Acta Scientiarum
http://periodicos.uem.br/ojs
ISSN on-line: 1807-8672
Doi: 10.4025/actascianimsci.v46i1.68751

ANIMAL PRODUCTION

Egg Quality Traits of Nigerian Indigenous Chickens Reared Under Scavenging and Improved Feeding Condition in Relation to Exotic Chickens Eggs

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ABSTRACT. This study was aimed at assessing the egg quality traits of Nigerian indigenous chickens raised under scavenging and improved feeding conditions in relation to exotic chicken's eggs. The study was conducted in Sam Tee farm Nukai Jalingo, Nigeria. The indigenous breed pullets were sourced from villages in Ardo Kola, Lau and Zing L.G.A. The birds were grouped into three treatments Viz: indigenous breed under improved feeding and scavenging conditions and the exotic breed. The indigenous breed pullets under improved feeding condition were placed on grower's diet and gradually replaced with a commercially prepared layers' mash. A total of 336 eggs from the three groups were examined. Eggs weight, length, width, shell thickness and yolk width were measured. Shell ratio, surface area and Haugh unit were calculated. Data were analyzed using ANOVA and correlation analysis. There were significant variations in egg weight, egg length and shell thickness between the indigenous and the exotic breed. The indigenous breed reared under improved feeding condition had the longest egg, largest surface area, thicker and heavier shell. Egg weight and surface area have significant positive correlations. In conclusion, Indigenous chickens' performance on some egg quality traits can be enhanced with judicious feeding and management.

Keywords: assessment; egg traits; indigenous; exotic; chicken.

Received on July 11, 2023.
Accepted on January 31, 2024.

Introduction

Eggs remain one of the most readily available and affordable animal protein sources. This has led to rapid increased in number and size of laying flocks in developing countries (Bain, Nys, and Dunn, 2016). Both high-performing commercial layer or broiler genotypes and lower-performing indigenous dual-purpose breeds are used in these developing countries' respective poultry industries. The proportions of these two groups vary considerably between countries. The indigenous breeds constitute almost 90 percent of the poultry population (Hinsemu, Hagos, Tamiru, & Kebede, 2018). The exotic/commercial strain (layers) are derived from imported parent stock and are capable of laying more than 300 eggs per year, as opposed to the 40 to 60 eggs laid by indigenous hens. (Behura & Samal, 2022). The most important difference between the two genotypes is the quantity and quality of feed supplied. The feed intake of indigenous scavenging flocks is primarily determined by the limited availability of scavenging feed resources during the dry season (Hinsemu et al., 2018; Al-Obaidi, Mahmood, Alnoori, Alnori, & Saeed, 2022). Egg number and quality are the determinant of the economic value of a laying flock (Bobbo, Baba, & Yahaya, 2013). Both genetic and environmental variables influence the quality of an egg. The optimal management of laying hens contributes to the enhancement of egg quality (Melesse, Worku, & Teklegiorgis, 2013). Egg qualities traits such as albumen thickness indicate freshness while egg protein is good for human nourishment and shell thickness help in reducing egg shell breakages (Kejela, Banerjee, & Taye, 2019). The evaluation of both exterior and interior egg quality characteristics is crucial for both the welfare of consumers and newly hatched chicks. However, little is known about the egg quality characteristics of the Nigerian indigenous breeds under improved feeding and scavenging conditions. This study aimed to assess the external and internal egg quality traits of Nigerian indigenous chickens raised under (scavenging and improved) feeding conditions in relation to exotic chickens (Isa brown) eggs.

Material and methods

The study was done at Sam Tee farm Nukai in Jalingo Local Government Area. The Jalingo Local Government Area located between Longitude 8089N and Latitude 11036E. The weather fits the two seasons (dry and wet) that are common in tropical areas.

Experimental design

The indigenous breed pullets were source from villages in Ardo Kola, Lau and Zing Local Governments Areas Taraba State Nigeria. The indigenous pullets have the following morphologically traits brown mottled plumage color and orange eye color. While the commercial pullets (Isa brown) were source from CHI hatchery and managed intensively with standard protocol for layers' management. The birds were grouped into three treatments group Viz: indigenous breed under improved feeding condition, indigenous chickens under scavenging condition and the exotic breed. The indigenous chickens were given oral broad-spectrum antibiotics, dewormed, and ectoparasite treatment. All the pullets under improved feeding condition were placed on grower's diet. The grower feed has a crude protein content of 15% and a Metabolizable Energy (ME) content of 2550 kcal kg^{-1}. Gradually, grower feed was replaced with a commercially prepared layer's mash. The birds were given water on demand and a layer mash diet that contained 17.0% crude proteins and 2650 kcal kg^{-1} ME. Those under scavenging condition are allowed to move freely in the surrounding environment to scavenged for their feed and provided with water fountain in their pens and around the farm. Wooden nesting boxes are provided for the chickens. On a daily basis, eggs were collected. For the three treatments groups a total of 336 eggs were collected and analyzed.

Egg collection

Eggs from both indigenous and exotic hens were collected daily. The weights of each egg were recorded to the nearest gram utilizing a digital weighing scale (HCK600A).

Egg quality measurement

Egg length and width measurement

Every egg laid by both indigenous and exotic hens were measured for length and width to the nearest 0.01 mm with a digital Vernier caliper. Distances along the longitudinal axis of the egg and the equatorial axis of the egg were measured in accordance with (Anderson, Tharrington, Curtis, & Jones, 2004). The egg shape index was determined by the percentage of egg width to egg length (Anderson et al., 2004).

Egg shape index (%) = $\frac{Egg\ width\ (mm)}{Egg\ length (mm)} \times 100.$

Shell weight

The shell of each egg was washed free of all remaining albumen and then air dry for 24 hours after which the shell was individually weigh to the nearest gram to obtain the shell weight. Shell percentages were calculated according to the following expression:

Egg shell percentage (%) = $\frac{egg\ shell\ weight\ (g)}{egg\ weight (g)} \times 100.$

Shell thickness measurement

Shell thickness were measure with a micrometer screw gauge to the nearest millimeter at the narrow, broad and equatorial with the average value of these three points to be recorded as the thickness according to (Melesse et al., 2013). Shell membrane thickness were obtained by measuring shell thickness, after which the shells were moistened and the membrane were carefully removed and the thickness measured again. Shell membrane thickness was the difference between the shell thickness with and without membrane.

Measurement of egg yolk and albumen

Each egg was cracked open on a smooth glass surface, and its albumen and yolk were measured for depth, length, and width to the nearest millimeter using a digital Vernier caliper. The weight of the yolk was determined by weighing it to the nearest gram after it had been separated from the albumen, as described by (Ayalew, 2022). Yolk percentage (%) were calculated using the following:

Yolk percentage (%) = $\frac{Yolk\ weight\ (g)}{egg\ weight(g)} \times 100.$

Albumen weight was calculated by taking the total egg weight and subtracting the relative amounts of the egg's yolk and shell. The albumen proportion was determined using the following formula:

Albumen percentage (%) = $\frac{Albumen\ weight\ (g)}{egg\ weight(g)} \times 100.$

Albumin height was transformed into Haugh Units to account for variations in egg mass. The egg's HUs were calculated using the following formula (Alig, Malheiros, & Anderson, 2023):

HU = 100 log $(H- 1.7W^{0.37} + 7.57)$,

where:

HU = Haugh unit;

H = height of the albumen (mm);

W = weight of the egg (g).

Statistical analysis

The data collected were analyzed using analysis of variance (ANOVA) to determine the existence and magnitude of statistically significant differences between evaluated variables. Tukey's test was used in testing significant differences between means groups. Egg shape index and surface area are correlated with internal and external quality characteristics. Statistical Analysis System software package version 9.4 (SAS Institute, 1997) used for these functions.

Results and discussion

Productive and external egg quality characteristics

Egg weight

Egg quality is heritable, and the factors that determine it differ across chicken breeds (Sinha, Mandal, Kumari, & Kumari, 2018). Significant ($P<0.05$) variations in egg weight between indigenous chickens raised under intensive and extensive management systems and exotic breed. Highest egg weight was found in exotic breed (47.97 g) than indigenous breed reared under improved feeding condition (intensive system) (42.33 g) and indigenous chicken reared under scavenging condition (extensive system) (40.33 g) Table 1. Similar to the current study, (Bobbo *et al.,* 2013) found that the average egg weight for Nigerian local frizzle x frizzle and frizzle x naked neck crossed chickens reared under intensive management was 45.04 g and 41.90 g, respectively. Faruque, Bhuiyan, Ali, and Joy (2017) also reported an average egg weight of (42.15 g) in indigenous Bangladesh chickens. There was a significant of almost 2g increased in egg weight with improvement in the feeding condition of the indigenous breed in the present study. Similarly, Desbruslais, Wealleans, Gonzalez-Sanchez, and di Benedetto (2021) reported that an increase of 1 g of protein in a hen's daily diet could lead to an increase of 1.4 g in the average egg weight. Table 2 shows that the egg shape index was significantly related to egg weight ($p < 0.05$). This indicates that egg weight is determined by it width area which was occupied by the denser portion of the egg (albumen). These findings were consistent with those of (Aygun & Yetişir, 2010; Sani et al., 2021; Tunsisa & Reda, 2023). However, Duman, Sekeroglu, Yıldırım, Eleroğlu, and Camcı (2016), reported a strong negative relationship between egg weight and the egg shape index.

Egg length

In terms of egg length, the two groups did not differ significantly ($p > 0.05$) indigenous chickens reared under intensive and extensive management system with that of exotic breed of chickens. High egg length was found in indigenous chickens reared under improved feeding condition (53.20 mm) than exotic breed (51.20 mm) and indigenous reared under scavenging feeding condition (50.75 mm) Table 1. Findings from the present study are within the range of (50-52 mm) as previously reported by Kejela et al. (2019) in Ethiopian local chickens. Similarly, (Bobbo et al., 2013) reported a range of (48.5 – 58.8 mm) egg length of Nigerian Local Frizzle x Frizzle, naked neck x naked neck, smooth x smooth, naked neck x naked neck, naked neck frizzle, naked neck x smooth, smooth x smooth, smooth x naked neck, and smooth x frizzle chickens. However, Ayalew, (2022), reported an average egg length of 56.4 mm in Rhode Island Red chickens. While (Sapkota, Kolakshyapati, Devkota, Gorkhali, & Bhattarai, 2020) reported 53.76 mm in indigenous Sakini chicken breed of Nepal. These differences may be as a result of the influence of both genetic and non-genetic factor as they affect egg length.

Table 1. Means ±standard error of productive and external egg quality traits for indigenous and exotic breeds of chickens.

Genotype	Egg weight (g)	Egg length (mm)	Egg width (mm)	Dry Shell weight (g)	Shell thickness (mm)	Shell ratio (%)	Shape index (%)	Surface area (cm^2)
Exotic breed	47.97±0.35^a	51.20±0.17^a	41.64±0.15^a	4.169±0.05^b	0.238±0.002^b	8.890±0.087^c	81.49±0.39^a	55.89±0.31^b
Indigenous breed (RIFC)	42.33±0.17^b	53.20±1.81^a	39.36±0.21^b	4.380±0.03^a	0.578±0.27^a	10.35±0.069^b	76.32±0.33^b	61.00±0.30^a
Indigenous breed (RSFC)	40.33±0.52^c	50.75±0.42^a	38.95±0.62^b	3.85±0.09^c	0.204±0.015^a	11.81±0.483^a	77.34±1.61^b	53.94±0.48^c

Means for a particular trait that do not share a common superscript are significantly different (p < 0.05). RIFC =Reared under Improved feeding condition, RSFC = Reared under Scavenging feeding condition.

Table 2. Indicators of egg quality in relation to index of egg shape and egg surface area

Parameters	Egg weight	Egg length	Egg width	Shell thickness	Shape index	Surface area	HU	Yolk Index	Shell ratio
Shape index	0.26**	-0.30**	0.77**	0.25**	1.00	0.28**	0.12*	-0.05	-0.18**
Surface area	0.99**	0.38**	0.52**	0.01	0.28**	1.00	0.30*	0.20**	-0.05

Width of egg

The width of an egg is also referred as the breadth or the short border (Meshcheryagina *et al.,* 2020). The egg width also significantly (P< 0.05) differed between breeds, with the exotic breed exhibiting the greatest variation (41.64 mm) as compared to the indigenous strain reared under improved feeding condition (39.36 mm) and that of indigenous breed reared under scavenging feeding condition (38.95 mm) Table 1. This is consistent with report of Bobbo *et al.* (2013), (36.9-39.5 mm) egg width of Nigerian Local Frizzle x Frizzle, naked neck x naked neck, smooth x smooth, naked neck x naked neck, naked neck frizzle, naked neck x smooth, smooth x smooth, smooth x naked neck, and smooth x frizzle chickens. Similarly, (Sapkota, Kolachhapati, Devkota, Gorkhali, & Bhattarai, 2017) also reported a range of (38.5-39.6 mm) egg width of local chickens in Nepal. The value of (41.64 mm) obtained from the exotic chicken breed in this study is consistent with previous findings of Ayalew,(2022) who reported (42.1 mm) egg width in Rhode Island Red chicken. Larger eggs were produced by commercial chickens compared to indigenous chickens, and this difference is likely due to genetic effects (Yusuf and Popoola, 2022).

Dry shell weight

Significant differences in egg shell weight (P< 0.05) were found between strains Table 1. Higher average was observed in indigenous breed reared under improved feeding condition (4.38 g) while indigenous chicken reared under scavenging condition recorded the least shell weight (3.85 g). This is consistent with (Kejela et al., 2019) who reported (3.93 g) dry shell weight for Ethiopian indigenous breed of chickens. Similarly, (Sapkota et al., 2017) also reported a range of (3.85-4.56 g) shell weight from indigenous chicken in Nepal. Calcium availability in the diet and calcium and phosphorus bioavailability may account for the observed difference in shell weight between indigenous chicken reared under improved feeding and scavenging conditions (Osei-Amponsah, Kayang, Manu, & Naazie, 2014).

Shell thickness

As a bio-economically significant trait, egg shell thickness plays an important role in commercial egg production, potentially lowering the number of cracked eggs (Ayalew, 2022). Shell thickness significantly (P < 0.05) differed between the indigenous breed reared under improved feeding condition (0.59 mm) Table 1. Similar finding was also reported by Sapkota et al. (2017) also reported a range of (0.35 -0.59 mm) shell thickness in local Nepal chickens. A typical shell thickness of (0.24 mm) was obtained from the exotic breed in the present study Table 1. However, Ayalew, (2022), reported that Rhode Island Reds have an average shell thickness of 0.38 mm. The trait also has commercial significance because eggs with thick and sturdy shells are the most desirable (Kejela et al., 2019). The trait is moderately heritable because it is affected by the bird's genotype in addition to its age-related changes in bioavailability of calcium and phosphorus and their metabolism (Melesse et al., 2013; Osei-Amponsah et al., 2014).

There is a statistically significant positive relationship between egg shape index and shell thickness, as shown in Table 2. This suggests that shell thickness is affected by shape index. These results reflect those of Aygun and Yetişir (2010) who proposed that there was a statistically significant positive correlation between egg shape index and shell thickness. However, (Tunsisa and Reda, 2023) stated that the shell thickness was not affected by egg shape, shell thickness and egg shape index were not statistically correlated.

Shell ratio

Differences in egg shell ratio between exotic and indigenous breeds, as well as between indigenous breeds, were statistically significant ($p < 0.05$) in the current study Table 1. The indigenous breed reared under scavenging feeding condition has a shell ratio of (11.81%) as compare to (10.35%) in the indigenous breed reared under improved feeding condition. While the exotic breed has a shell ratio of (8.89%). Similar to the results of the present study, Osei-Amponsah et al. (2014) reported a significant different in shell ratio between Ghanaian local and exotic strain of chickens. The indigenous chickens that are found in the Forest and Savannah regions have a shell ratio of 11%. While SASSO T44 a (a strain of the Label Rouge from France) has a shell ratio of (10%). In comparison to results found in other white leghorn strains, the ratio of shell to body weight was higher at (11.81%) (Sheoran et al., 2018). The importance of non-additive gene action and maternal effect was demonstrated by the observation that the heritability of shell ratio was higher when estimated from the 'dam' component of variance than from the 'sire' component (Rath Mishra, Mallick, & Behura, 2015).

Shape index

A sharp egg has a shape index (SI) of less than 72, while a normal egg has a SI of 72 to 76, and a round egg has a SI of 76 or more. The shape index was significantly different ($P<0.05$) between indigenous chickens reared under improved feeding and scavenging conditions with that of the exotic breed of chickens in the present study Table 1. Based on the classification above, the eggs from both the exotic and the indigenous breeds under improved and scavenging feeding conditions are round in shape with a shape index of (81.41%), (77.34%) and (76.32%) respectively. However, Ayalew, (2022) reported a non- significant differences Oravka and Rhode Island Red of Slovak Republic in egg shape index. Bobbo *et al*. (2013) reported a range of (74.18 - 77.61%) in frizzle naked neck and smooth Nigerian local chickens. The present study's shape index (81.49%) was higher than the reported range of 72-76 by (Altuntaş and Şekeroğlu, 2008) and lower than the report of Cüneydioğlu *et al*. (2022). Profitability and marketability improve with a higher egg shape index. Because they don't easily fit in containers, long eggs are more likely to break during packaging and transportation, while short, round eggs don't have the best aesthetics. The eggs should be long and square for the best aesthetic result (Yusuf and Popoola, 2022).

Egg surface area

Permeability of the avian egg shell to heat, metabolic gases, and water vapor can be measured in large part by determining the total surface area of these substances must be exchanged through the egg as the embryo develops. The total surface area of eggs varies significantly ($P< 0.05$) between the three groups, as shown in Table 1. The indigenous breed of chicken reared under improved feeding condition recorded the highest surface area. However, the indigenous breed reared under scavenging condition recorded the least surface area Table 1. Sapkota *et al*. (2017) also reported a surface area range of (68.75 - 73.06%) of Nepali local chickens from three different ecological zones.

There was a highly significant positive relationship ($P< 0.01$) between egg shape index and area of egg surface as shown in Table 2. In this case, the eggs could be ranked according to egg surface area as follows: round, standard, and sharp. This outcome is contrary to that of (Tunsisa and Reda, 2023) stated that the influence of egg shape on surface area was not statistically significant. Conversely, Aktan, (2004) reported a negative correlation that was not statistically significant between egg surface area and shape index.

Internal egg quality trait for indigenous and exotic breed of chickens

Albumen heights

Albumen quality is one of the egg trait of economic importance as consumers prefer an albumen in a broken-out egg be reasonably thick, the relative importance of this trait varies from one market to another (Winkler Hasenbeck, Murphy, & Hermes, 2017). Albumen levels were significantly ($P< 0.05$) difference between the exotic breed and the indigenous breed Table 3. However, no significant difference within the indigenous breed in terms of albumen height in the present. The exotic breed has the highest albumen height of (5.67 mm) while the least albumen height of (4.03 mm) was recorded in the eggs of indigenous breed reared under scavenging feeding condition. As in the present study, Kejela et al. (2019) reported an albumen height ranges of 5.2 - 5.7 mm in Ethiopian local chickens from two different regions and an average of 8.9 - 7.5 mm in two exotic strains of (Sasso and Bovans brown). The results were similar with the findings of Alewi et al.

(2012) and Mube et al. (2014) in Kei chickens from the Guraghe zone as 5.79 mm, while those from Cameroon are the smallest at 5.74 mm. However, the fresh egg length of native chickens raised in Ethiopia's Jimma and Amhara regions were reported to be 2.87 and 4.51 mm, respectively (Melesse et al., 2013). Several non-genetic factors, including egg freshness, contribute to the observed variation in albumin height (Hailemariam *et al*., 2022).

Table 3. Means ±standard error of internal egg quality traits for indigenous and exotic breeds of chickens.

Genotype	Albumen length (mm)	Albumen width (mm)	Albumen height (mm)	Yolk weight (g)	Yolk length (mm)	Yolk width (mm)	Yolk deep (mm)	Yolk index	Haugh unit (%)
Exotic breed	67.05±0.48^{c}	60.04±3.01^{a}	5.67±0.04^{a}	12.12±0.09^{c}	35.09±0.13^{c}	33.68±0.27^{b}	15.22±0.08^{a}	45.53±0.33^{a}	78.53±0.31^{a}
Indigenous breed (RIFC)	74.15±0.60^{a}	60.88±0.40^{a}	4.58±0.18^{b}	14.56±0.11^{a}	39.17±0.15^{b}	37.22±0.14^{a}	15.18±0.09^{a}	40.80±0.44^{b}	70.90±0.42^{b}
Indigenous breed (RSFC)	70.28±0.95^{b}	55.77±0.86^{a}	4.03±0.34^{b}	14.24±0.25^{a}	40.61±0.54^{a}	37.88±0.45^{a}	13.70±0.20^{b}	37.11±0.77^{c}	65.71±1.47^{c}

Means for a particular trait that do not share a common superscript are significantly different (p < 0.05). RIFC = Reared under Improved feeding condition, RSFC = Reared under Scavenging feeding condition.

Albumen length

Albumen length varied among breeds, with higher (P< 0.05) values recorded for indigenous chickens raised under improved feeding conditions, whereas the exotic breed had the shortest albumen length (Table 3).

Albumen width

There is no statistically significant difference (P> 0.05) in albumen width among the three groups (Table 3). The Albumen width of indigenous chicken under improved feeding condition, indigenous chicken reared under scavenging conditions and exotic breeds were 60.88, 55.77 and 60.04 mm, respectively. However, Ayalew, (2022) reported an albumen width of (79.8 mm) in the Slovak varieties of Oravka and Rhode Island Red.

Yolk weight

The egg yolk weight significantly differed (P< 0.05) between commercial and the indigenous breed of chickens reared under improved and scavenging feeding conditions in the present study Table 3. Yolk weight of (14.56, 14.24 and 12.12 g) were obtained from indigenous breed reared under improved and scavenging feeding conditions and the exotic breed respectively. Similarly, Bekele, Kebede, and Ameha (2016) reported a yolk weight of (15.0 g) in Ethiopian local chickens raised under intensive management. Kassa Tadesse, Esatu, and Dessie (2021) also reported a yolk weight of (14.54 g) in Fayoumi chicken breed under backyard management. However, Osei-Amponsah et al. (2014) reported a yolk weight of (15.67 g) and (17.18 g) for local and exotic strain of chickens in Ghana. Direct effects of estrogen and progesterone in addition to liver stimulating produce yolk components and increasing intestinal calcium absorption. This may be responsible for the observed variations in yolk weight (Bain *et al*., 2016). Egg yolk comprises slightly more than 30% of the total egg weight (Sapkota et al., 2017).

Yolk length

Table 3 shows that there was also a significant difference in yolk length between the different breeds of chickens. The indigenous chickens raised in a scavenging environment had the longest yolks (P < 0.05), while the exotic breed had the shortest.

Yolk width

Yolk width also differs significantly (P< 0.05) between commercial and indigenous breeds Table 3. However, no significant variation between the two groups of the indigenous breed. Although both the two has the highest yolk width than the exotic breed. The highest yolk width was found in indigenous breed reared under scavenging feeding condition (37.88 mm) than indigenous breed reared under improved feeding condition (37.22 mm) and the exotic breed (33.68 mm) Table 3. In agreement with the present study Bobbo et al. (2013) reported a yolk width of (38.4 mm) in smooth bodied local chickens in Nigeria. The current study's findings are higher than those reported by Melesse et al. (2013) for locally bred Kei chicken (36.3 mm) in the Guraghe zone of Ethiopia.

Yolk deep

Yolk depth differed significantly (P< 0.05) between commercial and indigenous breeds of chickens reared under improved and scavenging feeding conditions Table 3. Egg from the exotic chickens had the highest average yolk deep of (15.22 mm) while those from the indigenous breed reared under scavenging condition recorded the least average yolk deep (13.70 mm). The results of this study fall within a range of values (17.2, 14.9 and 13.5 mm) as reported by Markos, Belay, and Astatkie (2017) for native hens of western Ethiopia's Tigray region, which includes both mountainous and lowland regions. Similarly, Ayalew, (2022) reported a yolk deep of (17.63 mm) in Oravka and (16.97 mm) in Rhode Island Red of Slovak Republic.

Yolk index

The yolk index did not differ significantly (P> 0.05) between the exotic and indigenous breed reared under improved feeding condition Table 3. However, the indigenous breed reared under scavenging condition differ significantly (P< 0.05) with both the exotic and indigenous reared under improved feeding condition. The indigenous reared under scavenging condition recorded the least percent yolk index. Ayalew, (2022) reported a yolk deep Yolk height of (42.14%) in Oravka and (40.31%) in Rhode Island Red of Slovak Republic.

Table 2 shows a marginally significant negative correlation between the egg shape index and the yolk index (P > 0.05). The surface area of the egg correlates positively with the yolk index, as shown in Table 2. These results are similar to those of Tunsisa and Reda, (2023) who also discovered that there was no link between the shape of the egg and the index of the yolk.

Haugh unit

Haugh unit is the standard of measuring albumen quality. It also seems to pertain more to the appearance of a fresh egg than as a reference to its nutritional composition (Stadelman, 2017). The haugh unit was found to be significantly (P< 0.05) smaller in the indigenous breed reared under both improved feeding and scavenging conditions Table 3. The present study reported a Haugh unit of (78.53, 70.90 and 65.71%) for exotic and indigenous breed under improved and scavenging feeding conditions respectively. Ayalew, (2022) reported a Haugh unit of (71.46%) in Oravka and (74.45%) in Rhode Island Red of Slovak. However, Kejela et al. (2019) who reported a HU of (83.3%) in brown Bovans chicken eggs reared under the urban system in Addis Ababa.

Table 2 showed that egg surface area positively correlate (P< 0.05) with egg shape index with Haugh unit. This is in agreement with Tunsisa and Reda, (2023) who also report a positive correlation between shape index and Haugh unit. The Haugh unit also rose significantly (P< 0.01) as the egg morphed from a pointed to a round shape. The results obtained are consistent with the finding of Aygun and Yetişir, (2010).

Conclusion

There was significant almost 2 g increment in egg weight of the indigenous chicken reared under improved feeding condition. Indigenous chickens under improved management have favorable exterior egg quality traits. They have characteristically thicker and heavier dry shell compare to the other groups. The indigenous breed has a shape index range of (76.3 -77.3%) indicating round shape eggs as in the exotic breed. In general, this study showed that indigenous chickens reared under improved feeding condition have the potential of producing high quality eggs for human consumption. Breeders should include egg shape index in future breeding programs for egg quality characteristics.

Acknowledgments

The authors express their appreciation to the faculty members who worked in the Department of Animal Production in the College of Agriculture at the University of Anbar for their guidance and assistance with the research. The staff at the Al-Hayat laboratory, especially Mr. Ahmed K. Al-Salmani, have been very helpful.

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