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The Impact of Layer Strains Genotype on Egg Quality and Eggshell Ultrastructural

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Abstract

THE objective of this research was to investigate the influence of chicken genotype on various eggshell traits, egg quality, and ultrastructure during the egg production phase. Five established chicken strains, Fayoumi black, Fayoumi red, Fayoumi white, naked neck (Na) white, and Na red, as compared with commercial layer brown chickens were examined in this study. A total of 60 eggs from each genotype were used to determine egg quality and eggshell ultrastructural. The results of this study indicated that the genotype had a significant impact on various parameters including egg weight, egg length, egg width, shape index, albumen height, albumen weight, albumen percentage, yolk height, yolk diameter, yolk index, yolk weight, yolk percentage, yolk albumen ratio, wet shell weight, dry shell weight, and shell percentage. Specifically, the naked neck strain eggshell exhibited distinct ultrastructure defects such as late fusion, poor confluence, and different striations compared to the Fayoumi strain and commercial eggshell. On the other hand, the Fayoumi eggshell showed favorable ultrastructure features like early fusion and cuffing compared to the Na strain eggshell. These findings suggest that genetic differences among layer strains can significantly impact egg quality. Therefore, it is important to consider genotype when evaluating eggshell traits, egg quality, and ultrastructure. By understanding these genetic variances, improvements can be made to the overall performance and quality of eggs in egg production systems.

Keywords: Albumen yolk, Eggshell traits, Egg quality, Layer genotype, Shape index, Ultrastructure.

Introduction

In Egypt, local chicken is regarded as a significant and affordable source of meat and eggs [1]. Egyptian local chicken strains were created by crossing between a native and a foreign strain, and on some crossings, different features were selected for several generations [2-4]. Local chicken strains adapted to Egyptian conditions showed greater disease resistance [5].

Egg quality is a major factor in consumer demand and economic return for poultry egg producers. Akintunde and Toye [6] have found that the quality of eggs is genetically determined and can vary between different strains of hens. Egg quality includes various external and internal traits such as egg weight, length, width, shell weight, shell thickness, albumen weight, height, Haugh unit, and yolk weight. External qualities, such as shell weight and thickness, play a considerable role in the quality of eggs and the reproductive of chickens [7,8]. Additionally, shell quality is also important for ensuring the safety and longevity of the egg during storage and transportation. A strong and thick shell helps protect the egg from external damage, reducing the risk of bacterial contamination and breakage [9].

Internal qualities, such as the albumen weight, height, and the Haugh unit, are indicators of the freshness and nutritional value of the egg. The albumen, or egg white, contributes to the overall protein content of the egg and its structural integrity. The Haugh unit is a measurement of the albumen quality and is an important parameter for determining the freshness of the egg. Eggs with higher Haugh unit values are fresher and have better quality [10].

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Yolk weight is another important factor that determines the nutrient content of the egg. The yolk is rich in essential vitamins, minerals, and fats, and a heavier yolk generally indicates a higher nutrient content. Yolk color is also considered an important quality trait, with a deep orange or yellow color being preferred by consumers [11]. Genetic factors play a significant role in determining egg quality. Different strains of hens have been selectively bred for desirable traits, such as higher egg production and better egg quality. By selecting hens with superior genetics, egg producers can improve the overall quality of their eggs [12]. Egg quality is a multi-dimensional trait that encompasses various external and internal attributes. It is influenced by genetics and environment [13]. Ensuring high-quality eggs is essential for consumer satisfaction and the economic success of egg producers [14].

Egg weight increases with the age of the hen throughout the egg production cycle [8,15]. The reproductive endocrine system of hens is influenced by factors like daylight length and climate temperature, which affect the productivity characteristics and quality of eggs [16]. The eggshell plays a crucial role in protecting the developing embryo from physical and microbial threats. It acts as a barrier, allowing for the exchange of essential gases and water, also providing a source of calcium for the developing embryo. However, cracked, and broken egg-shells can result in significant economic losses for producers [17]. To prevent cracks, it is important to consider the strength of the eggshell, as it needs to withstand various environmental forces. Different breeds and strains of chickens exhibit genetic variations in eggshell characteristics. Therefore, when selecting chickens for breeding programs, it is essential to consider specific eggshell traits and ultrastructural measurements [18].

Genetic divergences in egg-shell features exist among chicken breeds and strains, and particular eggshell characteristics and ultrastructural estimations ought to be considered in chicken breeding programs for improving the quality of egg-shells and decreasing broken eggs [19-21].

Eggshells are remarkable biological structures that serve as a protective barrier for the developing embryos of birds, reptiles, and some species of fish. The microstructure of eggshells plays a crucial role in providing strength, durability, and permeability, ensuring proper embryonic development and protection from external threats [22].

The study of eggshell ultrastructure has provided valuable insights into the mechanical properties of eggshells, emphasizing that thickness alone cannot define their strength and quality. Therefore, evaluating both the structural and external appearance of eggshells is crucial for achieving optimal eggshell quality and overall economic success in egg production.

Material and Methods

Chicken genotypes

In the current investigation, six different layer strains were utilized at 32 weeks of age, including five strains established in Nubaria station Fayoumi black, Fayoumi red, Fayoumi white, Na white, and Na red, as compared with commercial layer brown chickens.

Fayoumi strains (three lines, black, red, and white) were established by crossing between males of fayoumi and females of commercial layer brown chickens).

Nacked neck strains

Red Nacked neckline was established by crossing between males of **Red Nacked neck** and females of commercial layer brown chickens).

White **Nacked neck line** was established by crossing between males of white **Nacked neck** and females of commercial layer brown chickens).

Data collection

These strains were used to assess egg quality. A total of 360 eggs, with 60 eggs from each strain, were selected for evaluation. To measure the form index, a sensitive balance was employed to weigh the eggs accurately. Additionally, the length and width of the eggs were measured to determine their size. These parameters provide valuable information about the quality of the eggs and can help in assessing the performance of the breeder strains. By analyzing the data obtained from this study, valuable insights can be gained regarding the egg quality of each strain. This information can be useful for breeders and researchers in making informed decisions regarding breeding programs, as well as for poultry farmers looking to improve the quality of their egg production.

Egg shape index = Egg length / Egg width × 100

Eggshell % = Eggshell weight / Egg weight × 100

All eggs were broken to measure the internal characters using the following equation:

Yolk shape index =Yolk height /Yolk height ×100

Albumen height and the height of the yolk were measured at the top by a spherometer. The yolk diameter was measured using digital calipers.

Specific gravity (SG) was calculated using the following formulas:

SG= [Egg weight / (0.968 Egg weight - 0.4759 The shell weight)]

Albumen percentage was calculated by this formula (albumen weight/egg weight) x 100.

Albumen weight was calculated using the following formula:

Egg weight- (yolk weight + Shell weight).

The Yolk albumen ratio was calculated using the following formula:

YA% = weight of yolk/weight of albumen.

Chick yield (%) was calculated using the following formula:

Chick weight (g) / Intimal egg weight (g) × 100

The yolk percentage was estimated using the following formula:

(Yolk weight / Egg weight) x100.

Shell microstructure

In this study, 25 samples of eggshell were collected from eggs of equal weight, representing five different strains: Fayoumi black, Fayoumi red, Fayoumi white, Na white, and Na red. To prepare the specimens, a piece of shell measuring 1 cm2 was cut from the equatorial region of each egg, and the shell membranes were removed using a chemical solution [23]. These samples were then examined under a JEOL JSM-T330A scanning electron microscope (JeoL, Tokyo, Japan) operating at 15 Kv. The cross-sectional lengths of the palisade and mammillary layers were directly measured in millimeters using scaling software provided with scanning electron microscopy, with a magnification of 200x.

The total thickness of each specimen was measured as the distance from its outermost surface to the point where the basal caps were inserted into the shell membranes. Additionally, the thickness of the mammillary layer was assessed, measuring the distance from the basal caps to the point where the palisade columns first fused. By subtracting these two measurements, the length of the palisade thickness or effective thickness was obtained [21,24]. The ultrastructural integrity of each egg was evaluated using a total ultrastructural score. Various features, such as confluence, type B, type A, cubic, aragonite, and changed membranes, were assessed and assigned a rank based on the degree of incidence, with a scale of 1 for none, 3 for isolated, and 7 for extensive. Fusion was ranked based on the degree of occurrence, with 1 for early, 3 for mainly early, 7 for mainly late, and 10 for late. Cuffing, another aspect of ultrastructure, was evaluated, and a rank of 7 was given if no cuffing was observed.

Statistical analysis

Data were analyzed as a one-way analysis of variance using the XLSTAT. software, a general linear model [Addinsoft, XLSTAT, 25]. The main effects were line and traits: egg weight (g), egg length (m.m), egg width (m.m), shap index, shell thickness, shell weight, shell percentage, Yolk height (m.m), Albumen height (m.m), yolk weight (g), yolk percentage, Albumen weight (g), albumen percentage and laroch.

The following model was used:

$$Y_{ijk} = \mu + L_i + e_{ijk}$$

Where:

Y_{ijk}: The k^{th} observation of the j^{th} Genotype within the i^{th} Animal Status.

μ: The overall mean.

L_i: The effect of the i^{th} line

E_{ijk}: Random error.

All data are reported as least square means (LSM) ± standard errors (SE). Mean values were separated when significance existed, using Duncan's multiple range test [Duncan's, 26]. The significance level was set at 5%.

Results and Discussion

The data presented in Table 1. highlights the impact of strain on various egg traits, of particular significance is the effect of strain on egg weight. The overall mean reveals that Na red strain exhibited the highest egg weight, followed by commercial brown, Na white, fayoumi black, fayoumi white, and fayoumi red strains, respectively. These findings align with a study conducted by Akintunde and Toye [26], who also observed that egg weight is influenced by different strains. The results of the study indicate that different chicken breeds exhibit variations in egg length, width, and shape. The highest egg length was observed in the commercial brown breed, followed by Na red, Na white, fayoumi black, fayoumi white, and fayoumi red. Similarly, the commercial brown breed exhibited the highest egg width, followed by Na red, Na white, fayoumi black, fayoumi white, and fayoumi red.

Moreover, the shape index, which indicates the overall shape of the eggs, was highest in fayoumi black, followed by commercial brown, Na red, Na white, fayoumi white, and fayoumi red.

These findings suggest that the uterine diameter factor plays a crucial role in determining the differences in egg shape. Eggs tend to be rounder when the uterus diameter is wider, while they tend to be oblong when the uterus diameter is narrower. This observation is consistent with previous studies conducted by Rahman [27], and Liu et al. [28]. To sum up, the findings of this study shed light on the variations in egg characteristics among different chicken breeds, particularly in terms of egg length, width, and shape. The research also emphasizes that the diameter of the uterus plays a significant role in shaping the eggs. This knowledge is crucial for enhancing egg production and making informed choices in breed selection within the poultry farming industry. By understanding the factors that influence egg characteristics, farmers can optimize their practices to meet consumer demands and improve overall efficiency. Ultimately, this research contributes to the advancement of the poultry farming industry by enabling more effective strategies for egg production and breed management.

TABLE 1. Least Square Means and Standard Error of the Difference between Strains in Egg Quality

	Egg weight (g)	Egg length (mm)	Egg width (mm)	Shape index
Commercial brown	65.29 ± 1.4 [b]	59.52± 2.1 [a]	46.84± 2.6 [a]	78.67 ± 1.2 [ab]
Na red	71.64± 0.59 [a]	59.33 ± 0.4 [a]	44.90 ± 0.7 [ab]	75.78 ± 0.6 [b]
Na white	64.25 ± 0.65 [bc]	55.91 ± 0.5 [b]	44.43 ± 0.1 [ab]	79.53 ± 2.1 [ab]
Fayoumi black	57.52 ± 2.1 [bc]	52.88 ± 0.8 [b]	43.35± 0.3 [b]	82.16± 0.7 [a]
Fayoumi white	60.16 ± 1.9 [d]	55.35 ± 0.6 [b]	42.57 ±0.6 [b]	76.97 ± 0.8 [b]
Fayoumi red	59.47± 1.5 [d]	54.65 ± 0.6 [b]	42.34± 0.4 [b]	77.55± 1.5 [b]
Probability	< 0.001	0.001	0.047	0.012

[a...d] Means, within trait and source of variation (S.O.V), followed by different superscripts, differ significantly [Duncan, 26].
Na red = naked neck red, Na white = naked neck white.

Table 2. presents the data regarding the effect of strain on eggshell traits. The results indicate that although the effect of strain on eggshell thickness was not statistically significant, the overall mean values indicate that Na white strain had the highest eggshell thickness, followed by fayoumi white, fayoumi red, Na red, commercial brown, and fayoumi black strains in descending order. However, the effect of strain on eggshell weight was found to be significant. The overall mean values show that commercial brown strain had the highest eggshell weight, followed by Na red, Na white, fayoumi white, fayoumi red, and fayoumi black strains. Similarly, the effect of strain on eggshell percentage was also found to be significant. The overall mean values revealed that commercial brown strain had the highest eggshell percentage, followed by fayoumi black, fayoumi white, fayoumi red, Na white, and Na red strains. In summary, the strain of the chicken has a significant impact on eggshell weight and percentage, with the commercial brown strain showing the highest values. However, the effect of strain on eggshell thickness was not found to be statistically significant.

The results of this study indicate a negative correlation between shape index and egg weight, which is consistent with the findings of Yan et al. [29]. This suggests that as the shape index of an egg decreases, the egg weight increases. Furthermore, there was a negative correlation observed between egg weight and shell percentage. This indicates that as the weight of the egg increases, the proportion of the egg that is composed of the shell decreases. A significant correlation was found between eggshell thickness and breaking force. This indicates that as the thickness of the eggshell increases, the breaking force required to crack the shell also increases. This finding aligns with the results of Yan et al. [29], who also reported a positive correlation between eggshell thickness and breaking strength. In addition, shell thickness was found to be positively correlated with shell weight and shell percentage. This suggests that as the thickness of the eggshell increases, both the weight and percentage of the egg that is composed of the shell also increase. Once again, this finding is supported by the findings of Yan et al. [29].

Previous studies, such as Zita et al. [30], have also reported significant positive correlations between eggshell percentage, shell thickness, and shell strength. This further supports the notion that shell thickness is an important factor contributing to the mechanical strength of the eggshell.

Interestingly, Ketta and Tumova [31], have proposed that eggshell thickness is influenced more by the genotype and the length of eggshell formation than by eggshell weight. They argue that eggshell thickness may be a more reliable indicator of eggshell quality compared to eggshell weight. Finally, Lordelo et al. [32], and Baldinger and Bussemas [33], found thicker eggshells with a higher breaking strength in commercial laying hens compared to local chickens. This suggests that the eggshell quality may differ between different breeds or types of chickens. Overall, this study adds to the existing literature by reaffirming the correlations between various eggshell traits and egg weight, as well as highlighting the potential importance of eggshell thickness as a reliable indicator of eggshell quality.

According to the data presented in Table 3, the strain of the hens had a significant effect on the internal quality of the eggs, specifically on the yolk height. The overall mean indicated that Na red strain had the highest yolk height, followed by fayoumi white, commercial brown Na white, fayoumi red, and fayoumi black strains, in descending order. Furthermore, the study also reported comparable values of yolk height for eggs obtained from different sources. Specifically, eggs from the market had an average yolk height of 15.40 mm, while commercial farms recorded a slightly higher average of 16.27 mm. On the other hand, eggs from backyard farms showed a lower average yolk height of 13.60 mm [34].

TABLE 2. Least Square Means and Standard Error of the Difference between Strains in Shell Quality

	shell thickness	shell weight	shell percentage
Commercial brown	0.026 ± 0.02 [a]	10.02 ± 0.4 [a]	15.38 ± 0.7 [a]
Fayoumi white	0.049± 0.02 [a]	8.32 ± 0.17 [c]	13.88± 0.2 [ab]
Nawhite	0.067 ± 0.01 [a]	8.68 ± 0.22 [bc]	13.50 ± 0.4 [b]
Fayoumi red	0.029 ± 0.02 [a]	8.22 ± 0.25 [c]	13.83 ± 0.17 [ab]
Na red	0.027± 0.01 [a]	9.10± 0.20 [ab]	12.72± 0.28 [c]
Fayoumi black	0.026 ± 0.01 [a]	8.15 ± 0.20 [c]	14.16 ± 0.2 [ab]
Probability	<0.167	< 0.001	<0.001

[a...d.] Means, within trait and source of variation (S.O.V), followed by different superscripts, differ significantly [Duncan, 26].
Na red = necked neck red, Na white = necked neck white.

The study investigated the impact of strain on albumen height and found that it had a significant effect. The average albumen height was highest in Na red, followed by Na white, commercial brown, fayoumi red, fayoumi white, and fayoumi black strains. This indicates that different strains of chickens exhibit variations in albumen height. The increase in albumen length and width can be attributed to the high loss of carbon dioxide (CO2) that occurs at room temperature. This finding aligns with the study conducted by Dada et al. [35]. The CO2 loss may result in the expansion of albumen and consequently lead to differences in albumen height among the strains. Furthermore, the observed differences in albumen height among strains correspond to the findings of a previous study conducted by Islam et al. [6]. This study also observed significant variations in albumen height and yolk width between the Nigerian indigenous naked neck and normal feathered strains.

Overall, the strain of chickens plays a significant role in determining albumen height, with Na red strain exhibiting the highest albumen height compared to other strains. These variations in albumen height can be attributed to the length and width adjustments resulting from CO_2 loss at room temperature. The results of this study showed that the strain of chicken has a significant effect on yolk weight. The highest yolk weight was recorded in Na red strain, followed by fayoumi red, fayoumi white, Na white, commercial brown, and fayoumi black. These findings are consistent with a study conducted by Udoh et al. [36], which reported similar yolk weight values for certain strains.

Similarly, the strain of chicken was found to have a significant effect on yolk percentage. The highest yolk percentage was observed in Na red strain, followed by fayoumi red, fayoumi white, Na white, commercial brown, and fayoumi black. The yolk percentage value obtained for Na white strain in this study was higher than those reported by Momoh et al. [37], but lower than the value reported by Ikeobi et al. [38]. Regarding albumen weight, the strain of chicken had a significant effect. The highest albumen weight was recorded in commercial brown strain, followed by Na white, fayoumi white, fayoumi red, Na red, and fayoumi black. However, the albumen weight obtained in this study was lower than the values observed in Oravka breed and Rhode Island Red breed in a study by Hasonuva et al. [39]. On the other hand, the effect of strain on albumen percentage and laroch (presumably a reference to eggshell color) was not significant in this study. The color of the yolk is influenced by factors such as the age of the chicken and the substances present in the feed. These findings align with a study by Hanusova et al. [39]. which reported lower albumen percentages for Oravka and Rhode Island Red chickens compared to the values obtained in this study.

Shell ultrastructural.

In this study, we investigated the eggshell microstructure of six different chicken strains. The aim was to analyze any variations in the microstructure that may exist between the strains and determine if these differences could have any impact on egg quality. The research findings presented in the figures demonstrate the effects of different strains on the ultrastructure of eggshells.

To begin, we collected eggs from six chicken strains: Strain commercial brown, Strain naked neck white, Strain naked neck red, Strain Fayoumi white, Strain Fayoumi red, and Strain Fayoumi black. The eggs were carefully examined under a Scanning Electron Microscope (SEM) to study the microstructure of their eggshells. We focused on three key aspects: shell thickness, pore density, and crystal structure. By examining the images presented in Figures 1 to 12, the researchers were able to assess how these strains impacted the structure of eggshells. In the case of the commercial brown strain, figures 1 and 2 clearly show a deterioration in the eggshell structure. This deterioration is characterized by type B's, late fusion, poor confluence, and alignment issues. Similarly, the naked neck white strain, as shown in Figures 3 and 4, displayed a decline in eggshell structure, with late fusion, poor confluence, and alignment problems evident. One of the primary components of an eggshell is calcium carbonate, which is arranged in a unique crystalline form. The arrangement of these crystals can vary in different parts of the shell, such as the outermost layer, the mammillary layer, and the innermost layer. Each layer has distinct microstructural features that contribute to the overall strength and durability of the shell [40].

Further analysis of the naked neck red strain (Figures 5 and 6) revealed similar deterioration in eggshell structure, with late fusion, poor confluence, and alignment issues present. The Fayoumi white strain (figures 7 and 8) also exhibited a decline in eggshell structure, specifically cuffing and early fusion. The innermost layer, known as the palisade layer, is responsible for providing additional structural support to the eggshell. It is composed of elongated crystals arranged parallel to the shell's surface. This layer acts as a reinforcement to prevent cracking or breaking of the shell under pressure [41]. Likewise, the Fayoumi red strain (figures 9 and 10) displayed a deterioration in eggshell structure, characterized by type B's, late fusion, poor confluence, and alignment problems. Lastly, the fayoumi black strain (figures 11 and 12) demonstrated a deterioration in eggshell structure, including cuffing, early fusion, and alignment issues. Beneath the cuticle lies the mammillary layer, which consists of small, densely packed crystalline structures called mammillae. These mammillae are irregularly shaped and vary in size, creating a rough texture at the surface of the shell. This roughness enhances the shell's mechanical strength and provides a better grip for the incubating bird during egg turning [42]. Additionally, Cheng and Ning [9], said the different species of birds may have variations in the thickness and crystal arrangement of their eggshells. Changes in diet, particularly calcium intake, can also impact the microstructure of the eggshell, affecting its strength and quality. The microstructure of eggshells is a complex arrangement of calcium carbonate crystals that contribute to the mechanical strength, durability, and quality of the shell. The different layers, such as the cuticle, mammillary layer, and palisade layer, each serve unique functions in protecting the egg and supporting the incubating bird. Further research is necessary to fully comprehend the relationship between microstructure and eggshell quality, as well as the factors that influence its variations [43].

TABLE 3. Least Square Means and Standard Error of the Difference between Strains in Internal egg Quality

	Na red	Fayoumi red	Na white	Fayoumi white	Commercial brown	Fayoumi black	Probability
Yolk height (mm)	$15.66^a \pm 0.25$	$14.28^b \pm 0.3$	$14.66^b \pm 0.24$	$14.76^b \pm 0.26$	14.66b ± 0.16	$14.07^b \pm 0.48$	0.014
Albumen height (mm)	$9.33^a \pm 0.3$	$7.28^b \pm 0.4$	$8.06^b \pm 0.17$	$7.13^b \pm 0.22$	$8.00^b \pm 0.3$	$5.58^c \pm 0.6$	< 0.001
Yolk weight (g)	$30.25^a \pm 4.3$	$18.50^b \pm 1.2$	$17.87^b \pm 0.9$	$18.23^b \pm 0.6$	$17.86^b \pm 0.33$	$15.53^b \pm 4.9$	0.001
Yolk percentage	$41.94^a \pm 5.7$	$31.22^{ab} \pm 1.8$	$27.84^b \pm 2.11$	$30.80^{ab} \pm 0.9$	$27.42^b \pm 0.6$	$27.15^b \pm 8.0$	0.066
Albumen weight (g)	$26.27^{ab} \pm 1.6$	$27.92^{ab} \pm 1.7$	$31.99^a \pm 2.3$	$28.21^{ab} \pm 2.0$	$33.04^a \pm 4$	$18.30^b \pm 5.0$	0.006
Albumen percentage	$36.93^a \pm 2.5$	$47.42^a \pm 2.4$	$49.81^a \pm 3.4$	$47.18^a \pm 3.8$	$50.59^a \pm 5.8$	$32.38^a \pm 8.4$	0.022
Laroch	$6.8^a \pm 0.2$	$6.8^a \pm 0.2$	$6.6^a \pm 0.2$	$6.73^a \pm 0.4$	$6^a \pm 0.4$	$6.14^a \pm 0.3$	0.317

[a...d] Means, within trait and source of variation (S.O.V), followed by different superscripts, differ significantly [Duncan, 26].

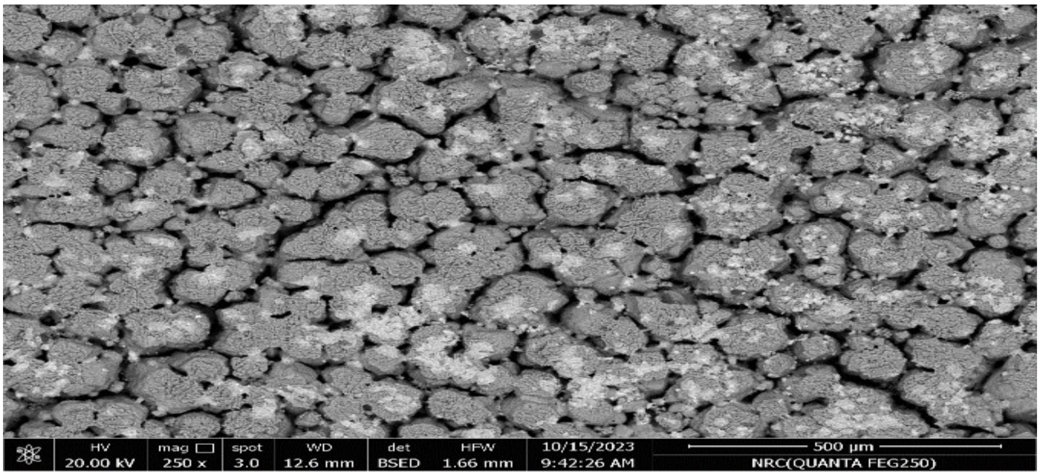

Fig. 1. Disorganised mammillary bodies and extensive type B's (arrowed) in eggshell (commercial brown strain).

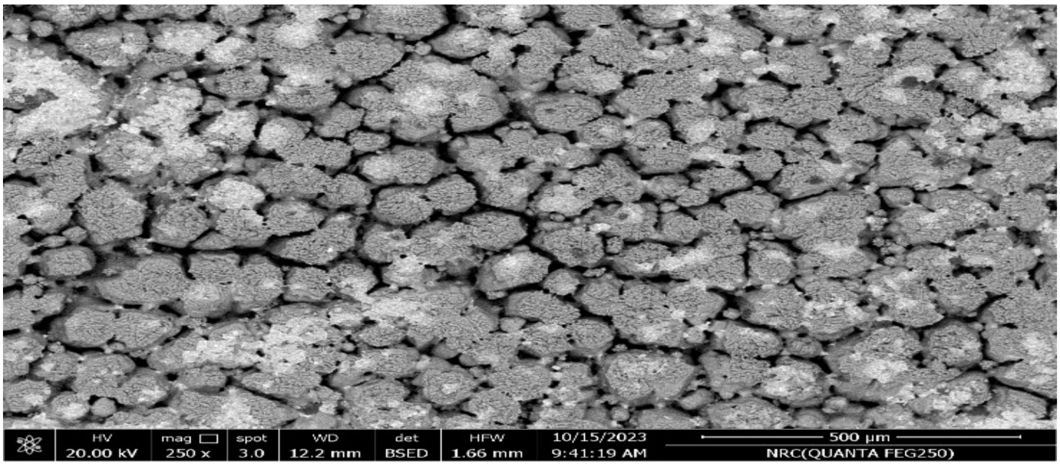

Fig. 2. Late fusion, poor confluence in eggshell (commercial brown strain).

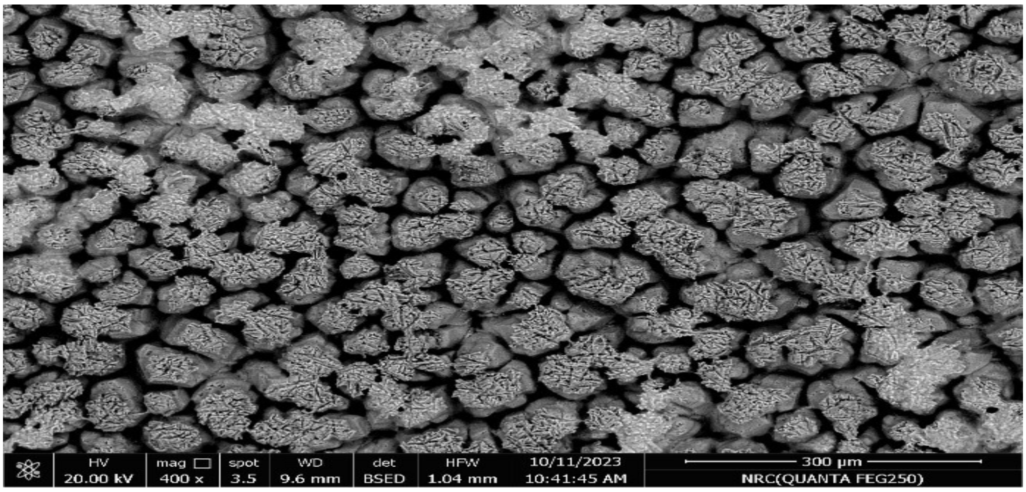

Fig. 3. Late fusion, in eggshell (naked neck white strain).

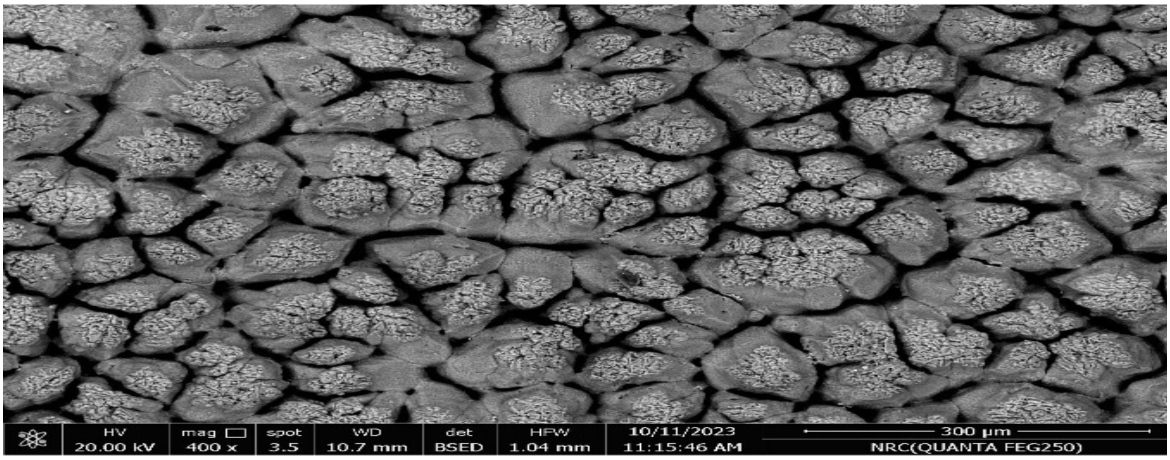

Fig. 4. Poor confluence in eggshell (naked neck white strain).

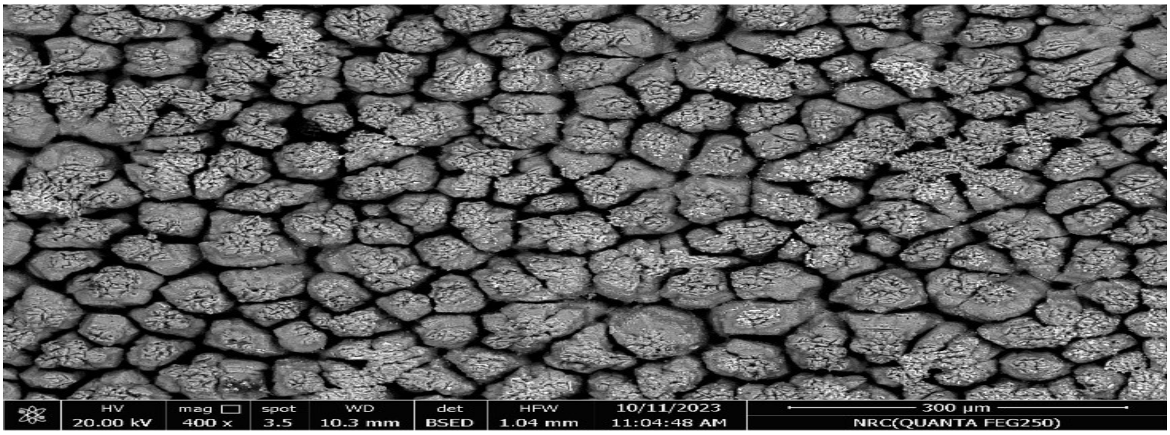

Fig. 5. Late fusion in eggshell structure (naked neck red strain).

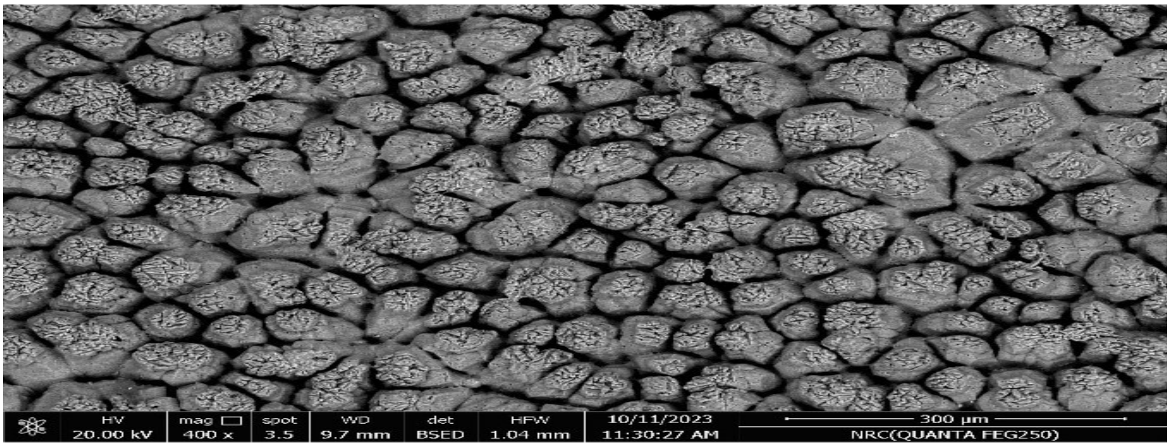

Fig. 6. Poor confluence in eggshell structure (naked neck red strain).

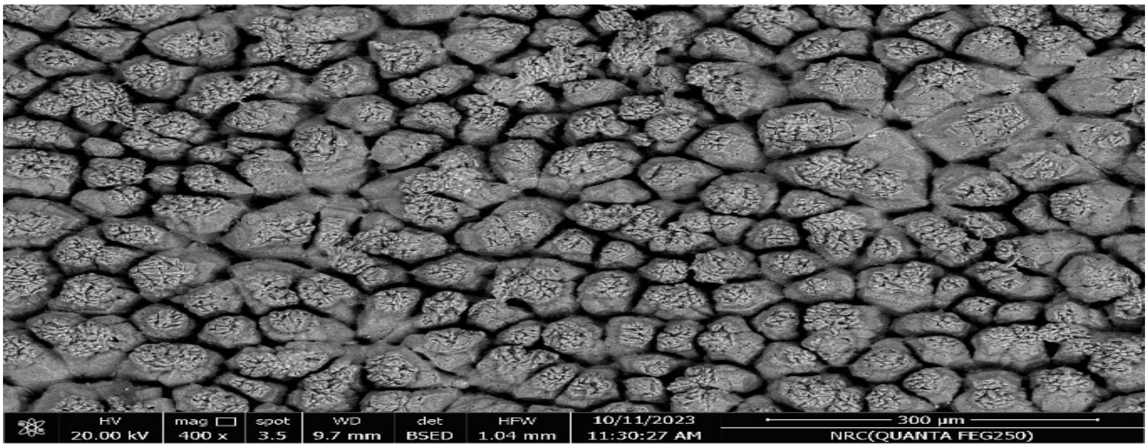

Fig. 7. Early fusion in eggshell structure (Fayoumi white strain).

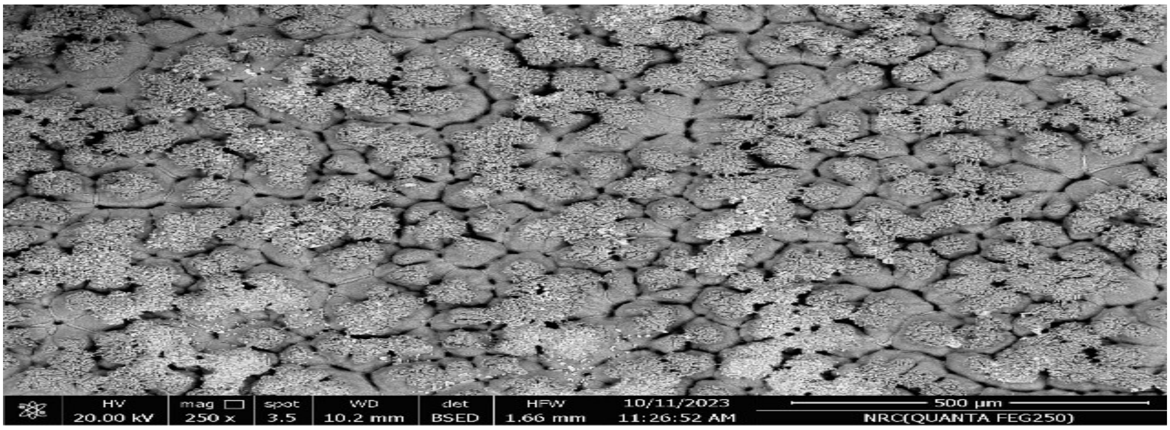

Fig. 8. Cuffing in eggshell structure (Fayoumi white strain).

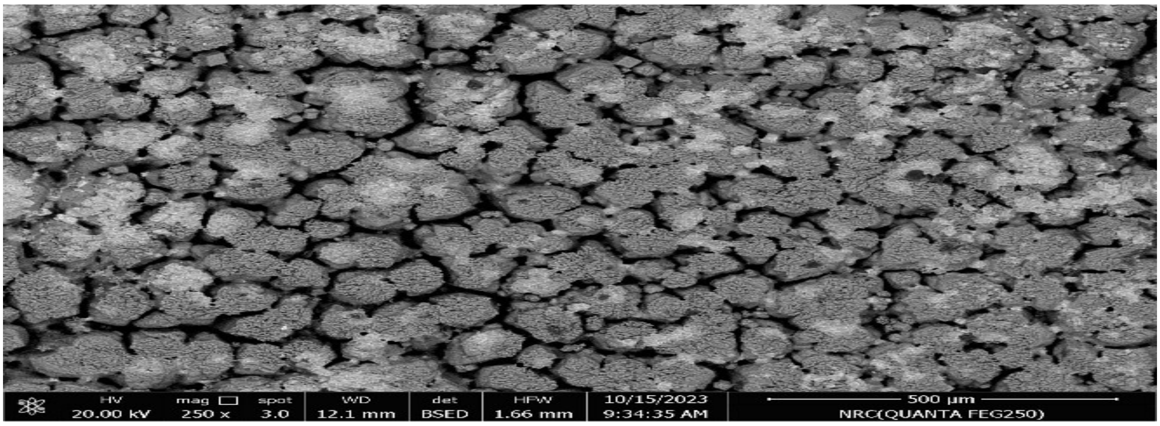

Fig. 9. Late fusion in eggshell structure (Fayoumi red strain).

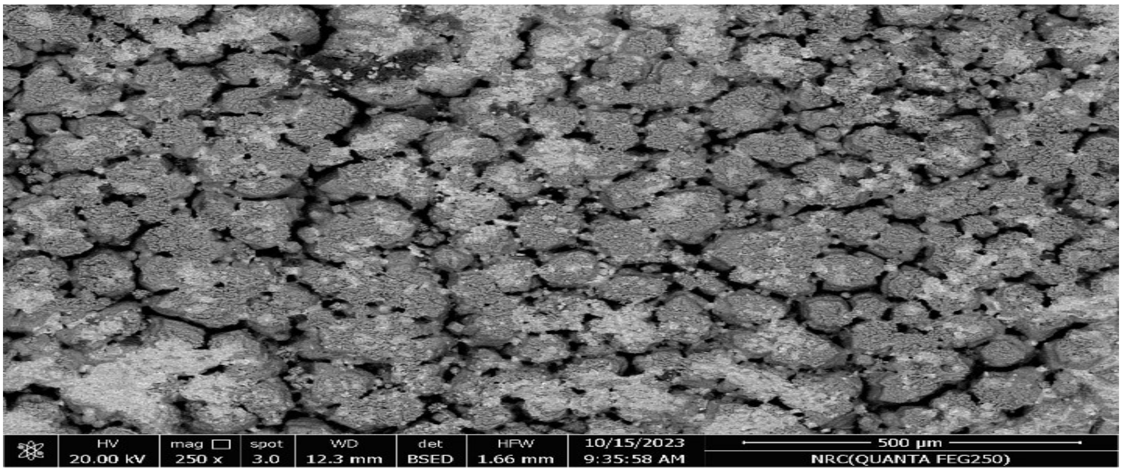

Fig. 10. Alignment in eggshell structure (Fayoumi red strain).

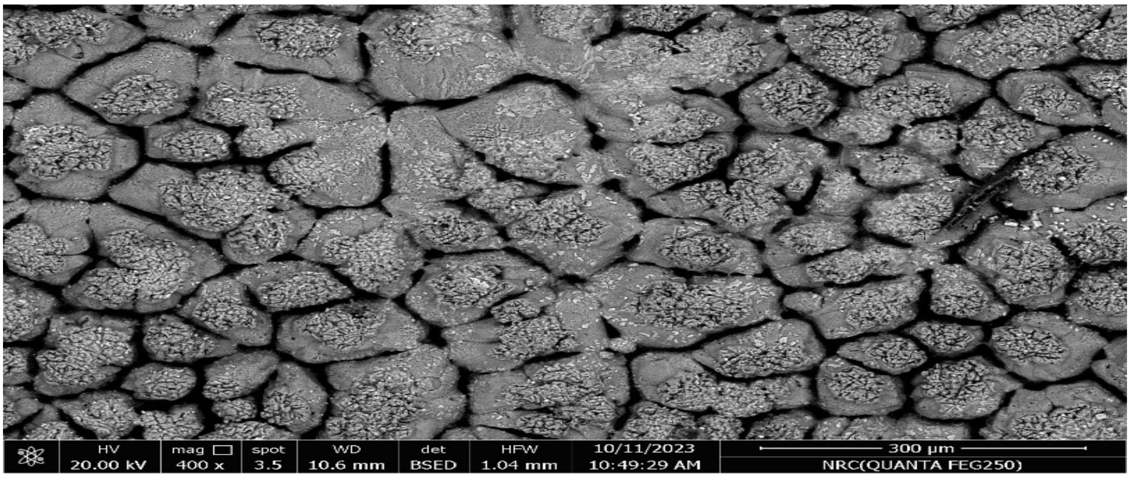

Fig. 11. Cuffing in eggshell structure (Fayoumi black strain).

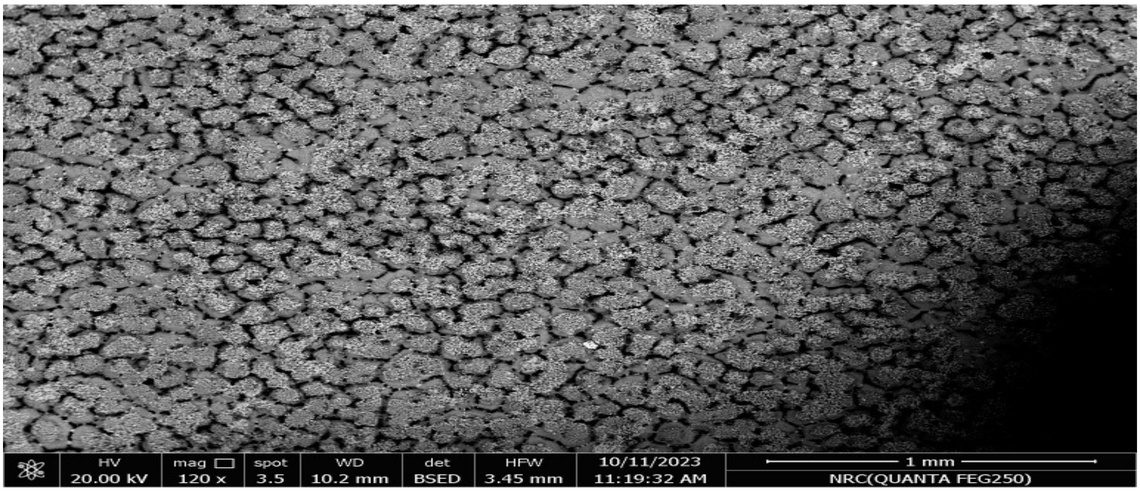

Fig. 12. Early fusion, in eggshell structure (Fayoumi black strain).

Conclusion

From the results obtained, it can be concluded that the naked neck strain (Na) of the eggshell exhibited several ultrastructure defects, such as late fusion, poor confluence, and the presence of type B's. These defects were particularly prominent in older breeders when compared to the brown strain. On the other hand, the Fayoumi eggshell displayed better ultrastructure features, including early fusion and cuffing, when compared to their white eggshell counterparts. These findings provide valuable insights into the impact of different strains on the ultrastructure of eggshells. They highlight the importance of considering strain variations when evaluating eggshell quality.

Conflict of interest

The authors declare that there is no conflict of interest.

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Ethical approval

The present study has been conducted by the guidelines of the Ethics Committee of the National Research Centre. Approval number 074110923

Data Availability Statement

All data generated or analyzed during the current study are included in this published article.

Author Contribution

This study was done in collaboration with all authors. E. M. El-Komy and G.S. Ramadan conceived the idea, designed the experiments and supervised the research. A. A. Abd El-Halim, A.M. Abdelsalam and E. M. El-Komy performed the experiments and co-wrote the paper. G.S. Ramadan analyzed the data. A. A. Abd El-Halim, A.M. Abdelsalam and E. M. El-Komy critically revised the manuscript. All authors read and approved the final manuscript.

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تأثير النمط الوراثى لسلالات الدجاج البياض على جودة البيض والتركيب البنائى لقشرة البيض

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المستخلص

كان الهدف من هذا البحث هو دراسة تأثيرالتركيب الوراثي للدجاج على صفات قشر البيض المختلفة وجودة البيض والتركيب البنائى لقشرة البيض خلال مرحلة إنتاج البيض. تم في هذه الدراسة فحص خمس سلالات من الدجاج: الفيومي الأسود، الفيومي الأحمر، الفيومي الأبيض، دجاج عارى الرقبة أبيض و دجاج عارى الرقبة أحمر، بالمقارنة بالدجاج البني التجاري. تم إستخدام إجمالي 60 بيضة من كل نمط وراثي لتحديد جودة البيض والتركيب البنائى لقشر البيض. أشارت نتائج هذه الدراسة إلى أن التركيب الوراثي له تأثير معنوي على عوامل مختلفة بما في ذلك وزن البيضة، طول البيضة، عرض البيضة، دليل الشكل، ارتفاع الزلال، وزن الزلال، نسبة الزلال، ارتفاع الصفار، قطر الصفار، دليل الصفار، وزن الصفار، نسبة الصفار، نسبة الزلال إلى الصفار، وزن القشرة الرطبة، وزن القشرة الجافة، ونسبة القشرة. على وجه التحديد، أظهر قشر البيض من سلالة الشركسى عيوبًا مميزة في التركيب البنائى لقشر البيض مثل الإلتحام المتأخر، والتقاء ضعيف، وتصدعات مختلفة مقارنة بسلالة الفيومى وقشر البيض التجاري. من ناحية أخرى، أظهر قشر البيض الفيومي ميزات تركيب بنائى مواتية مثل الإلتحام المبكر وضيق المسافات البينية مقارنة بقشر البيض من سلالة عارى الرقبة. تشير هذه النتائج إلى أن الإختلافات الوراثية بين سلالات الدجاج البياض يمكن أن يكون لها تأثير كبير على جودة البيض. لذلك، من المهم مراعاة التركيب الوراثي عند تقييم سمات قشر البيض، ونوعية البيض، التركيب البنائى لقشر البيض. من خلال فهم هذه التباينات الجينية، يمكن إجراء تحسينات على الأداء العام وجودة البيض في أنظمة إنتاج البيض .

الكلمات المفتاحية: صفار البيض، صفات قشر البيض، جودة البيض، التركيب الوراثي للبياض و التركيب البنائى لقشر البيض.