded at 51 weeks for egg albumen weight and egg yolk weight. At 51 weeks, there was a decline in the heritability estimates of egg production except egg weight that decline at 72 weeks suggesting that the genetic potential of egg weight and albumen weight are well expressed at peak egg production (25 weeks), which minimized the influence of environmental factors compared to later periods (51 weeks) of the laying year.

These agreed favourably with the report of (Gunder *et al.* 1989; Muir and Patterson, 1990; Hagger and Abplanalp, 1978; Sabri *et al.* 1999a; Sabri *et al.* 1991b) that obtained higher heritabilities at early stages of the laying year compared to later times of the laying year.

However, a robust heritability estimates were recorded for egg yolk weight and egg albumen weight at 72 weeks implying higher role of additive genetic variance in phenotypic expression of these traits compared to the influence of presumed non-additive genetic plus permanent environmental variance as a proportion of phenotypic variance thereby differing from the report in literature (Grunder *et al.* 1989; Muir and Patterson, 1990; Hagger and Abplanalp, 1978; Sabri *et al.* 1999a; Sabri *et al.* 1991b) employing white leghorn. This could be attributed to breed difference, environmental temperature, management procedures and method of estimation.

Repeatability estimates

The genetic potential, additive genetic variance and presumed non-additive genetic plus permanent environmental variance as a proportion of phenotypic variance from one age group to anther were the indications of the variations in the repeatability estimate observed for egg weight, egg yolk weight and egg albumen weight in this study as presented Table 6.

High repeatability estimates of 0.843-0.902, 0.666-0.838 and 0.712-0.887 for egg weight, egg yolk weight and egg albumen weight at 25-72 weeks respectively were recorded indicating higher role of additive genetic variance in the phenotypic expression compared to non-additive genetic plus permanent environmental variance as a proportion of phenotypic variance at 25-72 weeks. These high estimates are similar to the report in the literature. Toye *et al.* (2012) obtained egg weight of 0.46 for Black Harco breed and 0.50 for heavy Lohman Brown layers at 28 weeks employing mean square from the analysis of variance using statistical system and STAT programmed. Blanco *et al.* (2014) recorded repeatability estimates of egg weight of 0.75 for white egg line and 0.71 for Brown egg line between 67-70 weeks using mixed procedure of statistical analytical system for a half-sib correlation analysis adopted to multifarious species. Goto *et al.* (2015) reported estimates of 0.47 for egg weight, 0.48 for egg yolk weight and 0.51 for egg albumen weight for Onagadori breed; 0.42 for egg weight, 0.40 for egg yolk weight and 0.45 for egg albumen weight for white leghorn between 20-30 weeks employing one-way analysis of variance with Stat View for windows software. Udeh (2010) reported 0.44 for egg weight at 40 weeks in Black Olympia (strain 2) using one-way analysis of variance described by Becker (1984) for multifarious species and half-sib correlation. Ayorinde and Sado (1988) also reported repeatability estimates of 0.58-0.60 for egg weight from Hubbard layers; Ibe (1984) obtained 0.76 for egg weight in white leghorn hens; and obtained an estimate of 0.46-0.71 for egg weight in different lines of white leghorns.

It could be observed that at 51 weeks, there was a decline in the repeatability estimates of egg production except egg weight suggesting that the genetic potential of egg weight and albumen weight are well expressed at peak egg production (25 weeks) while egg weight experienced prolonged genetic potential between 25-51 weeks which minimized the influence of environmental factors compared to later periods (51 weeks for egg yolk weight and egg albumen weight, and 72 weeks for egg weight) of the laying year. This is in line with the report of that observed high repeatability estimates at peak egg production and declined estimates at later periods.

Comparison between heritability and repeatability estimates

Repeatability and heritability estimates for egg production varied slightly are shown in Table 6. It was observed that repeatability estimates were higher than estimates of heritability suggesting low influence of non-additive genetic and permanent environmental influence as a proportion of phenotypic variance on the traits. This trend was observed by Blanco *et al.* (2014) for estimates of repeatability and heritability in egg weight for white egg line and Brown egg line.

CONCLUSION

From the findings, it was observed that as the age of the laying hen increased, the magnitude of egg weight, egg yolk weight and egg albumen weight increased. The regression coefficient of the traits revealed that positive rate of change in trait from one age group to another. The Pearson correlation coefficient recorded a significant positive and the same high correlation between egg weight and other components and highest coefficient between egg yolk weight and egg albumen at different age groups. It was equally observed that the heritability and repeatability estimates were generally high while repeatability estimates were slightly higher than heritability values indicating a slight influence of presuming non-additive plus permanent environment variance on the traits of different age groups. This indicates that adequate and proper mass selection, management procedures, experimental design and method of estimation employed in the research were genetically responsible for the improvement of the traits.

ACKNOWLEDGEMENT

Our thanks go to Babcock University, Nigeria for providing us a peaceable environment for carrying out the practical. We also wish to thank all authors cited in this paper for making the manuscript a success.

REFERENCES

Abdallah A.G., Harms R.H. and Russell G.B. (1995). Effect of age and resting on hens laying eggs with heavy or light shell weight. *J. Appl. Poult. Res*. **4,** 131-137.

Akintola O.A.I., Ajuogu P.K. and Aniebo A.O. (2011). Effects of Ovabolin (Ethylestrenol) on egg laying performance and egg quality traits in second year layers. *Adv. Agric. Biotechnol*. **1,** 49-58.

Ayorinde K.L. and Sado C. (1988). Repeatability estimates for some egg traits in a commercial laying strain. *Nigeria J. Anim. Prod*. **15,** 119-125.

Becker W.A. (1984). Manual of Qualitative Genetics. Fourth ed. Academic Enterprise, Washington, USA.

Begli H.E., Zerehdaran S., Hassani S. and Abbasi M.A. (2010). Heritability, genetic and phenotypic correlations of egg quality traits in Iranian fowl. *British Poult. Sci*. **51,** 740-748.

Blanco A.E., Ieken W., Ould-Ali D., Cavero D. and Schmutz M. (2014). Genetic parameters of egg quality traits on different pedigree layers with special focus on dynamics stiffness. *Poult. Sci*. **93,** 2457-2461.

Ewa V.U., Otuma M.O. and Omeje S.I. (2005). Interrelationship of external egg quality traits of four inbred line chicken stains. *Trop. J. Anim. Sci*. **8,** 23-30.

FAO. (1998). Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

FAO. (2009). Food and Agriculture Organization of the United Nations the State of Food Insecurity in the World.

Goto T., Shiraishi J., Bungo T. and Tsudzuki M. (2015). Characteristics of egg-related traits in the Onagoidori (Japanese Extremely Long Tail) breed of chickens. *Japan Poult. Sci. Assoc*. **52,** 81-91.

Grunder A.A., Hamilton R.M.G., Fairfull R.W. and Thompson B.K. (1989). Genetic parameters of egg shell quality traits and percentage of eggs remaining intact between oviposition grading. *Poult. Sci*. **68,** 46-54.

Hagger C. and Abplanalp H. (1978). Food consumption records for the genetic improvement of income over food costs in laying flocks of White Leghorns. *British Poult. Sci*. **19,** 651-667.

Ibe S.N. (1984). Repeatability of egg quality traits in white Leghorn chickens. *Nigeria J. Genet*. **4(1),** 12-19.

Islam M.S. and Dutta R.K. (2010). Egg quality traits of indigenous, exotic and crossbred chicken (*Gallu gallus domesticus*) in Rajshahi, Baugladesh. *J. Life Earth Sci*. **5,** 63-71.

Jayalaxmi P., Prasad V.I.K., Sree R.M.A. and Eswara R.C. (2002). Inheritance of various eggf quality traits in three strains of White Leghorns. *Indian Vet. J*. **78,** 820-823

Kamanli S., Durmus I., Demir S. and Tarim B. (2015). Effect of different light sources on performance and egg quality traits in laying hens. *European Poult. Sci*. **79,** 1-10.

Khalil M.H., Iraqi M.M. and El-Atrouny M.M. (2013). Effects on egg quality traits of crossing Egyptian Golden Montazah with white leghorn chickens. Livest. Res. Rural Dev. Available at: http://www./wd.org/lrrd25/6/kha/251103.htm.

Ledur M.C., Liljedahl L.E., Mcmillan I., Asselstine L. and Fairfull R.W. (2002). Genetic effects of aging on egg quality traits in the first laying cycle of White Leghorn strains and strain crosses. *Poult. Sci*. **79,** 296-304.

Lukanov H., Genchev A. and Pavlov A. (2015). Egg quality and shell colour characteristics of crosses between Araucan and Schijndelaar with highly productive white leghorn and Rhode strains. *Agric. Sci. Technol*. **7(3),** 366-371.

Minelli G., Sirri F., Folegatti E., Meluzzi A. and Franchini A. (2007). Egg quality traits of laying hens reared in organic and conventional systems. *Italian J. Anim. Sci*. **6,** 728-730.

Molnar A., Maertens B., Ampe B., Buyse J., Kempen I., Zoons J. and Delezie E. (2016). Changes in egg quality traits during the last phase of production: is there potential for an extended laying cycle? *British Poult. Sci*. **57(6),** 842-847.

Mube H.K., Kana J.R., Tadondjou C.D., Yemdjie D.D., Marijei Y. and Tegnia A. (2014). Laying performance and egg quality of local Barred Hens under improved conditions in Cameroon. *J. Appl. Biosci*. **74,** 6158-6163.

Muir W.M. and Patterson D.L. (1990). Genetic and environmental association of unconllectible egg production with shell quality, rate of lay and erratic timinig of oviposition in white leghorn hens. *Poult. Sci*. **69,** 509-516.

Padhi M.K., Chatterjee R.N., Rajkumar U., Haunshi S., Niranjan M., Panda A.K., Reddy M.R. and Bhanja S.K. (2015). Evaluation of Vanaraja male line (PDI) for different production and egg quality traits. *Indian J. Anim. Sci*. **85,** 634-642.

Paleja H.I., Savalia F.P., Patel A.B., Khanna K., Vataliya P.H. and Solanki J.V. (2008). Genetic parameter in White Leghon (IWN Line) chicken. *Indian J. Poult. Sci*. **43,** 151-157.

Petek M., Gezen S.S., Alpay F. and Cibik R. (2007). Effects of non-feed removal molting methods on egg quality traits in commercial brown egg laying hens in Turkey. *Trop. Anim. Health Prod*. **21,** 1-5.

Rath P.K., Mishra P.K., Mallick B.K. and Behura N.C. (2015). Evaluation of different egg quality traits and interpretation of their mode of inheritance in white leghorn. *Vet. World*. **8,** 449-451.

Sabri H.M., Wilson H.R., Harms R.H. and Wilcox C.J. (1999a). Genetic parameter for egg and related characteristics of white leghorn hens in a subtropical environment. *Genet. Mol. Biol*. **2,** 183-192.

Sabri H.M., Wilson C.J. Wilson H.R. and Harms R.H. (1991b). Comparison of energy utilization efficiency among six lines of White Leghorns. *Poult. Sci*. **70,** 229-233.

SAS Institute. (1999). SAS®/STAT Software, Release 6.11. SAS Institute, Inc., Cary, NC. USA.

Sharma P.K., Varma S.K., Sharma R.K. and Brijesh S. (2002). Genetic parameters of production and egg quality characters White Leghorn. *Indian J. Poult. Sci*. **37,** 181-182.

Sreenivas D., Prakash M.G., Mahender M. and Chatterjee R.N. (2013). Genetic analysis of egg quality traits in white leghorn chickens. *Vet. World*. **6,** 363-372.

Tadesse D., Esatu W., Girma M. and Dessie T. (2015). Comparative study on some egg quality traits of exotic chickens in different production systems in East Shewa, Ethiopia. *African J. Agric. Res*. **10,** 1016-1022.

Toye A.A., Sola-ojo F.E. and Ayorinde K.L. (2012). Egg production, egg weight and egg mass repeatability and genetic gain from use of multiple time-spaced records in Black Harco and Lohman Brown layers. *Centrepoint J*. **18(2),** 147-156.

Tumova E. and Goust R.M. (2012). Interaction of hen production type, age, and temperature on laying pattern and egg quality. *Poult. Sci*. **91,** 1269-1277.

Udeh I. (2010). Repeatability of egg number and egg weight in two strains of layer type chicken. *Int. J. Poult. Sci*. **9,** 675-682.

Zhang L.C., Ning Z.H., Xu G.Y., Chou Z. and Yang N. (2005). Heritability and genetic and phenotypic correlations of egg quality traits in brown-egg dwarf layers. *Poult. Sci*. **84,** 1209-1213.