



## Phenotypic Correlations among Egg Weight, External and Internal Egg Quality Traits of Harco Black and Isa Brown Chicken in a Derived Savanna Environment of Nigeria.

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### ABSTRACT

The phenotypic correlations among egg weight, external and internal egg quality traits of two commercial egg type chickens, Isa brown and Harco black chickens were determined. A total number of 200 point of lay hens of 100 each of Isa brown and Harco black were used for the study. Data were collected on egg weight, egg length, egg content, shell weight, shell thickness, yolk weight, albumen height, albumen weight, yolk height, yolk length and yolk colour, from 960 eggs consisting 40 each of the strain analyzed on weekly bases for 12 weeks. Results shows a significant ( $P < 0.05$ ) effect between the measured parameters and the two strain of hens. Isa brown eggs had higher values of egg length (54.12mm), egg content (45.48g), shell weight (4.68g) and albumen length (5.75mm) than Harco black eggs. The association between egg weight and other egg biometrical traits was found to be positive and very highly significant ( $r = 0.31 - 0.80$ ;  $p < 0.0001$ ) while other egg parameters were either positively or inversely correlated with each other for Isa brown strain. The relationship between egg weight and other egg biometrical traits was found to be very highly significant ( $p < 0.0001$ ;  $r = 0.73$ ) while other egg variables were also either positively or inversely correlated with each other for Harco black strain. It is observed that Isa brown eggs was better than Harco black in respect to egg length, egg content, shell weight and albumen length while the phenotypic correlation coefficient results can be used in selection criteria.

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### Introduction

Egg is a biological structure intended by nature for reproduction. It protects and provides complete diets for the developing embryo and serves as the principal source of food for the first few days of the chick's life (Abanikannda *et al.*, 2007). The egg of a laying hen is the end product of complicated series of processes. It is the vehicle for reproduction and also serves as a source of food for humans (Jacobs *et al.*, 2000). The quality of eggs depends on physical make up and chemical composition of its constituent parts. Egg quality is the more important price contributing factor in table and hatching eggs (Chukwuka *et al.*, 2011). Among external egg quality parameters, shell thickness, as a measure of shell strength, is an important bio-economic trait that primarily breeds of egg laying flock incorporate in their breeding programme to reduce egg shell breakages.

Egg quality is a general term which refers to several standards which define both internal and external quality such as egg weight, egg length, egg circumference, egg index, shell weight, shell thickness, albumin height, albumin width, yolk height, yolk index and Haugh unit. Egg and meat are among the most nutritious food; and egg rated with milk as one of the best protein food rich in iron (Fe) and vitamins

(Amao and Olugbemiga, 2016). Egg quality is composed of those characteristics of an egg that affects its acceptability to consumers, it is therefore important that all attention is paid to the problems of preservation and marketing of eggs to maintain the quality (Adeogun and Amole, 2004). Knowledge of the correlation between traits permits prediction of direction and magnitude of change in the dependent trait as a correlated response to direct the selection of the principal trait (Udoh and John-jaja, 2014). The relationship between external traits, yolk and albumen had contributed to the egg weight increases with hen's age, reaching an apex by the end of the laying cycle (Danilov, 2000). Thus, egg external qualities are one of the important phenotypic traits which influence egg quality and reproductive fitness of the chicken parent, (Islam and Dulta, 2010). This study was conducted to investigate egg quality traits and phenotypic correlations between internal and external quality traits of Harco black and Isa brown laying birds in derived savanna environment.

### MATERIALS AND METHODS

#### Site of Experiment

The experiment was carried out at the poultry unit of the Teaching and Research Farm of Ladoko Akintola University of Technology, Ogbomoso, Oyo State.

Ogbomoso is a derived Savanna, lies on Longitude  $4^{\circ}51'$  East of Greenwich Meridian and Latitude  $8^{\circ}51'$  North -East towards Ibadan, the capital of Oyo State. The Latitude between 300 and 600m above sea level, while mean temperature is  $27^{\circ}\text{C}$  and annual rainfall is 1247mm (Ige *et al.* 2014).

### Experimental birds and Management

A total of two hundred birds consist of Harco black and Isa brown of one hundred each of the two commercial layer strains were procured for this study at 14 weeks of age from a reputable commercial poultry farm, the farm is known for its hygienic management. At the farm at arrival, half of the birds were reared in standard battery rearing cages. They were dewormed at 3 months interval, antibiotics, vitamin and vaccination against new castle disease were administered on regular basis.

### Feeds and Feeding

The birds were fed with commercially prepared feed in two phases: 18% of crude protein 2864kcalMEkg grower diet till 18-20 weeks of age and 17% crude protein, 2892cal MEkg layer diet from 20 week upward. The hens had *ad libitum* access to water and normal layer crumbled ration throughout the period of the experiment.

### Data Collection

The data were collected on 960 fresh laid eggs, 40 eggs were randomly picked for each strain on weekly bases for the assessment of the following parameters; egg weight (g), egg length (mm), Egg mass (g), shell weight (g), shell thickness (mm), albumen weight (g), albumen height (mm), yolk weight (g), yolk height (mm), yolk circumference (mm) on weekly bases for 12 weeks with the following procedures:

Eggs were weighed to the nearest of 0.01 g using a digital weighing balance (Model: DT 5k, LARK®). The length (mm) and width (mm) of each egg was measured at midpoint using a digital caliper to nearest of 0.05 mm. Each egg was then broken out and albumen and yolk height measurements were taken using a tripod micrometer while yolk diameter was measured using digital caliper meter. Measurements of albumen heights were taken from the right and left sides of the albumen and average values were calculated. AH= albumen height in mm, YH= yolk height in mm and EW= egg weight in grams. Yolk color was measured with a Roche yolk color fan scale (Roche scale). Before measuring shell thickness, the shell was cleaned with tissue paper and air-dried at room temperature for 24 hours. Then, three pieces of shell was taken from the narrow side (sharp region), the middle side (equatorial region), and the broad-end side (blunt region) of each egg. First, shell membranes were removed by hand and then measured by a digital caliper to the nearest of 0.05 mm. The shell thickness (mm) was then calculated as an average of the thicknesses of the three pieces.

### Statistical analysis

The data collected were subjected to General linear model analysis of variance procedure of SAS(2003), and means was separated using Duncan procedure of same software. The data were analyzed using the model specified below:

$$Y_{ij} = \mu + G_i + e_{ij}$$

Where,  $Y_{ij}$ = individual observation on eggs

$\mu$ = Overall mean

$G_i$ = Fixed effect of  $i^{\text{th}}$  egg genotype (1, 2)

$e_{ij}$ = Residual random error

Correlations of egg quality parameters were also achieved using the formula below;

$$r = \frac{\sum XY}{(\sum X^2 \sum Y^2)^{0.5}}$$

Where: r = correlation coefficient

$\sum X^2$ ,  $\sum XY$  and  $\sum Y^2$  = sum of variables.

## RESULTS AND DISCUSSION

Table 1 revealed the least square means of external and internal egg quality traits of Harco and Isa Brown laying birds. Egg quality was significantly ( $P < 0.05$ ) affected by the two strains of laying birds. Isa brown strain has the higher values of 54.12 mm, 45.48 mm, 5.57mm, 13.69mm and 4.68 mm for egg length, egg mass, albumen height, yolk height and shell weight respectively than Harco black strain. The outstanding performance of Isa brown strain on egg quality traits in this current study supports the findings of Zita *et al.* (2009) on the egg quality traits of brown- egg laying hens. These authors documented a range of values similar to the current findings for their laying birds. This observation that favoured Isa brown on egg quality traits were also in agreement with the works of Rath *et al.* (2015) for white leghorns eggs. However, the pattern of this present results on egg quality traits was in line with the observations of Bovera *et al.*, (2014) on the egg quality of laying hens of Lohmann brown during 20 to 36 weeks of age. Meanwhile, no significant ( $P > 0.05$ ) difference was observed for egg weight, albumen weight, yolk weight, yolk length and shell thickness values among the genotype chicken and this non- significant observation was in line with the works of Hocking *et al.* (2003) who reported no significant difference in albumen weight, yolk weight, yolk length and egg shell thickness of commercial and traditional breeds of chicken. Similarly, non - significant effects were also reported by Nwachukwu *et al.* (2006) for albumen weight, yolk weight, yolk length and shell thickness between F1 crosses of Nigerian local, naked neck and frizzle chickens with exotic broiler chickens.

**Table 1. Least Square Means of External and Internal egg quality traits of Harco black and Isa Brown commercial laying birds.**

Variables	Obs	Harco	Isa Brown
Egg weight (g)	80	52.15 $\pm$ 0.36	52.72 $\pm$ 0.37
Egg length (cm)	80	50.52 $\pm$ 0.64 <sup>b</sup>	54.12 $\pm$ 0.31 <sup>a</sup>
Egg content (cm)	80	40.13 $\pm$ 0.88 <sup>b</sup>	45.48 $\pm$ 0.35 <sup>a</sup>
Shell weight (g)	80	4.27 $\pm$ 0.06 <sup>b</sup>	4.68 $\pm$ 0.07 <sup>a</sup>
Shell thickness (mm)	80	0.36 $\pm$ 0.01	0.36 $\pm$ 0.01
Yolk weight (g)	80	13.33 $\pm$ 0.15	13.19 $\pm$ 0.16
Albumen height (mm)	80	5.27 $\pm$ 0.08	5.57 $\pm$ 0.08
Albumen weight (g)	80	31.78 $\pm$ 0.24	32.25 $\pm$ 0.30
Yolk height (mm)	80	12.75 $\pm$ 0.71 <sup>b</sup>	13.69 $\pm$ 0.16 <sup>a</sup>
Yolk length (mm)	80	35.38 $\pm$ 0.20	35.50 $\pm$ 0.22
Yolk colour	80	2.84 $\pm$ 0.13	2.65 $\pm$ 0.11

<sup>ab</sup>Means along the same row with different superscripts are significantly different ( $P < 0.05$ )

Obs=Number of observation.

Correlation coefficients of egg weight and other egg traits of Isa brown birds are presented in Table 2. Positive and very high significant ( $P < 0.0001$ ) correlations were observed.

**Table 2. Phenotypic correlation between external and internal egg quality traits Isa brown layers.**

	EW	EL	EC	AW	YW	AH	YH	YL	YCL	SW	ST
EW	—										
EL	0.24**	—									
EC	0.80***	0.08	—								
AW	0.72***	—	0.87***	—							
YW	0.28***	0.26	0.33***	0.09	—						
AH	0.24***	0.09	0.25**	0.35***	0.09	—					
YH	0.20**	0.11	0.14*	<b>-0.04</b>	0.26**	—	0.21	—			
YL	0.11***	0.06	0.13	0.09	0.05	—	0.13	0.11	—		
YCL	—	—	—	—	—	—	—	—	—	—	—
SW	0.23***	0.08	0.21**	0.21**	0.05	0.13	—	0.03	0.04	0.12	—
ST	0.31***	0.16	0.21**	0.15*	0.16	—	0.08	0.16	0.05	—	0.09

\*\*\*P<0.0001, \*\*P<0.001, \*P<0.05

**Table 3. Phenotypic correlation between external and internal egg quality traits Harco laying birds.**

	EW	EL	EC	AW	YW	AH	YH	YL	YCL	SW	ST
EW	-										
EL	0.14*	-									
EC	0.22*	0.95***	-								
AW	0.73***	0.23**	0.33***	-							
YW	0.20**	-0.17*	-0.06	0.09	-						
AH	0.08	0.06	0.12	0.20*	0.04	-					
YH	0.07	-0.24	-0.22*	-0.14	0.44***	-0.03	-				
YL	0.05	-0.06	-0.14*	-0.10	0.05	-0.13	0.13	-			
YCL	-0.09	0.08	0.08	0.09	-0.13	0.13	-0.32***	-0.36***	-		
SW	0.16*	-0.19	-0.19	0.10	0.01	0.06	0.16	0.07	-0.20	-	
ST	0.24**	-0.16	-0.20*	0.07	-0.05	-0.02	0.19**	0.22*	-0.35	0.25	-

\*\*\*P<0.0001. \*\*P<0.001. \*P<0.05

The correlation coefficients for egg weight and traits measured ranged from -0.13 to 0.87. The highest correlation value (0.80) was for albumen weight and egg content and the least correlation value (-0.15) was between yolk length and yolk colour. A very high positive significant ( $P<0.0001$ ) correlation existed between egg weight against egg length (0.24), egg content (0.80), albumen weight (0.72), yolk weight (0.28), albumen height (0.24), yolk length (0.11), shell weight (0.23) and shell thickness (0.31). Also, the relationships between albumen weight and egg content (0.87), yolk weight and egg content (0.33), albumen height and albumen weight (0.35) were positive and very highly correlated. Positive and high significant ( $P<0.01$ ) correlation were observed between egg weight and egg length (0.24), yolk height and egg weight (0.20), albumen height and egg content (0.25), shell weight and egg content (0.21), yolk height and yolk weight (0.26), shell weight and albumen weight (0.21) while the relationship between yolk height and egg content (0.14), shell thickness and albumen weight (0.15) were positively and significantly ( $P<0.05$ ) correlated. The present positive relationship between egg weight and other egg quality indices is in concordance with the observations of Abanikannda and Leigh (2007) for table eggs and Yakubu *et al.* (2008) for naked neck and full-feathered chickens. The strong association between egg weight and albumen height, yolk height, yolk weight, albumen weight, shell thickness and yolk width indicates that the improvement on any of these traits through artificial breeding could result in continue improvement of the other traits.

In other words, their action could more or less be additive in nature, suggesting an integrated manner of influence. The low value recorded for egg weight and shell weight agreed with the submission of El-Safty *et al.* (2006). However, the pattern of the phenotypic correlation documented for Isa brown hens was in accordance to the reports of Olawumi and Ogunlade, (2008) for Isa brown layer breeders.

Table 3 shows the correlation coefficients between some egg measurements of Harco birds. The values were positive and highly significant ( $P<0.0001$ ) between egg weight and albumen weight ( $r = 0.73$ ), egg length and egg content ( $r = 0.95$ ), egg length and albumen weight ( $r = 0.33$ ), yolk weight and yolk height ( $r = 0.44$ ). Similar relationship but negative also existed between yolk colour and yolk height ( $r = -0.32$ ), yolk colour and yolk length ( $r = -0.36$ ). However, the values were also positive and highly significant ( $P<0.01$ ) between egg weight and yolk weight ( $r = 0.20$ ), between egg weight and shell thickness ( $r = 0.24$ ), between egg length and albumen weight ( $r = 0.23$ ) and between shell thickness and yolk height (0.22). Meanwhile, values were positive and significant ( $P<0.05$ ) between egg weight and egg length ( $r=0.14$ ), between egg weight and egg content( $r = 0.22$ ), between egg weight and shell weight ( $r = 0.16$ ), albumen height and albumen weight ( $r = 0.20$ ) and between shell thickness and yolk length ( $r = 0.22$ ). Similar relationships but negative also existed between egg length and yolk weight ( $r = -0.17$ ) shell thickness and egg length ( $r = -0.16$ ), shell thickness and egg content ( $r = -0.20$ ) and yolk height and egg

content ( $r = -0.22$ ). These observations of phenotypic correlation on the egg weight and other measurements were in support of Apuno *et al.* (2011) who reported similar range of values for local chickens and suggested that egg weight in local chickens could be predicted using these factors. Also, the present result was in line with findings of Udoh and John-jaja (2014) with conclusion that changes in the dependent trait is a correlated response to direct the selection of the principal trait.

#### CONCLUSION

Based on the present results, it can be concluded that Isa brown hens eggs was better than harco black ones in respect to egg length, egg content, shell weight and albumen length while the phenotypic correlation coefficient results can be used in selection criteria.

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