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REPEATABILITY ESTIMATES AND PHENOTYPIC CORRELATIONS OF EGG QUALITY TRAITS OF ISA BROWN LAYERS

[1*]Adeoye, A.A, [2]Ajayi, B. A and [1]Olorunsola R.A

[1]Animal Production and Health, Olusegun Agagu University of Science and Technology, Okitipupa.
[2] Department of Animal Science, Faculty of Agricultural Production and Management, College of Agriculture, Osun State University
*Corresponding Author's Email: adeomoh@yahoo.com

Abstract
Repeatability is the likelihood of an individual repeating its performance at any given time in subsequent measurement. It expresses the proportion of the total variance that is due to permanent or non-localized differences between individuals. A total of fifty (50) eggs were collected daily continuously for ten days from fifty (50) selected ISA brown layers in a base population at 31st week of age for egg quality analysis. The birds were kept at Poultry Unit, Teaching and Research Farm, Olusegun Agagu University of Science and Technology Okitipupa. Data collected on the egg quality were subjected to one-way Analysis of Variance (ANOVA) and Pearson correlation with the Computer aided Software, Statistical Analysis System (SAS, version 8), to estimate the repeatability and phenotypic correlations among the egg quality traits. The phenotypic correlations among the external egg quality ranged between -0.333 to 0.737 while internal egg quality ranged between -0.878 to 0.828. Low to high estimates (0.11 to 0.81) were reported for repeatability of most of the traits while 0.23, 0.11 and 0.12 were reported for egg weight, yolk weight and albumen height, respectively. The traits with high repeatability estimates require few record while those with low estimates require more records to effect selection for genetic improvement.
Keywords: ISA brown layers, Repeatability, egg weight, yolk weight, albumen height

Introduction

Egg quality is the general term which refers to general standards which define both internal and external quality such as egg weight, egg length, width, egg index, shell weight, shell thickness, albumin height, albumin width, yolk height, yolk index, Haugh unit (Ref?). Eggs and meat are amongst the most nutritious foods and eggs are rated with milk as one of the best protein foods rich in iron (Fe) and vitamins (Oluyemi and Roberts, 2000). It has also been defined by Stadelmam, (1977) as the characteristics of eggs that affect its acceptability to the consumers and is more important price contributing factor in table and hatching eggs. The significance of the egg as a protein source for the nourishment of humans led to the consumers' demand for some qualities in these nutrients (Uluocak *et al.*, 1999). Therefore, monitoring and evaluation of external and internal quality of chicken eggs is important in production economy and consumers' preferences for better quality of eggs. Islam *et al.* (2001) found that the external and internal egg quality traits of the breeds affect the future generations and their performance. Tumova *et al.* (2007) reported that genotype significantly affected the egg shape index, yolk and albumin quality and yolk index. Similarly, Yakubu *et al.* (2008) observed significant differences between naked neck and normal feathered in most of the egg parameters except shell weight and yolk index. Olawumi and Ogunlade (2008) reported highly significant correlation in most of the internal and external quality traits in exotic Isa brown layer breeders. Furthermore, Yousria *et al.* (2010) reported significant positive correlation in most of the egg quality traits in Egyptian Gimmizah and Bandra and their crosses. The economic success of a laying flock solely depends on the total number of quality eggs produced. Approximately 7-8% of the total amount eggs are broken through the transfer of the eggs from the production to the consumer. Thus, the amount of cracked and broken eggs results in serious economic problems both for the producers, dealers and consumers (Hamilton, 1982). Peters *et al.* (2007) and Kul and Seker (2004) reported that egg weight and egg index are determinant of egg resistance to cracking and are considered very important traits when eggs are packed in container.

In Nigeria, different poultry species contribute significantly to the annual animal protein supply to the populace (Ikeobi *et al.,* 1999). Poultry eggs are good sources of income and are of particular significance in scientific research, such as vaccine production (Adebambo, 2005). The egg is a complex structure distinguished by having four different parts; the egg shell, shell membrane, albumen and yolk. When eggs are for human consumption, it is important that they are suitable for this purpose (Kabir *et al.,* 2014). This will be determined by both the internal and external quality of the egg (Smith, 1990). External quality is focused on egg shell cleanliness and thickness, egg weight, height, width and shape whereas internal quality refers to albumen cleanliness and viscosity, yolk quality and absence of blood spots (Kabir *et al.,* 2014). Unlike external (shell) quality, internal quality of the egg begins to decline as soon as the egg is laid.

To fully characterize an avian and other animal species, reliable estimates of their genetic parameters are required. Apart from heritability and genetic correlations among traits, repeatability is another useful genetic parameter, providing a tool for quantifying the transmitting ability of a stock and its ability to maintain its performance and ranking within a test group on subsequent performance. (Udeh, 2010). This transmitting ability according to (Ibe, 1984) arises from inherent and other permanent influences causing observable differences among the individuals. Generally, the magnitude of a repeatability estimate gives indication of the extent to which selection practiced at any stage would affect subsequent flock performance (Buss,1982). A number of egg quality traits are known to be moderately to highly heritable and repeatable (Kotaiah *et al.,* 1976) and consequently, they tend to lend themselves to improvement through selection Ibe (1984). However, a number of investigators have reported low repeatability values for egg production and egg quality traits in different strains of chicken (Chineke, 2001).

The objective of this study is to determine the repeatability and phenotypic correlation of egg quality traits in ISA brown eggs.

Materials and methods

The experiment was carried out at Poultry Unit, Teaching and Research Farm and Analytical Laboratory of Olusegun Agagu

University of Science and Technology, Okitipupa. Okitipupa lies between latitude 6.25 and 6.78^{0} N and Longitude 4.35 and 4.50 E within the tropical rainforest zone of Nigeria (www.google.com/sea). Eggs were collected from fifty (50) selected ISA brown breed of layer at 31stweeks of age continuously for ten (10) days. The birds were fed with commercial layers' mash and water supplied throughout the experimental period. Eggs collection was done early in the morning and internal and external quality of the eggs were analyzed within 24 hours of collection.

Egg analysis: The eggs were weighed after collection. Egg shell thickness was evaluated by a TSS QCT shell thickness micrometer (TSS England) in equatorial region. Haugh units were calculated based on the formula using the egg weight and albumen weight. Egg yolk was weighed and Eggshell was air-dried for three days, weighed and used to calculate albumin weight by subtracting yolk and shell weights from egg weight.

The analysis of variance technique was employed to estimate variance components which were utilized in the estimation of repeatability of traits' response.

The estimator of repeatability (R) was obtained as follows:

$$R = \frac{\sigma_i^2}{\sigma_i^2 + \sigma_e^2}$$

Where R = repeatability estimate in line with Becker (1984)

σ_i^2 = individual variance component

$\sigma_i^2 + \sigma_e^2$ = total phenotypic variance

$$S.E(r) = \frac{\sqrt{2(1-r)^2[1+(k-1)r]^2}}{K(k=1)(n-1)}$$

Where r = repeatability estimate

K = number of eggs per bird

n = number of birds involved.

The relationships amongst the parameters measured were determined using Linear Correlation and

Analysis Procedure of SAS (SAS, 2004).

Results

The summary statistics of the egg quality traits is shown in Table 1. The egg weight ranged between 50-72g while the average egg length was 5.59mm. The haugh unit ranged between 62 - 98, with average of 81.98%.

Table 1: The summary statistics of egg quality traits

VARIABLES	MEAN	MINIMUM	MAXIMUM	CV (%)
Egg weight(g)	60. 09	50.00	72.000	7.605
Egg Length(cm)	5.59	5.140	6.050	3.827
Egg width(cm)	4.41	4.060	4.740	2.857
Shell weight(g)	7.73	5.000	9.000	11.169
Shell thickness (mm)	0.732	0.210	0.990	23.930
Yolk height(mm)	15.50	15.020	15.980	1.742
Yolk weight(g)	14.66	12.000	17.000	9.458
Albumen height(mm)	6.66	5.160	8.200	9.610
Haugh unit	81.98	61.820	98.050	10.739
Yolk diameter(mm)	40.120	37.000	43.000	3.838

The repeatability estimates for the egg quality is shown in Table 2. The estimates for egg weight, egg length, egg width and shell weight were 0.23 ± 0.065, 0.42 ± 0.18, 0.65 ± 0.071 and 0.59 ± 0.033, respectively while 0.86 ± 0.108, 0.11± 0.072, 0.54± 0.034, 0.43

± 0.088, 0.12 ± 0.072 and 0.81 ± 0.117 were repeatability estimates for Shell thickness, Yolk weight, Yolk diameter, Yolk height, Albumen height and Haugh unit, respectively.

Table 2: Repeatability estimates of egg quality traits

Traits	Repeatability ±Standard error
Egg weight	0.23 ± 0.065
Egg length	0.42 ± 0.180
Egg width	0.65 ± 0.071
Shell weight	0.59 ± 0.033
Shell thickness	0.86 ± 0.108
Yolk weight	0.11± 0.072
Yolk diameter	0.54± 0.034
Yolk height	0.43 ± 0.088
Albumen height	0.12 ± 0.072
Haugh unit	0.81 ± 0.117

The correlation coefficients among the external egg quality is shown in Table 3. Egg weight was significantly and positively correlated with egg length (0.629), egg width (0.670) and shell weight (0.333) while negative correlations were observed with shell index (-0.168), shell ratio (-0.320) and shell thickness (-0.096). egg length was significantly correlated with other external egg quality considered in this study. Similarly, shell weight was significantly and positively correlated with shell ratio and shell thickness.

Table 3: Phenotypic correlation among external egg quality

	EWT	EL	EW	SI	SW	SR	ST
EWT	1.00						
EL	0.629**	1.00					
EW	0.670**	0.321*	1.00				
SI	-0.168*	0.737**	0.389*	1.00			
SW	-0.333*	-0.243*	0.243*	0.522**	1.00		
SR	-0.320*	-0.122*	-0.290*	-0.065	0.572**	1.00	
ST	-0.096	-0.107*	-0.099	-0.039	0.194*	0.139*	1.00

** – Highly significant (P < 0.01), * – Significant (P < 0.05). Egg weight (EWT), Egg length (EL), Egg width (EW), Shell index (SI), Shell weight (SW), Shell ratio (SR), Shell Thickness (ST).

Table 4 shows the phenotypic correlation among the internal egg quality. The correlations ranged between -0.878 to 0.828. least correlation (-0.878) was observed between yolk ratio and albumin ratio while the highest correlation (0.828) was between albumin ratio an albumin weight.

Table 4: Phenotypic Correlation among internal egg quality

	YH	AW	AR	YI	YR	YW	AH	HU	YD
YH	1.000								
AW	0.034	1.000							
AR	-0.069	0.828**	1.000						
YI	0.183*	0.071	0.134*	1.000					
YR	0.036	-0.769**	-0.878**	-0.164*	1.000				
YW	0.095	-0.172	-0.576**	-0.206*	0.740**	1.000			
AH	-0.195*	0.001	0.039	-0.065	0.019	-0.023	1.000		
HU	0.011	0.034	0.051	0.039	-0.068	-0.042	-0.042	1.000	
YD	0.183*	-0.067	-0.106*	-0.720**	0.149*	0.147*	0.072	0.037	1.000

** – Highly significant ($P < 0.01$), * – Significant ($P < 0.05$).Yolk Height (YH), Albumen weight (AW), Albumen Ratio (AR), Yolk Index (YI), Yolk Ratio (YR), Yolk weight (YW), Albumen Height (AH), Haugh Unit (HU), Yolk Diameter (YD).

Discussion

The egg weight observed in this study (60.09g) was higher than 56.82g observed by Adeoye *et al.* (2020) for the same breed meanwhile the values for egg length (5.59mm) and egg width (4.41mm) observed in the present study were lower than the report of Adeoye *et al.* (2020). The reason for these discrepancies might be attributed to the differences in the age of the laying chickens. The average haugh unit, shell weight, shell thickness, albumen height, yolk height obtained in the present study were lower than those reported by Chatterjee *et al.* (2007). However, the average yolk weight reported in this study was higher than those reported by Salahudin and Miah (2003). The differences in the result can be attributed to genetic differences and non-genetic factors.

Phenotypic correlations obtained in this study is similar to the report of Adeoye *et al.* (2020) but lower than the values reported by Seker *et al.* (2015) and Sezer (2017). Meanwhile, the result of internal egg quality with low but positive correlations and non-significant negative correlations were similar to the results reported by Ingram *et al.* (1989). The negative but non-significant correlations between most of the internal egg quality traits obtained in this study were similar to the findings of Kul and Seker (2004). However, the pattern of variation for all the internal egg quality trait phenotypic correlations were similar with the findings of Wilson and Douglas (1983).

The repeatability estimates for egg length (0.42), egg width (0.65), shell weight (0.59), yolk diameter (0.54), yolk height (0.43) were high and generally agreed with the report in literature. Goto *et al.* (2015) recorded values at 0.42 for egg length, and 0.50 for yolk diameter, Blanco *et al.* (2014) obtained 0.64 for egg width and Udeh (2010) reported 0.59 and 0.54 for shell weight and yolk diameter respectively. However, low estimates of 0.23, 0.11 and 0.12 were recorded for egg weight, yolk weight and albumen height respectively. The low estimates could be attributed to environmental influence and age related factors, among other factors. Repeatability estimate for Haugh unit is similar to that reported by Godfrey *et al.* (1954). The low estimates are indicative of strong environmental influence on the traits while the traits with high repeatability estimates require few record to effect selection for genetic improvement.

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