

Association between egg weight and internal quality parameters in two commercial layer strains

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Received 16th May 2025; Accepted 18th June 2025

ABSTRACT: Egg quality is crucial in poultry production, as it significantly impacts market value, hatchability, and profitability. Internal quality traits, such as albumen weight, yolk height, and Haugh unit, are commonly evaluated alongside egg weight. This study aimed to assess the relationship between egg weight and internal egg quality parameters in Harco Black and Isa Brown layer strains to inform strain-specific breeding and nutritional strategies. A total of 100 birds per strain were evaluated at weeks 6 and 7 of lay to minimise age-related variation. Internal egg traits measured included albumen weight and height, yolk weight, length, and height. One-way ANOVA was used to compare traits between strains, and Pearson correlation assessed relationships among variables. Significant strain differences ($p < 0.05$) were observed in egg weight and several internal traits. At week 6, Harco Black produced heavier eggs with higher albumen and yolk weights than Isa Brown. At week 7, Harco Black maintained superior yolk height and length. In Isa Brown at week 6, egg weight strongly correlated with albumen weight ($r = 0.90$) and yolk weight ($r = 0.74$). In Harco Black, albumen height correlated positively with albumen weight ($r = 0.63$). At week 7, strong correlations existed between egg weight and albumen weight ($r = 0.96$) in both strains. Additional significant associations were found between albumen height and weight, yolk height, and yolk length. Egg weight influences internal quality; strain-specific differences should therefore guide breeding programmes for quality improvement.

Keywords: Harco Black, Isa Brown, strain, egg quality traits, Pearson correlation.

INTRODUCTION

Egg quality traits are essential indices in industrial poultry egg enterprises (Jibir *et al.*, 2010). These traits directly influence market value, consumer preference, and production efficiency, especially in large-scale layer operations. In commercial flocks, egg quality is often defined in relation to consumer demands, including factors such as shell strength, egg weight, yolk size, and albumen consistency (Harwju *et al.*, 2024). Beyond consumer preference, egg quality also has biological and economic implications, as it affects the hatchability of fertile eggs and the subsequent growth and survivability of chicks (Ng'ambi, 2014). Consequently, the success and profitability of any commercial layer enterprise are largely dependent on the number and consistency of top-grade

eggs (Ojedapo *et al.*, 2009).

While environmental conditions such as nutrition, housing, and management practices have been shown to significantly influence egg quality traits, genetic factors, including breed and strain differences, also play a substantial role (Yasmeen *et al.*, 2008). Strain-specific variations in internal quality traits of eggs, including albumen height, yolk index, and Haugh unit, have been widely reported (Silversides, 2006). These internal parameters are known to be heritable and can therefore serve as selection criteria in breeding programs aimed at improving egg quality traits. Egg quality assessments are most reliable during the early laying period when the birds have reached peak production and their physiological

systems have stabilised. Evaluating traits at this stage minimises the influence of age-related decline in egg quality and provides a clearer picture of genetic differences between strains (Rizzi and Chiericato, 2005). Specifically, the 6th and 7th weeks of lay (approximately 26–27 weeks of age) represent a stable production phase when hens consistently lay eggs of commercial size and quality (Aygun and Yetisir, 2010).

Among the widely used commercial layer strains, Harco Black and Isa Brown are two prominent breeds valued for their laying performance and adaptability to varied environments. The Harco Black, a hardy and prolific dual-purpose breed, is known for its consistent laying ability, resilience, and relatively larger egg size (Fayeye *et al.*, 2017). It is commonly raised in smallholder and semi-commercial poultry systems due to its adaptability and robust nature. The Isa Brown, on the other hand, is a hybrid layer strain globally recognised for its high egg production, feed efficiency, and early maturity. It is preferred in many commercial operations due to its reliable performance under intensive management systems (ISA, 2025). Despite their popularity, information on their internal egg quality traits, particularly in tropical or semi-intensive production settings, remains limited.

Therefore, the current study was performed to analyse the egg weight and internal quality traits of Harco Black and Isa Brown commercial layer strains so as to provide evidence-based recommendations for strain selection and quality improvement in commercial egg production.

MATERIALS AND METHODS

Study location

This experiment was carried out in the poultry unit of the Teaching and Research Farm at Ladoke Akintola University of Technology, located in Ogbomoso, Oyo State, Nigeria. The site is situated in the derived savanna ecological zone, at approximately 8°05' North latitude and 4°05' East longitude. The elevation of the area ranges from 300 to 600 meters above sea level. The climate is characterised by an average annual temperature of 27°C and a mean annual rainfall of around 1247 mm (Ige *et al.*, 2014).

Experimental birds and management practices

The study involved 200 pullets at 14 weeks of age, with equal numbers (100 birds each) from two commercial layer breeds: Harco Black and Isa Brown. The birds were sourced from a reputable poultry breeder and housed separately in a single-tier, double-sided battery cage system. Standard poultry husbandry practices and strict biosecurity measures were maintained throughout the study. Routine health management included deworming at three-month intervals, vaccination against Newcastle disease, and periodic administration of antibiotics and

vitamins. From 14 to 20 weeks of age, birds were provided with a commercial grower feed containing 18% crude protein and 2864 kcal/kg of metabolizable energy (ME). At 20 weeks, the birds were transitioned to a layer mash diet consisting of 17% crude protein and 2892 kcal/kg ME. Clean water was supplied without restriction. No experimental treatments outside of standard care protocols were applied.

Data collection procedures

Egg samples were collected over five consecutive days each week, and 60 eggs were randomly selected from each strain for analysis. The traits measured included: Egg weight (g), albumen weight (g), albumen height (mm), yolk weight (g), yolk height (mm), yolk length (mm). These evaluations were performed during the 6th and 7th weeks of lay (corresponding to the 26th and 27th weeks of age). Each egg was weighed using a high-precision digital scale (Model: DT 5k, LARK®) with an accuracy of 0.001 g. Albumen weight was obtained by cracking the egg on a clean flat surface and separating the albumen from the yolk. Albumen height was recorded using a tripod micrometre, measured at a point between the inner and outer edges of the thick albumen, excluding the chalaza. Yolk weight was recorded using the same precision scale. Yolk height was also measured with the tripod micrometre, while yolk length was measured using a vernier calliper.

Statistical analysis

The collected data were analysed using one-way Analysis of Variance (ANOVA), applying the General Linear Model (GLM) procedure in SAS software (SAS Institute, 2003). The following model was used:

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

Where: Y_{ij} = Dependent variable; μ = Overall mean; B_i = Fixed effect of the i th strain ($i=1, 2$) on egg quality traits (egg weight, albumen weight, albumen height, yolk weight, yolk height and yolk length); and e_{ij} = Residual random effect of each observation.

Differences were considered statistically significant at $p < 0.05$. Pearson's correlation coefficients were used to evaluate the associations between egg weight and internal egg quality parameters within each strain.

RESULTS

Table 1 presents the mean values and standard errors for egg weight and internal egg quality traits across both weeks for the two layer strains. Significant ($p < 0.05$) differences were found in several egg quality traits between Harco Black and Isa Brown. In the 6th week of lay, Harco Black hens produced eggs with significantly

Table 1. Effect of strain on egg weight and internal egg quality traits of laying hens.

Traits	Week of Laying			
	Week 6		Week 7	
	Harco Black	Isa brown	Harco Black	Isa brown
Egg Weight	53.80±0.40 ^a	47.30±0.61 ^b	52.10±1.10	50.80±0.31
Albumen Weight	33.30±0.43 ^a	29.60±0.48 ^b	31.70±0.76	31.40±0.31
Albumen Height	5.54±0.17	6.24±0.10	5.42±0.08	5.94±0.14
Yolk weight	13.90±0.18 ^b	11.30±0.16 ^a	13.90±0.14 ^b	12.40±0.17 ^a
Yolk Height	14.30±0.18 ^a	11.10±0.21 ^b	14.80±0.17 ^a	11.20±0.13 ^b
Yolk Length	35.28±0.25	34.59±0.24	37.05±0.15 ^a	35.25±0.31 ^b

Means within a row that have distinct superscripts indicate a significant ($p < 0.05$) difference.

Table 2. Correlation among egg weight and internal egg quality traits in Isa Brown (above diagonal) and Harco Black (below diagonal) Chickens at week 6.

Traits	Egg weight	Albumen weight	Yolk weight	Albumen height	Yolk height	Yolk length
Egg weight	1.00	0.90 ^{**}	0.74 [*]	0.29	-0.14	0.42
Albumen weight	0.48	1.00	0.53	0.28	-0.41	0.14
Yolk weight	0.26	-0.07	1.00	0.47	0.37	0.75 [*]
Albumen height	0.35	0.63 [*]	-0.26	1.00	0.37	0.16
Yolk height	0.04	-0.42	0.07	0.06	1.00	0.61
Yolk length	-0.09	0.37	-0.14	0.16	-0.13	1.00

Significance levels: $p < 0.05$ (*) and $p < 0.01$ (**).

Table 3. Correlation among egg weight and internal egg quality traits in Isa Brown (above diagonal) and Harco Black (below diagonal) Chickens at week 7.

Traits	Egg weight	Albumen weight	Yolk weight	Albumen height	Yolk height	Yolk length
Egg weight	1.00	0.96 ^{**}	-0.11	0.51	0.24	-0.17
Albumen weight	0.96 ^{**}	1.00	-0.23	0.38	0.28	-0.12
Yolk weight	0.46	0.42	1.00	-0.36	0.49	0.43
Albumen height	0.80 ^{**}	0.88 ^{**}	0.42	1.00	-0.21	-0.13
Yolk height	0.54	0.63 [*]	0.60	0.53	1.00	0.67 [*]
Yolk length	0.33	0.25	0.20	0.15	0.11	1.00

Significance levels: $p < 0.05$ (*) and $p < 0.01$ (**).

greater weight (53.80 ± 0.40 g), albumen weight (33.30 ± 0.43 g), yolk weight (13.90 ± 0.18 g), and yolk height (14.30 ± 0.18 mm) compared to Isa Brown, which had lower values for egg weight (47.30 ± 0.61 g), albumen weight (29.60 ± 0.48 g), yolk weight (11.30 ± 0.16 g), and yolk height (11.10 ± 0.21 mm). However, albumen height and yolk length did not differ significantly ($p > 0.05$) between the strains at this stage. In the 7th week, the Harco strain continued to exhibit superior internal egg quality. It recorded significantly ($p < 0.05$) higher yolk length (14.80 ± 0.17 mm) and yolk height (37.05 ± 0.15 mm), while the Isa brown strain showed lower values for the same parameters—yolk length (35.25 ± 0.31 mm) and yolk height (11.20 ± 0.13 mm).

The correlation coefficients (r) indicating the relation-

ships between egg weight and internal egg quality parameters for weeks 6 and 7 are shown in Tables 2 and 3, respectively. During the 6th week, a strong and statistically significant positive correlation was observed between egg weight and albumen weight ($r = 0.90$, $p < 0.01$), as well as between egg weight and yolk weight ($r = 0.74$, $p < 0.05$) in the Isa Brown strain. Additionally, yolk weight was significantly associated with yolk length ($r = 0.75$, $p < 0.05$). Other measured traits in this strain exhibited either weak or non-significant correlations. In the Harco Black strain, a significant moderate positive correlation was found between albumen height and albumen weight ($r = 0.63$, $p < 0.05$) during the same week. By week 7, the Isa Brown strain continued to show a very strong positive relationship between egg weight and

albumen weight ($r = 0.96$, $p < 0.01$). Similarly, in the Harco Black strain, egg weight was also very strongly correlated with albumen weight ($r = 0.96$, $p < 0.01$) and had a strong positive correlation with albumen height ($r = 0.80$, $p < 0.01$). Albumen weight was likewise strongly related to albumen height ($r = 0.88$, $p < 0.01$) and yolk height ($r = 0.63$, $p < 0.05$). A moderate but significant positive correlation was also observed between yolk height and yolk length ($r = 0.67$, $p < 0.05$).

DISCUSSION

Recognising the genetic and phenotypic differences in egg quality traits among commercial layer strains is essential for improving egg production efficiency and meeting consumer demands. This study aimed to analyse key internal egg quality parameters between Harco and Isa Brown strains during early lay, with a view to identifying strain-specific advantages that can inform breeding and selection decisions. This study identified statistically significant ($p < 0.05$) variations in egg weight and multiple internal egg quality parameters between the Harco Black and Isa Brown layer breeds, particularly during the 6th and 7th weeks of lay. The Harco Black strain consistently outperformed Isa Brown in key traits such as egg weight, albumen and yolk weights, yolk height, and yolk length. These outcomes align with findings by Fayeye *et al.* (2017), who observed that Harco layers produced heavier eggs with superior internal qualities compared to other commercial hybrids in Nigeria. Similarly, Ojedapo *et al.* (2009) reported that dual-purpose breeds like Harco tend to exhibit enhanced yolk and albumen attributes, likely due to their larger body frame and better genetic potential for nutrient allocation to egg development.

The higher egg weight recorded for Harco across both weeks supports earlier studies by Silversides and Scott (2001), which demonstrated that egg size and internal composition vary significantly among genetic lines. Moreover, the consistent advantage of the Harco strain in traits such as yolk weight and height agrees with the findings of Narushin and Romanov (2002), who reported that larger eggs tend to contain proportionally larger yolks and thicker albumen, contributing to higher quality classifications. However, the absence of significant differences in albumen height and yolk length during week 6 contrasts with reports by Roberts (2004), who highlighted albumen height as a sensitive indicator of both egg freshness and genetic potential. This discrepancy might be attributed to the narrow window of egg collection (weeks 6 and 7), or the possibility that uniform environmental and nutritional conditions reduced trait variability.

The strong positive associations between egg weight and internal components such as albumen weight ($r = 0.90$, $p < 0.01$) and yolk weight ($r = 0.74$, $p < 0.05$) in Isa Brown, and albumen weight ($r = 0.96$, $p < 0.01$) in Harco black are consistent with findings from Aygun and Yetisir

(2010), who noted similar relationships across different layer strains. These associations affirm that egg weight is a reliable indicator of internal egg quality and can be useful in both genetic studies and commercial egg evaluation. Furthermore, the observed correlations between egg weight and dimensional traits like albumen height (ranging from 0.63 to 0.88) support the conclusions of Rath *et al.* (2015), who emphasised the value of such physical traits in assessing both egg quality and breed performance.

Taken together, these results emphasise the influence of genetic background on internal egg characteristics and highlight the importance of selecting appropriate strains to improve egg quality in both intensive and semi-intensive production systems. The enhanced internal quality traits found in the Harco strain suggest its suitability for markets that value larger eggs and higher yolk content.

Conclusion

This study confirmed that egg weight plays a significant role in determining internal egg quality characteristics. It also demonstrated that the relationship between egg weight and internal quality traits varies by strain. Consequently, breeding and selection programs aiming to enhance internal egg quality should prioritise strain-specific traits to achieve optimal results.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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