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Effects of egg shape and egg weight on body weight during the starter phase in Kedu chickens

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ABSTRACT

This study evaluated the effects of egg shape and egg weight on the body weight of Kedu chickens up to 3 weeks of age. A total of 100 fertile Kedu chicken eggs were classified into three categories based on the egg shape index (ES): elongated (ES-I), normal (ES-II), and round (ES-III). The eggs were incubated under controlled conditions, and the chicken were reared in a brooding cage until 3 weeks of age. Body weight was recorded at 0, 1, 2, and 3 weeks. Data were analyzed using ANOVA, linear regression, and correlation analyses to assess the relationships between egg shape, egg weight, and body weight. No significant differences were observed in hatch weight or subsequent body weight among the egg shape groups, indicating that egg shape had no significant influence on these parameters. In contrast, egg weight exhibited a very strong positive correlation with hatch weight (r = 0.829), with 68.83% of the variation in hatch weight explained by egg weight. However, the correlation between egg weight and body weight declined markedly after the first week, suggesting that post-hatch growth is more strongly influenced by factors such as feed quality, management practices, and genetic potential. These findings provide useful insights for hatching egg selection strategies aimed at enhancing the productivity of Kedu chickens.

Introduction

Kedu chickens are a local poultry breed that originated from and developed in the Kedu District area. Kedu chickens have good adaptability, are resistant to heat stress, exhibits rapid growth, and has a high egg production. At 12 weeks of age, the weight of Kedu chickens reaches 572–729 grams, whereas at the same age, native chickens weight 490.62 grams and Kampung Unggul Balitbangtan (KUB) chickens weight 506.53 grams (Indriana *et al*., 2023). Another potential source of Kedu chickens is their high egg production capacity. The egg production of Kedu chickens reaches 200 eggs/year through intensive rearing (Nataamijaya, 2010).

Kedu chickens represent a valuable indigenous genetic resource in Indonesia, characterized by a range of favorable traits. To ensure their long-term sustainability and to optimize their genetic potential, continuous and well-structured development efforts are essential. Currently, breeding practices among Kedu chicken farmers are generally unregulated, with the absence of standardized breeding guidelines. This lack of structured selection often leads to random mating without consideration of genetic or phenotypic quality, which may contribute to a gradual decline in key traits such as growth performance and disease resistance. One of the most practical and effective strategies to address this issue is the implementation of an early selection program. Such a program should begin with the careful selection of high-quality hatching eggs, as this is a critical step in producing superior day-old chicks (DOC) with desirable characteristics for further breeding and production (Esatu *et al*., 2023).

Previous studies have investigated the relationship between egg quality particularly egg weight and shape, and the growth performance of broiler chickens. Iqbal *et al*. (2017) reported that egg size significantly influences the hatching weight of chicks and their body weight during the first three weeks of age, although this effect diminishes after the fourth week. The underlying mechanism is attributed to the higher nutrient content present in larger eggs, which provides the developing embryo with greater nutritional resources, resulting in heavier DOC (Paputungan *et al*., 2017). Furthermore, Akil and Zakaria (2015) found that chicks with higher hatching weights tend to possess a greater number and larger size of cells compared to those with lower hatching weights. These cellular differences contribute to enhanced cell growth and division, which may support improved early post-hatch development.

Although similar research has been conducted on Kedu chickens, previous studies have not examined the influence of egg shape as a contributing factor. Therefore, investigating the effects of both egg weight and shape on the growth performance of Kedu chickens is warranted. The present study aimed to evaluate the relationship between egg weight and egg shape expressed as egg index and the body weight of Kedu chickens during the starter phase. The findings are expected to support early selection practices by identifying optimal egg characteristics for hatching. The results of this study may provide valuable insights into the most suitable egg index and weight for producing high-quality day-old chicks, thereby serving as a practical reference for improving the efficiency and effectiveness of breeding programs for Kedu chickens.

Materials and methods

This study was conducted at the Faculty of Animal and Agricultural Sciences, Universitas Diponegoro. The materials used were 100 fertile eggs obtained from 12 hens of Kedu chicken.

Preparation of hatching eggs

Kedu chicken eggs were collected twice daily, in the morning and afternoon. Selection was based on eggs with intact shells and clean physical appearance. To ensure hygiene, the selected eggs were first washed with warm water to remove visible dirt, followed by disinfection using 70% al-

cohol. Each egg was labeled with a unique identification code (Fig. 1) and weighed three times to ensure accuracy and consistency. Weighing was performed using a digital scale with a precision of 0.1 grams, ensuring that the egg was positioned centrally on the scale during each measurement (Fig. 2). Egg length and width were measured using digital calipers (Figs. 3 and 4). The egg shape index (ESI) was calculated according to the method described by Alasahan and Copur (2016), using the formula:
Egg shape= (gg width/Egg length) x 100%

Eggs were then classified based on their ES values. The intervals were determined using the following formula:
Class Inverval= Highest value - Lowest value/Desired number of classes

Based on the class intervals calculated using the aforementioned formula, eggs were categorized into three groups according to their egg shape index (ES) values: elongated (ES-I) with an index of 70.11–74.13%, normal (ES-II) ranging from 74.14–78.16%, and round (ES-III) from 78.17–82.19%.

Fig. 1. Giving code to eggs.

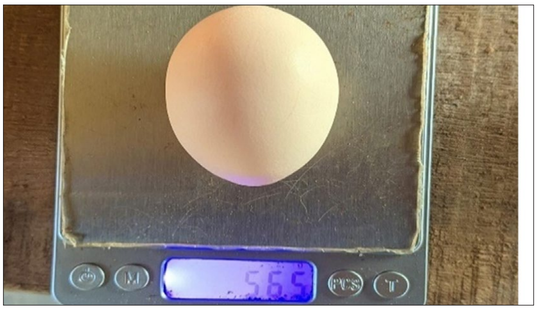

Fig. 2. Egg weight measurement.

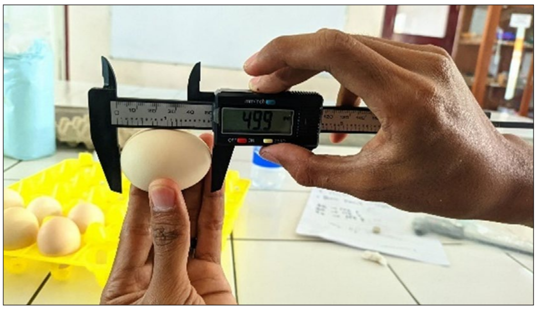

Fig. 3. Egg Length Measurement.

Fig. 4. Egg width measurement.

Incubator preparation

Prior to use, the incubator was thoroughly cleaned using alcohol and antiseptic solutions and allowed to air dry for 24 hours. The cleaning process included sanitizing the water tray, which was then placed inside the incubator. Following cleaning, the incubator was powered on and adjusted to maintain a temperature range of 37.0–37.5°C and a relative humidity of 55–60%. The egg rotation mechanism was programmed to turn the eggs every 4 hours, as recommended by the manufacturer (Mitra Jaya). The incubator was considered ready for use once temperature and humidity levels stabilized within the specified parameters.

Egg incubation

Eggs deemed suitable for incubation were carefully placed in the incubator. During the first three days, the incubator remained closed to maintain stable temperature and humidity conditions, and the egg-turning mechanism was temporarily deactivated. After this initial period, the egg-turning system was activated, and temperature and humidity levels were monitored daily. Water was added to the tray as necessary to sustain humidity, ensuring that adjustments were made gradually to prevent abrupt fluctuations in environmental conditions.

Embryonic development and mortality were assessed through weekly candling. The first candling, conducted between days 1 and 7, was used to differentiate live fertile eggs, dead fertile eggs, and infertile eggs (Alasahan and Copur, 2016). Live fertile eggs were identified by the presence of a spider web-like network of blood vessels with a central embryo, whereas dead fertile eggs exhibited a darkened blood spot (Okatama *et al*., 2018). Infertile and dead fertile eggs were removed promptly to prevent contamination and conserve incubator space.

Between days 19 and 21, the automatic egg-turning system was disabled to facilitate hatching. Throughout the hatching period, continuous monitoring was conducted to accurately identify chicks as they emerged. Hatched chicks were marked immediately to prevent confusion with those hatched from other eggs.

Chicken management

Day-old chicks were initially housed in a brooding cage for seven days, after which they were transferred to a rearing cage until reaching three weeks of age. The brooding temperature was maintained between 32 and 35°C to provide optimal warmth during the early developmental stage. Hatch weight was recorded by weighing chicks once their feathers were dry (Fig. 5). Feed and drinking water were provided ad libitum throughout the rearing period, with a vitamin supplement (Vitachick) added to the drinking water to support health and growth. Body weights of the chicks were measured at 1, 2, and 3 weeks of age (Figs. 6, 7, and 8, respectively). Weighing was conducted each morning prior to feeding to ensure consistent and accurate assessment of growth performance.

Fig. 5. Hatch weight measurement.

Fig. 6. Week 1 Body weight measurement.

Fig 7. Week 2 body weight measurement.

Fig. 8. Week 3 body weight measurement.

Data analysis

Data were analyzed using the Statistical Analysis System (SAS) OnDemand for Academics. The effect of egg shape on hatch weight and body weight at weeks 1 through 3 was evaluated using one-way analysis of variance (ANOVA). When significant differences were detected, Duncan's multiple range test was conducted for post hoc comparisons. Additionally, regression and correlation analyses were performed to assess the relationship between egg weight and body weight of the chickens.

Results

The effects of egg shape on hatch weight and body weights at 1, 2, and 3 weeks of age are summarized in Table 1. Statistical analysis revealed no significant differences (P > 0.05) among the egg shape groups for any measured parameter. The average hatch weights were 30.27 ± 4.03 g for the elongated group (ES-I), 28.86 ± 4.73 g for the normal group (ES-II), and 28.91 ± 3.30 g for the round group (ES-III). Corresponding average body weights at week 1 were 51.80 ± 11.31 g (ES-I), 52.60 ± 11.59 g (ES-II), and 55.41 ± 8.04 g (ES-III). At week 2, the averages were 96.35 ± 22.35 g (ES-I), 97.51 ± 21.01 g (ES-II), and 104.82 ± 17.08 g (ES-III). At week 3, body weights were 154.56 ± 30.81 g (ES-I), 157.48 ± 31.23 g (ES-II), and 162.87 ± 25.98 g (ES-III).

The relationship between egg weight, hatch weight, and subsequent body weights at 1, 2, and 3 weeks of age is summarized in Table 2. Correlation and regression analyses indicated a strong positive association between egg weight and hatch weight, with a correlation coefficient (r) of 0.82967 and a coefficient of determination (R^2) of 68.83%. This suggests that approximately 69% of the variation in hatch weight can be attributed to differences in egg weight. In contrast, the correlation between egg weight and body weight at 1 week of age was very weak (r = 0.05144; R^2 = 0.26%), indicating a negligible relationship. Similarly, the associations between egg weight and body weights at 2 and 3 weeks of age were not significant, with R^2 values < 2%, suggesting that the influence of egg weight on growth diminishes rapidly after hatching.

Table 1. Effect of egg shape on hatch and Kedu chicken weights (g).

Egg Shape[1]	n [2]	HW[3]	BW[4] Week 1	BW[4] Week 2	BW[4] Week 3
ES-I	22	30.27±4,03	51.80±11,31	96.35±22,35	154.56±30.81
ES-II	47	28.86±4,73	52.60±11,59	97.51±21,01	157.48±31.23
ES-III	31	28.91±3,30	55.41±8,04	104.82±17,08	162.87±25.98
Total	100	29.19±4,18	53.30±10,55	99.52±20,31	158.51±29.48

[1]ES = Egg shape. [2]n = number of eggs. [3]HW= Hatch Weight. [4]BW= Body Weight.

Table 2. Relationship between egg weight and kedu chicken weights.

Variable[1]	Egg Weight[2]		
	Regression Equation	r	R^2
HW	Y= 0.01319 + 0,67029X	0.82967	0.6883
BW 1	Y= 48.73252 + 0.10490X	0.05144	0.0026
BW 2	Y= 120.88860 - 0.40101 X	-0.12508	0.0156
BW 3	Y= 173.05681 - 0.33430 X	-0.05867	0.0034

[1]HW= Hatch weight; BW = Body weight. [2] r = correlation; R2 = coefficient of determination; X = independent variable; Y = dependent variable

Discussion

Hatch weights among the ES-I, ES-II, and ES-III groups did not differ significantly (p > 0.05), indicating that egg shape had no measurable effect on hatch weight. This suggests that other factors—such as parental genetics, incubation temperature and humidity, and egg storage conditions—may exert a more substantial influence on hatching outcomes (Iqbal *et al.*, 2014). These findings imply that while egg shape itself may not significantly affect hatch weight, variables such as egg size, incubation parameters, and storage conditions play critical roles in embryonic development, hatchability, and chick viability. Consequently, optimizing these environmental and management-related factors may be more effective for improving hatch performance than focusing solely on egg shape (Molenaar *et al.*, 2010; Tainika *et al.*, 2023).

Similarly, no significant differences in body weights at weeks 1, 2, or 3 were observed among the egg shape groups, further indicating that egg shape does not influence post-hatch growth performance. Instead, growth appears to be governed primarily by nutritional, genetic, and environmental factors. This observation is consistent with the findings of Apalowo *et al.* (2024), who emphasized that postnatal growth in livestock is the outcome of complex interactions between genetic potential and environmental influences. Supporting this, Praptiwi and Wahida (2025) noted that species, sex, age, and feeding strategies are key determinants of growth trajectories in poultry.

In contrast, a strong positive correlation was observed between egg weight and hatch weight, with a coefficient of determination (R^2) of 68.83%, indicating that approximately 69% of the variation in hatch weight could be explained by egg weight. This aligns with earlier research showing that larger eggs typically contain greater yolk and albumen reserves, which are critical for embryonic development and result in heavier chicks at hatch (Paputungan *et al.*, 2017). Furthermore, egg composition and quality particularly yolk content have been shown to significantly influence embryogenesis, a process also modulated by external factors such as temperature and humidity during incubation (Boleli *et al.*, 2016). However, the relationship between egg weight and chick body weight weakened considerably after hatching. At week 1, the correlation was very weak, and by weeks 2 and 3, it became weakly negative. These findings suggest that the influence of egg weight on body weight is transient and does not persist beyond the first week post-hatch.

This decline can be biologically explained by the transition from endogenous to exogenous nutrient sources. During the early post-hatch period, chicks rely on the residual yolk sac for energy and nutrients. By the end of the first week, the yolk sac is mostly absorbed, and chicks become dependent on feed intake and digestive function (Tabeidian *et al*., 2015). From this point onward, growth is driven by factors such as feed quality, nutrient utilization efficiency, gut development, metabolic activity, and immune status, all of which are shaped by genetics, management practices, and environmental conditions, and are largely independent of initial egg characteristics (Gao *et al*., 2025). Additionally, compensatory growth may contribute to the diminishing influence of egg weight. Chicks hatched from smaller eggs may exhibit higher growth rates under optimal conditions, thereby reducing early weight disparities. This adaptive mechanism allows for the equalization of body weights among chicks over time, especially in environments with adequate nutrition and favorable management (kruenti *et al*., 2022).

Moreover, sex-based differences in growth rates may further obscure any residual correlation between egg and body weights in later stages. For instance, males generally grow faster than females, which can introduce variability unrelated to egg size (Sutopo *et al*., 2022). Iqbal *et al*. (2017) also reported that the impact of egg weight and size on chick live weight diminishes with age. Importantly, post-hatch management practices including temperature control, brooding quality, stocking density, and dietary supplementation have been identified as critical determinants of growth performance and health outcomes in poultry (Rao *et al*., 2011). Therefore, emphasis should be placed on optimizing nutritional strategies and rearing conditions to support uniform growth, rather than relying solely on pre-incubation egg characteristics such as weight or shape.

Conclusion

Egg shape did not have a significant effect on hatch weight or body weight of Kedu chickens up to three weeks of age. While egg weight showed a strong correlation with hatch weight, its influence on body weight beyond the first week was minimal. Post-hatch growth was predominantly influenced by factors such as nutrition, management, and genetics.

Conflict of interest

The authors have no conflict of interest to declare.

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