Evaluating Egg Quality Traits In Different Quail Genetic Patterns In Feather Color

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Abstract

This study was designed to evaluate the effect of genotype on some external and internal egg traits of quail. The experiment was conducted in a hall designated for quail rearing, one of the poultry farm (Department of Animal Production), College of Agriculture, Tikrit University, from 1 September 2024 to 25 November 2024. Birds were reared from 35 days of age, close to the onset of first egg laying, and were divided according to plumage color into two genotypes: brown and sandy. A total of 88 birds was used; within each genotype, males and females were distributed equally as 11 males and 33 females. Birds were allotted uniformly among replicates at a mating ratio of 1 male to 3 females. Egg samples were collected, and quality traits were analyzed 24 hours post-collection. The evaluated parameters included egg weight, shell thickness, relative shell weight, relative albumen weight, relative yolk weight, egg shape index, and both yolk and albumen indices.The results indicated no significant differences between the two genetic groups in egg weight, relative shell weight, egg shape index, and albumen index. However, significant differences were observed in shell thickness, yolk index, and relative albumen weight, suggesting a genetic influence on certain egg quality traits. This study highlights the importance of genetic composition in improving specific egg quality characteristics and supports the potential use of these traits as selection criteria in quail breeding programs aimed at enhancing production efficiency and improving final product quality.

Keywords:
Quail, Egg quality traits, Genetic composition Egg weight,

Introduction

The poultry industry is one of the most important sources contributing to the supply of animal protein for human consumption, owing to the increasing demand for poultry meat and eggs. It also represents an important means of strengthening food security in many countries and constitutes a source of national income for the economies of several nations. These advantages are associated with the short production cycle and high feed conversion efficiency of poultry compared with other farm animals. In addition, the growing demand for meat products, the diversity of production sources, and relatively low prices have contributed to the rapid emergence of Japanese quail as one of the preferred poultry species among consumers compared with other poultry industries [1]

In light of the global trend toward improving production efficiency in domestic birds, quail represents a promising choice, particularly because of its high productive capacity and distinctive biological characteristics. Quail eggs constitute an important product in terms of both quantity and quality. Egg traits are affected by numerous genetic and environmental factors, including strain, bird age, feed type, lighting conditions, and rearing system [2] Therefore, studying egg quality traits is an essential step for understanding bird performance under different rearing conditions and for developing effective strategies to improve egg quality in line with consumer preferences and market requirements. In recent years, quail eggs have gained a distinguished position among food products because of their health benefits, yolk flavor, and shell appearance. Improving egg quality also enhances marketing efficiency, as egg quality directly affects marketability, shelf life, and consumer satisfaction. These traits are also used as important indicators in genetic improvement programs through selection. the reported that brown Japanese quail is superior to white and black plumage of Pharaoh quail in most of the egg quality traits measured. the sizes of quail eggs had a substantial impact on the eggs' width, height, shape index, shell ratio and surface area. The white and black Pharaoh quail plumage are inferior to the brown Japanese quail in the majority of the measured egg quality parameters the study female quails from four lines involved two European (White and Dark Ukrainian) and two Asiatic (White and Dark Local). The results revealed

the significant superiority of European quails on Asiatic ones in egg quality characteristics; also, the white Ukrainian line appeared a significant difference compared to the rest lines for egg weight and yolk percentage; however, Haugh units resulted in almost the same values for both European lines which surpassed significantly both Asiatic ones; the same trend was found for albumen index.

Accordingly, the present study aimed to clarify the importance of these traits and their potential use in future improvement programs for quail.

Materials and Methods

A total of 88 quail birds, 35 days of age, were reared after sexing into males and females. The flock was divided according to feather color into two genotypes: brown and sandy. Each genotype included 11 males and 33 females. A mating ratio of one male to three females was adopted for each replicate , The birds used in this study were 56 days old. The study was conducted at the quail farm affiliated with the Department of Animal Production, College of Agriculture, Tikrit University, from 1 September 2024 to 25 November 2024. Feed and water were provided ad libitum throughout the study period. The experimental diet contained 20% crude protein and 2860 kcal metabolizable energy per kg of feed. The main objective of the study was to determine the effect of genotype on the external and internal quality traits of quail eggs and to identify the most suitable genotype as a potential egg-production line for future selection and mating programs.

Traits Studied

Egg quality attributes were measured once, 24 hours after collection. The measurements were conducted in a room where the temperature was maintained between 22 and 24°C. A sample consisting of 30 eggs from each genotype was used to ensure statistical accuracy; the eggs were broken, and their external and internal quality attributes were assessed in accordance with the methods described in reference [3].

Egg weight

Eggs were weighed using a sensitive electronic balance reading to the nearest two decimal places.

Shell thickness (mm)

Shell thickness was measured after removing the egg contents and drying the inner surface of the shell. It was calculated as follows:

Shell thickness (mm) = [shell thickness at the broad end + shell thickness at the midpoint+ shell thickness at the pointed end] / 3

Shell weight (g)

After complete removal of the yolk and albumen, the shell and its membranes were dried and weighed using a balance with a sensitivity of 0.01 g.

Yolk weight (g)

Yolk weight was estimated using a sensitive balance reading to the nearest two decimal places.

Albumen weight (g)

Albumen weight was calculated using the following equation:

Albumen weight (g) = egg weight (g) - [yolk weight (g) + shell weight with membranes (g)]

Yolk height (mm)

Yolk height was measured using an electronic Vernier caliper in millimeters.

Yolk diameter (mm)

Yolk diameter was measured using an electronic Vernier caliper in millimeters.

Relative shell weight with membranes (%)

Relative shell weight was calculated according to the following equation:

Relative shell weight with membranes (%) = [shell weight (g) / egg weight (g)] x 100

Relative albumen weight (%)

Relative albumen weight was calculated according to the following equation:

Relative albumen weight (%) = [albumen weight (g) / egg weight (g)] x 100

Relative yolk weight (%)

Relative yolk weight was estimated according to the following equation reported by [3] .

Relative yolk weight (%) = [yolk weight (g) / egg weight (g)] x 100

Egg shape index (%)

Egg shape measurements were taken at the broad and pointed ends using an electronic Vernier caliper in millimeters. The index was calculated according to the following equation:

Egg shape index (%) = [egg width (mm) / egg length (mm)] x 100

Albumen index

The albumen index was calculated according to the following equation reported by [3].

Albumen index = [albumen height (mm) / ((albumen length + albumen width) / 2)] x 100

Yolk index

The yolk index was calculated according to the following equation reported by [3].

Yolk index = [yolk height (mm) / yolk diameter (mm)] x 100

Statistical Analysis

Data were statistically analyzed using a Completely Randomized Design (CRD) to evaluate the effect of treatments on the studied traits. Significant differences among treatment means were compared using Duncan’s multiple range test [4] . Data were analyzed using the[5]. Statistical analysis was performed using [6]. according to the following mathematical model:

$$Yij = \mu + Ti + eij$$

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where Yij is the value of observation j belonging to treatment i; μ is the overall mean of the studied trait; Ti is the effect of treatment i; and eij is the random error, assumed to be normally and independently distributed with a mean of zero and a common variance of $\sigma^2 e$.

Results and Discussion

Egg weight

The results presented in Table 1 showed no significant difference between brown-plumage quail and sandy-plumage quail in egg weight. This may be attributed to the close body weights of females from the two genotypes during the egg collection period. It may also be related to the presence of a highly significant positive genetic and phenotypic correlation between body weight and average egg weight [7].

Relative shell weight

The statistically analyzed data shown in Table 1 indicated no significant difference between brown-plumage quail and sandy-plumage quail in average relative shell weight. The lack of significant variation in this trait among genotypes may be due to a state of physiological equilibrium in the metabolism of nutrients consumed by the birds, whether their effect is expressed in the shell or in the egg as a whole. For example, when the diet provides calcium and females reach a stable physiological state, nutrient metabolism may direct resources toward the formation of internal egg components, such as yolk and albumen, at the expense of shell deposition. Thus, the shell may have lower metabolic priority than the yolk and albumen, making changes in relative shell weight less apparent. These findings agree with those reported by [8] . who found no significant differences in shell weight while studying egg quality traits in quail.

Shell thickness

The means and standard errors of the different genotypes, together with the significance comparison using Duncan's multiple range test at $P \leq 0.05$, are presented in Table 1. The results revealed significant differences in shell thickness between the two genotypes. These findings suggest genetic variation affecting shell thickness. The present results agree with [9] . who reported a shell thickness of 0.26 mm in Japanese quail eggs, and with [10]. who studied egg quality traits in Japanese quail. However, the results do not agree with [11]. who reported that eggshell thickness did not differ significantly among the quail genotypes they examined.

Table 1. Effect of genotype on egg weight, relative shell weight, and shell thickness (mean ± standard error).

Treatment	Relative shell weight (%)	Egg weight (g)	Shell thickness (mm)
Brown	12.89a ± 0.07	11.37a ± 0.13	0.28a ± 0.002
Sandy	13.11a ± 0.09	11.78a ± 0.16	0.24b ± 0.003

Different letters within the same column indicate significant differences at $P \leq 0.05$.

Egg shape index

The results in Table 2 show no significant difference between brown-plumage quail and sandy-plumage quail in egg shape index, with values of 79.18% and 79.30%, respectively. The egg shape index values obtained in this study fall within the range of the oval egg shape, which is generally reported as 73-80% [12].

Yolk index

The results presented in Table 2 indicate significant differences between brown-plumage quail and sandy-plumage quail in yolk index. This may be associated with the positive relationship between egg size and yolk diameter; as egg size increases, yolk diameter also increases, which is reflected in the yolk index. Improved yolk height also contributes to the yolk index, as yolk height and yolk diameter together define this trait. The significant effect on egg and yolk components may also be attributed to genetic differences between sandy and brown quail in the proportions of egg components.

Albumen index

The results in Table 2 showed no significant differences between brown-plumage quail and sandy-plumage quail in albumen index. The albumen index is determined by albumen height and diameter and depends on the albumen content of amino acids and proteins, particularly ovomucin, which contributes to the gelatinous consistency of the albumen.

Table 2. Effect of genotype on egg shape index, yolk index, and albumen index (mean ± standard error).

Treatment	Yolk index (%)	Egg shape index (%)	Albumen index (%)
Brown	42.57B ± 0.25	79.18A ± 0.15	12.53A ± 0.29
Sandy	46.87A ± 0.36	79.30A ± 0.27	13.38A ± 0.33

Different letters within the same column indicate significant differences at $P \leq 0.05$.

Relative albumen weight (%)

Duncan's multiple range test for relative albumen weight revealed significant differences between the two genotypes classified according to plumage color, namely brown and sandy, with percentages of 26.13% and 27.58%, respectively, as shown in Table 3. Relative albumen weight is an important indicator directly associated with the internal components of the egg and is used to evaluate egg quality, particularly when considered together with the albumen index, which depends on albumen height and width. [11]reported that relative albumen weight is significantly affected by genetic factors.[13] also indicated that egg components, including albumen, exhibit moderate to high heritability, suggesting that these traits can be improved through genetic selection, especially when associated with albumen protein content such as ovomucin, which contributes to improved consistency and albumen height and provides the albumen with its distinctive gelatinous structure as a biological indicator of egg quality.

Relative yolk weight (%)

The statistical analysis presented in Table 3 for relative yolk weight showed significant differences among the study treatments. The sandy genotype was superior in this trait, with a value of 27.58%, compared with the brown genotype, which recorded 26.13%. This superiority may be due to genetic and physiological factors affecting yolk formation and concentration within the egg. Recent studies have indicated that relative yolk weight has a moderate heritability estimate among egg-related traits, suggesting the possibility of improving this trait through genetic selection [14]. Experimental evidence has also shown that increased nutritional efficiency contributes to higher relative yolk weight in laying quail sandy . The present results agree with those reported by [1]. in their study of selected

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external and internal quality traits of quail eggs.

Haugh unit

The results in Table 3 showed no significant differences between brown-plumage quail and sandy-plumage quail in Haugh unit. The values were high, indicating that all egg samples were fresh and that the studied factors did not negatively affect internal albumen quality. which may enhance utilization of nutrients available in the diet. Plumage color variation in quail is primarily associated with external phenotypic traits and does not necessarily correspond to clear differences in egg quality traits. Therefore,, which may explain the similarity in Haugh unit values among the different genotypes. These findings agree with [15]. who studied three different quail genotypes. However, they differ from the results of Utami [16]. who reported a Haugh unit value of 58.20 for the control group in their study on quail.

Table 3. Effect of genotype on relative yolk weight, relative albumen weight, and Haugh unit (mean ± standard error).

Treatment	Relative albumen weight (%)	Relative yolk weight (%)	Haugh unit
Brown	6.69B + 0.27	26.13B + 0.11	93.05A ± 0.78a
Sandy	7.06A + 0.25	27.58A + 0.15	93.12A ± 1.34a

Different letters within the same column indicate significant differences at P≤ 0.05.

Conclusion

The findings of this study indicate that differences in egg quality traits can be used in selection and genetic improvement programs and may guide breeding toward genotypes with higher productive efficiency. The study also opens the way for further research involving chemical analysis of egg components and linking these components with genetic traits across different genotypes.

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