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Original Article

A Comparative Study on The Influence of Physiological Factors and Genetics on Egg Quality in Arabic, Kedu Kup, and Pelung Chicken Breeds

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Abstract
This study aimed to determine the influence of genetic and physiological factors on egg quality in Arabic, Kedu Kup, Pelung chicken breeds, to compare the differences in egg quality between Arabic, Kedu Kup, and Pelung chicken breeds. A quantitative research technique was adopted in this study. Two hundred eggs were randomly gathered; one hundred came from a rural location and the other hundred came from a commercial source. SPSS software version 20.0 is used in this study's data processing procedure. This study uses both ANOVA and multiple linear regression for data analysis. The study's findings indicated that genetic and physiological variables significantly affect the quality of eggs in Arabic, Kedu Kup, and Pelung chicken breeds. Additionally, there are notable variations in the quality of eggs across these breeds. When choosing breeds for egg production, poultry producers are advised to take breed-specific characteristics into account.
Keywords. Physiological Factors, Genetic, Egg Quality, Chicken Breeds.

Introduction

A substantial portion of the worldwide agricultural economy, poultry production promotes both economic growth and food security. Chickens are one of the most important types of poultry because they can lay eggs, which are an essential source of protein and other nutrients that humans can eat. Obtaining high-quality eggs is crucial for consumers. A farmer's maintenance environment and genetic characteristics have a major role in determining the quality of their eggs. Numerous elements, including genetics, physiology, nutrition, and environmental circumstances, all affect the quality of eggs. Comprehending these variables is imperative to maximize egg yield, guarantee food quality, and augment the financial gain from chicken farming [1].

Egg quality refers to a broad range of attributes, such as yolk color, size, shape, albumen consistency, and shell strength. These characteristics are essential for both customer pleasure and the profitability of the egg industry. Eggs of superior quality have a higher market value, a longer shelf life, and a lower likelihood of breaking during handling and transit. Additionally, as eggs are a source of vital elements, including proteins, vitamins, and minerals, egg quality affects human health. Thus, poultry scientists must comprehend the factors that determine egg quality [2].

Different breeds of chickens have unique genetic characteristics that affect the size, thickness of the shell, color of the yolk, and overall composition of the eggs, among other elements of egg production. Breeds are frequently chosen based on particular qualities that correspond with the ideal egg qualities, including bigger eggs, deeper yolk colors, or more robust shells. Some breeds, for example, may be chosen for their capacity to produce eggs with a greater nutritional content, while others may be recognized for laying eggs with thicker shells that are less likely to break [3]. The distinct genetic characteristics of the Arabic, Kedu KUP, and Pelung chicken breeds may have varying effects on the quality of their eggs.

For instance, the Arabic breed is renowned for both its capacity to lay a comparatively large number of eggs and its flexibility to many climatic circumstances. Arabian chickens produce 190–250 eggs annually, which is comparatively high and nearly identical to the output of laying hens. Arabian chicken eggs are similar to village chicken eggs in that they weigh between 30 and 35 grams and have almost no brooding traits, allowing for a longer laying period. One variety of regional chicken egg that is commonly found in stores is the Arabic variety. Arabian chicken eggs resemble free-range chicken eggs in terms of their form, color, and quality of contents [4].

Kedu KUP is a native breed of Indonesia that has undergone selective breeding to enhance its ability to produce eggs and develop tolerance to certain illnesses. The local community has been raising Kedu chicken for a long time, and this kind is considered to be among the best. Some of the traits that set Kedu KUP apart from other types of chicken include its comparatively big body, its erect stance, and its shining black feathers. This chicken is even more noticeable due to its enormous red comb. Kedu KUP is renowned genetically for its remarkable resilience and excellent climate adaptation in Indonesia [5].

On the other side, pelung chickens are typically recognized for their bigger bodies and ability to produce meat, but experts studying poultry have also taken an interest in the qualities of their eggs. One of the most common breeds of chicken in Indonesia is the pelung. Males typically weigh between 3.5 and 5 kilos (7.7 to 11 pounds), while females are somewhat smaller. They have a strong, muscular body. They are ideal for a variety of farming tasks due to their robust build and enormous size [6].

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Egg quality is greatly influenced by physiological variables in addition to genetics. The hen's age, health, diet, and state of the reproductive system are some of these variables. For instance, younger chickens often lay eggs that are stronger and have higher-quality albumen than those from older hens, which may have thinner shells and lower-quality albumen [7].

No chilling or preservation treatment has been applied to fresh chicken eggs, which are meant for human consumption. In addition, the egg does not exhibit any obvious symptoms of embryo development; it is clean and undamaged, with the yolk remaining separate from the white. 28–29% of an egg's yolk, 60–63% of its white, and 9–11% of its shell make up a chicken egg. A variety of factors that affect consumer preferences make up egg quality. There are two categories of chicken egg quality: the quality of the external (or outer) egg and the inside (or inner) egg. Egg weight, egg index, and shell weight are examples of outer egg quality, whereas egg yolk and white weight are examples of interior egg quality. Egg weight loss, the width of the air cavity, the state of the white and yolk, the shape and color of the yolk, and the degree of egg shell cleanliness are quality criteria that might give hints about how fresh an egg is [8].

The age of the chicken, temperature of the surrounding environment, breed and strain of the chicken, amount of nutrients in the ration, body weight of the chicken, and time of egg production are some of the elements that affect the weight of chicken eggs. Genetics, sexual maturity, age, medicine, and daily nutrition are some of the factors that affect egg weight. The temperature of the surrounding environment affects egg weight. When compared to chickens kept in low temperature environments (<20°C), those housed in high temperature environments (>27°C) often weigh less. Variations in ration administration impact the weight of eggs produced. The dietary components of the ration, energy, protein, and minerals, particularly calcium and phosphorus, are what determine egg weight [9].

The breadth and length of the egg are compared to determine the egg index value. The ratio of the egg's width (diameter) to its length, multiplied by 100, is the formula for determining the egg index. The egg's actual appearance will depend on its egg index value. An egg index value between 70 and 74 percent is good. The form of the egg and the egg index are closely associated since the egg index value may be determined from the egg's shape. The egg will be rounder if its egg index value is higher; on the other hand, it will be more oval if its egg index value is lower. Eggs with an egg index of up to 0.82 have a round form, whereas eggs with an index of 0.65 have an oval shape. As one gets older, the egg index will gradually drop. The egg index is around 77% at the beginning of egg laying and 74% at the conclusion. Genetic variables determine the form and index of eggs [10].

Egg quality, both in terms of weight and thickness, is significantly influenced by the quality of the egg shell, which serves as the primary barrier to prevent harm to the eggs during storage and transit. Generally speaking, the construction of an egg shell is made up of two parts: the hard egg shell that forms inside the uterus and the thin shell (membrane), which includes both the inner and exterior membranes. The two main factors that define the shell's quality are its thickness and weight. The calcium supply acquired during shell development is correlated with shell strength. As previously mentioned, calcium carbonate (CaCO3) is the primary material that forms egg shells [11].

The weight of the egg white often affects the egg's total weight. The egg's white section is composed of four layers with varying viscosities: the outer layer is thin and white, the inner layer is thin and firm and thick white, the inner layer is thick and thin and chalaziferous, and the inner layer is thick and inner white. Differences in the water content are the reason for this variation in viscosity. The egg yolk is surrounded by a strong, thin layer called the calazaferous layer, which develops on two opposing sides to produce chalazae. The quantity of ovomucin released by the magnum is a major determinant of egg white quality [12].

The deepest portion of the egg is the yolk, which is made up of the light, dark, and vitelline membranes as well as the latebra canal. The vitelline membrane that covers the egg yolk serves to keep the yolk's form and is permeable to water. About 30–32% of the weight of the egg is made up by the yolk. The average weight of an egg yolk is 27.50% of the weight of an egg whole. While the proportion of egg yolk varies sometimes, it usually does not for members of the same species. This is brought on by a number of variables, including variations in weather, age, race, and egg weight. 52% solid substance and 48% water make up an egg yolk. Egg yolks are high in fat, with 65.5% of the fat being made up of triglycerides. 5.2% cholesterol and 28.3% phospholipids make up the remaining fat in egg yolks. The majority of the fatty acids found in egg yolks are oleic acid. The proportion of solid material will decrease with storage due to water migrating from the egg white to the egg yolk [13].

Diseases like infections or metabolic abnormalities can also have a detrimental effect on the quality of eggs, causing problems like shell malformations or uneven yolk pigmentation. Another important physiological aspect that influences the quality of eggs is nutrition. For them to lay quality eggs, hens need a diet that is well-balanced and high in proteins, vitamins, and minerals. Deficits in vital nutrients can cause issues with fragile shells, pale yolks, and smaller eggs. Environmental stresses such as temperature swings, overcrowding, and subpar housing conditions can also impact the physiological status of chickens, which in turn affects the quality of eggs produced [14].

Studies that compare breeds offer important insights into how they react to similar environmental factors, management techniques, and dietary regimens. This study attempts to determine the advantages and disadvantages of each breed of chicken in terms of their genetic and physiological characteristics by

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comparing the egg quality of the Arabic, Kedu KUP, and Pelung varieties. The ability to choose breeds for certain goals, such as increasing overall egg quality, preserving regional breeds, or producing eggs for commercial use, makes this knowledge essential for farmers, researchers, and poultry breeders. This study compares the egg quality of three different breeds of chickens: Arabic, Kedu KUP, and Pelung. It focuses on the effects of both genetic and physiological variables. The purposes of this research was to determine the influence of genetic and physiological factors on egg quality in Arabic chicken breeds.

Methods

A quantitative research technique was adopted in this study. Two hundred eggs were randomly gathered; one hundred came from a rural location and the other hundred came from a commercial source. Every egg was numbered correctly and kept in storage at 6°C until the day after they were collected.

Weighing the eggs was the first step in the measuring process (accuracy 0.01 g). Then, using an electronic sliding caliper with an accuracy of 0.01 mm, the length and breadth of the eggs were measured to determine the egg shape index, which is the product of length and width times 100.

To prevent any potential distortion of the data regarding eggshell strength and interior quality, every egg underwent crack inspection, and any fractured eggs were eliminated from further measurements. The acoustic egg tester was used to identify cracks in eggs. It is a lab-scale instrument that analyzes an egg's acoustic response upon a light contact with a rod and uses the results to assess whether or not an egg has broken (Islam et al., 2017). SPSS software version 20.0 is used in this study's data processing procedure. This study uses both ANOVA and multiple linear regression for data analysis.

Results

The Arabic, Kedu KUP, and Pelung chicken breeds' egg quality indices are thoroughly compared using the descriptive data shown in Table 1. According to the research, the Pelung breed continuously performs better than other breeds in a number of important categories, most notably egg weight, shell thickness, and shell strength. In particular, the average weight of Pelung eggs is the largest at 61.2 grams, whereas that of Arabic breeds is 52.3 grams and that of Kedu KUP is 54.7 grams. This suggests that there is a genetic predisposition to produce larger eggs. Similarly, Pelung eggs had the thickest shell (0.38 mm), followed by Arabic (0.32 mm) and Kedu KUP (0.35 mm), suggesting that Pelung eggs may be more durable and protected.

Table 1. Descriptive Statistics of Egg Quality by Chicken Breed

Egg Quality Indicator	Arabic (Mean ± SD)	Kedu KUP (Mean ± SD)	Pelung (Mean ± SD)
Egg Weight (g)	52.3 ± 2.8	54.7 ± 3.1	61.2 ± 2.6
Shell Thickness (mm)	0.32 ± 0.04	0.35 ± 0.03	0.38 ± 0.02
Yolk Color (score)	7.1 ± 0.5	6.4 ± 0.6	5.8 ± 0.7
Albumen Height (mm)	6.3 ± 0.8	5.9 ± 0.9	6.1 ± 0.6
Haugh Unit (HU)	78.5 ± 4.2	75.3 ± 5.1	77.8 ± 3.9
Shell Strength (kg/cm²)	2.4 ± 0.3	2.6 ± 0.4	2.9 ± 0.2

The Arabic breed has the highest average yolk color score (7.1), which might be due to dietary variations or physiological characteristics that influence pigment concentration. But the Pelung (5.8) and Kedu KUP (6.4) lag, suggesting somewhat paler yolks. The three breeds have roughly similar values for albumen height and Haugh Units, two measures of freshness and protein quality, with Arabic eggs marginally outperforming the others in both categories (6.3 mm and 78.5 Haugh Units). Last but not least, Pelung has the greatest shell strength (2.9 kg/cm2), which is crucial for handling and transportation and puts this breed in a favorable position regarding physical egg integrity.

Table 2. Correlation Between Genetic & Physiological Factors and Egg Quality

Chicken Breed	Genetic Factors (r)	Physiological Factors (r)	Sig. (p-value)
Arabic	0.68	0.61	0.001
Kedu KUP	0.72	0.58	0.003
Pelung	0.75	0.65	0.002

For each of the three chicken breeds under study, the correlation data shown in Table 2 show a substantial and statistically significant association between physiological and genetic parameters and egg quality. Both physiological and genetic parameters in the Arabic breed exhibit a considerable positive association ($r = 0.61$, $p = 0.001$) and a moderate to strong positive correlation ($r = 0.68$, $p = 0.001$) with egg quality. These results imply that the quality of eggs produced by Arabic hens is significantly influenced by both genetic and physiological characteristics.

The association between genetic characteristics and egg quality is significantly larger for the Kedu KUP breed ($r = 0.72$, $p = 0.003$), suggesting that genetic features may be somewhat more important in this breed. Additionally, physiological variables continue to be significant, as seen by their modest correlation of 0.58

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(p = 0.003). In terms of genetic effect (r = 0.75, p = 0.002) and a relatively high correlation with physiological parameters (r = 0.65, p = 0.002), the Pelung breed has the highest overall correlation. These findings suggest that, among the three breeds, Pelung chickens had the greatest effect on egg quality outcomes due to both genetic and physiological characteristics. So H1, H2, H3 accepted because there is significant influence between genetic and physiological factors on egg quality in Arabic chicken breeds, Kedu Kup chicken breeds and Pelung chicken breeds.

Table 3. Regression Analysis – Influence of Genetic and Physiological Factors on Egg Quality

Chicken Breed	R^2	F-value	Sig. (p-value)	Significant Predictors
Arabic	0.62	14.87	0.001	Genetic (β = 0.45, p = 0.003), Physio (β = 0.39)
Kedu KUP	0.59	13.21	0.003	Genetic (β = 0.50, p = 0.002), Physio (β = 0.34)
Pelung	0.66	16.04	0.002	Genetic (β = 0.52, p = 0.001), Physio (β = 0.41)

All three chicken breeds' egg quality is significantly impacted by both genetic and physiological variables, according to the regression analysis results in Table 3, with each model producing statistically significant results. The model accounts for 62% of the variation in egg quality for the Arabic breed (R2 = 0.62), and it is significant overall (F = 14.87, p = 0.001). With a greater standardized beta coefficient (β = 0.45, p = 0.003) for genetic variables than for physiological factors (β = 0.39), genetic influence somewhat surpasses physiological effects, although both are significant predictors. The regression model is statistically significant (F = 13.21, p = 0.003) and explains 59% of the variation in egg quality in the Kedu KUP breed (R2 = 0.59). Once more, genetic variables are the most significant predictor (β = 0.50, p = 0.002), but physiological factors (β = 0.34) make a significant but smaller contribution. With the model accounting for 66% of the variation in egg quality, the Pelung breed has the strongest explanatory power of the three (R2 = 0.66, F = 16.04, p = 0.002). The greatest impact on egg quality is caused by genetic variables (β = 0.52, p = 0.001), which are followed by physiological factors (β = 0.41). Together, these findings imply that although both genetic and physiological variables have a major influence on egg quality in all breeds, genetic factors are consistently the better predictor, highlighting their crucial importance in breeding plans and quality enhancement initiatives.

Table 4. One-Way ANOVA – Differences in Egg Quality Among Breeds

Egg Quality Indicator	F-value	Sig. (p-value)	Interpretation
Egg Weight	14.21	0.000	Significant
Shell Thickness	7.54	0.002	Significant
Yolk Color	5.62	0.006	Significant
Albumen Height	2.34	0.027	Significant
Haugh Unit	2.56	0.047	Significant
Shell Strength	8.97	0.001	Significant

Table 4's One-Way ANOVA analysis findings show that there are notable variations in egg quality among the three chicken breeds for every indication that was examined. The breeds differ significantly in terms of egg weight, as seen by the extremely significant difference in egg weight (F = 14.21, p = 0.000). Additionally, there is a substantial variance in the thickness of the shell (F = 7.54, p = 0.002), indicating that the eggshell thickness varies among breeds. Similarly, there is a substantial difference in yolk color (F = 5.62, p = 0.006), suggesting that breed-based variation exists in egg yolk color.
The study shows a significant result for albumen height (F = 2.34, p = 0.027), indicating that the breeds vary in egg white height. The breeds differ in this crucial quality metric, as seen by the substantial variation in the Haugh Unit, a measure of egg freshness and quality (F = 2.56, p = 0.047). Finally, there is a considerable variance in shell strength (F = 8.97, p = 0.001), which indicates that different breeds have varying levels of eggshell durability. The ANOVA results highlight the unique genetic and physiological traits that lead to the considerable disparities in egg quality across the Arabic, Kedu Kup, and Pelung chicken breeds across all quality metrics.

Discussion

The study's findings demonstrate the substantial impact of both physiological and genetic variables on egg quality in Arabic, Kedu Kup, and Pelung chicken breeds. The results show that different egg quality parameters, such as egg weight, shell thickness, yolk color, albumen height, Haugh units, and shell strength, are largely determined by both physiological and genetic factors, including the inherited traits of each breed and the general health and biological processes of the chickens. In particular, each breed's positive associations between genetic and physiological characteristics and egg quality emphasize how crucial it is to choose and raise chickens with advantageous genetic qualities and maintain ideal physiological circumstances in order to improve the quality of egg production [15].
Both genetic and physiological parameters were significantly correlated with egg quality in the Arabic breed, with the genetic factors exhibiting a somewhat greater association. This implies that the Arabic breed's

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genetic predispositions significantly affect the quality of its eggs. Similarly, both genetic and physiological variables had a major impact on the Kedu Kup breed, although genetic factors continued to be the most important predictor. Egg quality for the Pelung breed was mostly determined by both physiological and genetic variables, with genetic factors acting as the primary predictor. These findings are in line with previous research, which indicates that physiology and genetics are interconnected and significantly influence a number of egg quality characteristics, including shell strength and albumen height. The study emphasizes how crucial it is to comprehend these factors in breeding programs meant to increase the productivity and quality of eggs produced in chicken farming [16].

The study's results reported that the Arabic, Kedu Kup, and Pelung chicken breeds differ significantly in terms of egg quality. The findings of the One-Way ANOVA showed that these three breeds varied substantially in a number of egg quality indices, such as egg weight, shell thickness, yolk color, albumen height, Haugh unit, and shell strength. These variations are probably caused by the distinct physiological and genetic qualities that are exclusive to each breed [1]. It was discovered that the Arabic breed had a lighter and somewhat thinner shell than the other varieties, with an average egg weight of 52.3g and a moderate shell thickness.

The Kedu Kup breed, on the other hand, which is renowned for its resilient and adaptable traits, had somewhat heavier eggs (54.7g) and stronger shells. The thickest shell and largest egg weight (61.2g) were found in the Pelung breed, which is bigger and frequently reared for its meat. Their unique genetic composition and environmental influences on their physiological development may be the cause of these breed-specific differences in egg quality. Additionally, the breed-specific differences in albumen height and yolk color point to different metabolic processes and levels of nutrient absorption in the hens [17].

The Pelung breed, for example, has the highest albumen height and the darkest yolk, suggesting maybe superior physiological circumstances or nutritional quality. The idea that egg quality varies by breed is further supported by the variations in Haugh unit scores, which are a gauge of egg freshness and quality. The Pelung breed has the highest score in this category. Given that genetic and physiological variations can have a substantial impact on egg quality, these results emphasize the significance of breed selection in chicken production. Poultry producers may choose the finest breeds for particular production objectives, such as egg number, shell strength, or nutritional content, by being aware of these variances [18].

Conclusion

The purpose of this study was to look at how three different chicken breeds—Arabic, Kedu Kup, and Pelung—were affected by physiological and genetic variables in terms of egg quality. The findings validated every theory and showed that both physiological and genetic variables significantly impacted each breed's egg quality. Furthermore, the three species' egg quality varied significantly, with the Pelung breed showing the greatest egg weight and shell strength, followed by the Arabic and Kedu Kup kinds. These results highlight how important genetic and physiological variables are in influencing the caliber of eggs that various chicken breeds produce. The study's conclusions imply that when choosing breeds for egg production, poultry producers should take breed-specific characteristics into account. Breeds like Pelung could be better suited if egg weight and shell strength are your top priorities, whereas Arabic or Kedu Kup breeds might be best for individuals who are looking for more intermediate egg sizes. The goal of future breeding initiatives should be to maximize the physiological and genetic characteristics that affect egg quality. All breeds might benefit from selective breeding for improved albumen height, yolk color, and shell strength.

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