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INTERNAL AND EXTERNAL EGG QUALITY TRAITS OF ISA BROWN LAYER BIRDS RAISED IN SEMI-ARID REGION OF NIGERIA

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Abstract
This study was conducted to assess the internal and external egg quality traits in Isa Brown layer strain reared in semi-arid region of Nigeria. One hundred (100) eggs were randomly collected from Isa Brown layer birds. The birds were housed in battery cage system. The parameters measured on individual eggs included: egg weight (EWT), egg length (ELT), egg width (EWD), egg diameter (EDT), shell thickness (STK), shell weight (SWT), shell thickness (STK), shell weight (SWT), egg shell ratio (ESR), egg shape index (ESI), shell surface area (SSA), albumen weight (AWT), yolk weight (YWT), albumen ratio (ALR), yolk ratio (YKR) and yolk:albumen ratio (YAR). Data obtained were subjected to statistical analysis following the procedures of IBM SPSS statistical software (23.0.0). Results showed that the mean (±SE) of egg quality traits in Isa Brown layer birds were; EWT (58.36±0.50), ELT (54.34±0.23), EWD (40.47±0.14), STK (0.20±0.01), SWT (5.57±0.06), AWT (35.44±0.40), YWT (14.97±0.12), ESR (9.57±0.10), ALR (60.71±0.44), YKR (25.77±0.24), YAR (42.73±0.57), ESI (78.69±0.70) and SSA (59.62±0.38). The results of the correlations showed that EWT had positively high statistically significant relationship ($P<0.05$) with ELT ($r = 0.715$), EWD ($r = 0.758$), SWT ($r = 0.469$) and AWT ($r = 0.785$). The results of the correlation analysis revealed that improving ELT, EWD, SWT and AWT egg parameters might result in improvement in EWT, these traits could be selected during breeding to improve EWT of Isa Brown Layer Birds. The outcomes of the current study could be applied to predict EWT using egg quality traits.
Keywords: Egg weight, Egg quality, Isa brown, Phenotypic correlation

Introduction
The quality traits of an egg are parameters that affect its acceptability to the consumer (Duman *et al*., 2016). Evaluation of egg quality parameters is essential both for table eggs and for the production of hatching eggs. The egg size and internal quality of eggs are important for both table and hatching eggs (Alkan *et al*., 2013). Isa Brown is an efficient brown egg layer with high production and excellent persistency in various conditions.
There are studies on the relationship between egg weight and egg quality parameters (Olawumi and Ogunlade, 2008; Sarica *et al*., 2012). However, Ukwu *et al*. (2017) reported on the relationship between the internal and external egg traits in Guinea Savanna region, there is therefore need to investigate this same layer strain raised in the semi-arid region of Nigeria. Such information could be useful in a selection programme to improve the quality of chicken egg as table egg. This study, therefore, was designed to evaluate the internal and external egg quality parameters in Isa Brown layer birds raised in the semi-arid region of Nigeria.

Materials and Methods
Description of the study Location
This study was conducted at the Livestock Teaching and Research Farm of Department of Animal Science, Federal University Dutsin-Ma. The description of the experimental location was according to Rotimi *et al*. (2020).

Experimental animals and their management.
The study was conducted using Isa Brown layer hens. Birds were housed in a battery cage system. A total of one hundred (100) eggs were randomly selected and evaluated in this study. The hens were about 40 weeks of age. The birds were fed a diet containing 21% crude protein and 2.900 kcal/kg metabolic energy and provided with fresh water *ad libitum* during the laying period.

Data collection and Analysis
Data were collected on individual egg. All measurements and evaluations were done following the procedures as described by Alkan *et al*. (2013) and Ukwu *et al*. (2017). Data obtained from the study were subjected to one-way Analysis of Variance and phenotypic correlation procedures of IBM SPSS statistical software (version 23.0.0).

Results and Discussion
Table 1 shows the results of the descriptive statistics of external egg quality traits. The results showed that the mean egg weight (±SE) was 58.36 g (±0.50). The average egg weight obtained in this study was higher than the value range (34-36 g) obtained by Ukwu *et al*. (2017) on Isa Brown layer hens raised in the Guinea Savannah region of Nigeria, Alkan *et al*. (2013), who reported value of 0.14 g (±0.235) on guinea fowl layers. Nagarajan *et al*. (1991) asserted that the difference between the egg weights might be due to variations in factors such as; strain, stocking density, seasons, feeding systems and age of birds. In this study mean (±SE) ELT and EWD was found to be 54.34 (±0.23) and 40.47 (±0.14) mm, respectively. The egg length and width values in this study were higher than the values recorded by other authors; Alkan *et al*. (2013); Tebesi *et al*. (2012); Ukwu *et al*. (2017) and Singh *et al*. (2008). The mean (±SE) ESI obtained was 78.69 (±0.70). The value obtained from this study is higher than the values (72-76) for standard egg reported by Duman *et al*. (2016). Eggs in this study are round-shaped and unusually long eggs. This shape has poor appearances and do not fit well in egg cartons; therefore, they are much more likely to be broken during the transportation than the eggs of normal shape. The mean (±SE) egg shell weight in this study was 5.57 g (±0.06). The mean eggshell weight recorded in this study was lower than that reported by Hlokoe and Tyasi (2021) who recorded the value of 9.60±0.37 in Potchefstroom Koekoek chicken. The average egg shell surface area obtained from this study was 69.62(+0.38). This result is higher than the values reported by Alkan *et al*. (2013), Dudusola. (2010) and Nowaczewski *et al*. (2008). However, this value is lower than the value obtained by Duman *et al*. (2016).
Table 2 shows the results of the descriptive statistics of the internal egg quality traits in Isa Brown layers. The mean (±SE) AWT reported in this study was 35.44 g (±0.40). However, Hlokoe and Tyasi. (2021) reported lower value of 32.11±0.35 on Potchefstroom Koekoek Chicken Genotype. Average of 14.97 g (±0.12) was obtained for yolk weight in this study. This lower than the value of 17.48 g (±0.07) obtained by Hlokoe and Tyasi. (2021) on Potchefstroom Koekoek Chicken Genotype. However, this is higher than the value reported by Alkan *et al*. (2013).

Table 1: Descriptive statistics for egg weight and external egg quality traits of the Isa Brown layers

Parameters	N	Min.	Max.	Mean	Std. Error	Std. Deviation
Egg weight (g)	100	45.50	69.80	58.36	0.50	4.98
Egg length (mm)	100	48.00	59.00	54.34	0.23	2.33
Egg width (mm)	100	37.00	44.00	40.47	0.14	1.40
Shell thickness (mm)	100	0.11	0.48	0.20	0.01	0.05
Shell weight (g)	100	3.50	6.80	5.57	0.06	0.57
Egg Shell ratio (%)	100	6.58	11.70	9.57	0.10	0.98
Egg Shape index (%)	100	65.51	106.25	78.69	0.70	6.97
Shell surface area (cm^2)	100	49.49	68.24	59.62	0.38	3.82

Table 2: Descriptive statistics for internal egg quality traits of the Isa Brown laying hens

Parameters	N	Min.	Max.	Mean	Std. Error	Std. Dev
Albumen weight (g)	100	26.60	46.50	35.44	0.40	4.04
Yolk weight (g)	100	12.10	17.90	14.97	0.12	1.23
Albumen ratio (%)	100	50.16	78.24	60.71	0.44	4.45
Yolk ratio (%)	100	19.94	32.35	25.77	0.24	2.44
Yolk:Albumen ratio (%)	100	29.89	60.07	42.73	0.57	5.70

Table 3: Phenotypic correlation among measured egg quality traits.

	EWT	ELT	EWD	STK	SWT	AWT	YWT	ESR	ALR	YKR	YAR
ELT	0.715**	1									
EWD	0.758**	0.426**	1								
STK	0.097	0.081	0.072	1							
SWT	0.469**	0.229*	0.334**	0.002	1						
AWT	0.785**	0.565**	0.639**	0.111	0.360**	1					
YWT	0.352**	0.315**	0.429**	-0.100	0.135	0.131	1				
ESR	-0.376**	-0.384**	-0.303**	-0.089	0.639**	-0.308**	-0.165	1			
ALR	0.041	0.043	0.110	0.043	-0.008	0.648**	-0.212*	-0.052	1		
YKR	-0.590**	-0.370**	-0.304**	-0.174	-0.296**	-0.582**	0.542**	0.202*	-0.211*	1	
YAR	-0.452**	-0.292**	-0.269**	-0.157	-0.196	-0.768**	0.516**	0.192	-0.685**	0.853**	1
ESI	0.186	0.189	0.154	0.291**	0.124	0.224*	-0.073	-0.031	0.113	-0.228*	-0.229*
SSA	1.000**	0.716**	0.757**	0.097	0.468**	0.783**	0.354**	-0.378**	0.039	-0.589**	-0.450**

**Correlation is significant at the 0.01 level (2-tailed), *Correlation is significant at the 0.05 level (2-tailed). EWT = Egg weight, ELT = Egg lenght, EWD = Egg width, STK = Shell thickness, SWT = Shell weight, ESR = Egg Shell ratio, ESI = Egg Shape index, SSA = Shell surface area, AWT = Albumen weight, YWT = Yolk weight, ALR = Albumen ratio, YKR = Yolk ratio, YAR = Yolk:Albumen ratio.

Pearson's Correlations was employed to evaluate the relationship between egg weight and egg quality traits of Isa brown hens. The results indicated that EWT had a positively statistically significant correlation ($P<0.05$) with ELT, EWD, SWT, and AWT with the highest value recorded with AWT ($r=0.758$). The results is similar to the report on South-eastern Nigeria local chicken by Adeolu and OleforuhOkoleh, (2011), Isa Brown egg layer chickens in Makurdi by Ukwu *et al*. (2017) and indigenous Sakini chicken by Saroj *et al*. (2020). The results showed that by enhancing ELT, EWD, SWT and AWT might result in significant improvement of EWT. Therefore, ELT, EWD, SWT and AWT might be involved in the criteria for selection during breeding for improvement of EWT in Isa Brown layer hens.

Conclusion

The findings showed that that EWT had a positively statistically significant correlation ($P<0.05$) with ELT, EWD, SWT, and AWT of Isa Brown egg layer strain. Conclusively, these traits should be employed as selection criteria during breeding to improve egg weight of Isa Brown egg layer strain.

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