The weight and hatchability of quail egg viewed from the weight, index, and surface area of the egg

T Kostaman and S Sopiyana
Balai Penelitian Ternak, Jl. Veteran III, Banjarwaru Ciawi, Bogor 16720
Email: tatankostaman@gmail.com

Abstract. The research objective was to determine the weight and hatchability of quail eggs which were influenced by the weight, index, and surface area of the eggs. Quail eggs were obtained from Slamet Quail Farm, Sukabumi. The experimental design used was CRD. The treatments consisted of 3 categories, namely light egg weight (≤11.20 g), medium (11.21–13.06 g), and heavy (≥13.07 g); oval egg shape index (≤74.72), normal (74.73–84.04), and round (≥84.05); and the surface area of eggs is narrow (≤89.22 cm²), medium (89.23–95.88 cm²), and large (≥95.89 cm²). The data obtained were analyzed with GLM SPSS 22. If it shows a significant difference, then proceed with the Duncan test. The analysis showed that egg weight had an effect on the weight and hatchability (P<0.05), while the egg index had no effect on the weight and hatchability (P>0.05). While the large surface area affects the weight and hatchability (P<0.05), while the narrow and medium surface area does not affect the weight and hatchability (P>0.05). It can be concluded that the weight and hatchability of quail eggs are influenced by egg weight and large surface area, but not by egg index and narrow and medium surface area.

1. Introduction
The success in the hatching process depends on several factors including egg quality, egg weight, and hatchability [1]. Egg weight and high hatchability can be obtained from the method when selecting hatching eggs. High hatchability can be obtained if the embryo mortality rate is low. Previous research examined the quality of hatchability which was influenced by the size of the egg shape index. Egg shape can affect hatchability due to the internal composition of the egg [2], where eggs that are oval and broad are thought to have a higher internal egg composition, so that later it can have an impact on egg weight, hatching weight and embryo mortality. The egg surface area is a technique used as an indication of measuring the surface area of the egg and is an important geometric calculation for the livestock industry, this is because it can be used to predict child weight and hatchability [3].

In the study, which was used for model livestock was quail. This is because quails are highly productive with shorter generation intervals, require less space, feed, and capital to start up, have greater resistance to disease, and can be raised under a variety of climates and agricultural conditions compared to other bird species. Quail breeding is important because of its meat and eggs.

Hatching weight is the weight of the young immediately after hatching and the coat is dry. Meanwhile, the hatchability of eggs is a number that shows the high and low ability of the eggs to hatch, so that it will be greatly influenced by temperature and humidity, because low temperatures can also cause heart, respiratory, and nutritional problems that the embryo cannot absorb [4].
The effect of egg weight, egg shape index, and egg surface area on hatchability of quail eggs have been widely reported by other researchers [5, 6]. However, there is still little information that evaluates the effect of egg weight, egg shape index, and surface area in one complete paper. Therefore, the study was designed to evaluate these 3 effects on hatching weight and hatchability in quails.

2. Method
The study used 99 quail eggs from Slamet Quail Farm Sukabumi. Before putting the quail eggs into the hatching machine, cleaned slowly using a tissue that has been moistened with warm water. After drying, the eggs were arranged and placed on the trey hatching machine and sprayed with 70% alcohol.

The study used a completely randomized design (CRD) with 3 treatments based on the category of egg weight, egg shape index, and egg surface area. Categorization is calculated by finding the average value and standard deviation, then the average value is calculated by adding and subtracting the average value with a standard deviation [7]. The results of this categorization obtained light egg weight (≤11.20 g), medium (11.21–13.06 g), and heavy (≥13.07 g). The egg shape index is oval (≤74.72), normal (74.73–84.04), and round (≥84.05), while the surface area of the egg is narrow (≤89.22 cm²), moderate (89.23–95.88 cm²), and area (≥95.89 cm²).

Measurement of egg length and width using calipers and egg weights with electric scales. Calculation of egg shape index [8], egg surface area [9], percentage of hatching weight [10], and hatchability [11] were calculated using the formula:

\[
\text{Egg shape index} = \frac{\text{Egg width}}{\text{Egg length}} \times 100
\]  
(1)

\[
\text{Egg surface area} = 4\pi \left( \frac{1}{4(\text{Length}+\text{Width})} \right)^2
\]  
(2)

\[
\text{Percentage of hatching} = \frac{\text{Weight of Day-Old Quail (DOQ)}}{\text{Egg weight}} \times 100\%
\]  
(3)

\[
\text{Hatchability} = \frac{\text{Number of Day-Old Quail (DOQ)}}{\text{Number of fertile eggs}} \times 100\%
\]  
(4)

The data obtained were analyzed using the General Linear Model (GLM) assisted by the SPSS 22 program. If the analysis results show a significant difference, then proceed with Duncan's test [12].

3. Results and discussion
3.1. Egg weight
The weight of the eggs used in hatching is an important aspect that must be considered. Egg weight affected the parameters of hatching weight and hatchability (P<0.05) (table 1). Factors that affect the size of the percentage value of hatching weight are the amount of day-old quail (DOQ) weight and egg weight when entering the hatching machine, according to the formula for calculating the percentage of hatching weight, where the division between DOQ weight and egg weight is multiplied by 100% [10].

It was proven in research that a large egg weight produces a large hatching weight as well. However, when viewed from the number of eggs, the average medium egg weight gives the hatching weight with more eggs compared to light and heavy egg weights, namely 63 (63.64%) vs 15 (15.15%) vs 21 eggs (21.21%).

| Parameters     | Egg weight      |
|----------------|-----------------|
|                | Light          | Medium         | Heavy          |
| Hatching weight (g) | 10.75±0.60 (15) | 12.05±0.50 (63) | 13.38±0.37 (21) |
| Hatchability (%)  | 10.91±0.23 (11)  | 12.04±0.49 (58)   | 13.45±0.35 (15)    |

*abcDifferent letter superscripts on the same line show significantly (P<0.05).
The same thing also happened for the percentage of hatchability, medium egg weight gave better hatchability (69.05%) compared to light eggs and heavy eggs, namely 13.09%, and 17.86%. The same result was reported by Kostaman et al (2020) showed that medium-sized eggs had better hatchability compared to small and large eggs in cemani and white leghorn chickens [13]. However, there are other researchers who divide egg weight into 2 categories, namely small eggs and heavy eggs with an average hatchability of 67.42% (small egg weight) and 78.64% (heavy egg weight) [6]. These differences may arise due to differences in the classification of egg weight, poultry species, and breeds [14].

The average weight of light and heavy eggs in the study was lower than that reported by Hegab and Hanafy (2019), respectively 11.83 and 13.80 g [6]. The difference may be due to differences in the classification of egg weight as previously mentioned, where the study was divided into 3 groups, while only 2 groups reported by Hegab and Hanafy (2019), so the data range in the study was shorter than the literature [6].

The size of the egg weight is influenced by the factor of the composition of the internal egg ratio, namely the yolk and the egg white. Egg weight is influenced by the size of the yolk [15]. Meanwhile, egg yolk weight is influenced by ovarian development, parent body weight, and sex maturity [16].

### 3.2. Egg shape index

The egg shape index measurement expresses the ratio of the width and length of the egg. The egg shape index is used to determine a good egg shape which is useful as a requirement for hatching eggs. Based on the results of statistical analysis, weight and hatchability were not affected by the egg shape index (P>0.05) (table 2). This is because egg shape is a trait inherited from its parents [17], so that the eggs of each type of poultry have a distinctive shape index according to the shape and size of their reproductive organs and will affect the length and width of the eggs produced. The results of this study are in line with Rozi et al (2018) who reported hatching weight and percentage of hatchability of quail eggs were not influenced by the egg shape index [5].

| Parameters            | Egg shape index |
|-----------------------|-----------------|
|                       | Oval | Normal | Round |
| Hatching weight (g)   | 11.97±0.63 (6) | 12.17±0.96 (86) | 11.78±0.72 (7) |
| Hatchability (%)      | 11.99±0.67 (4) | 12.20±0.87 (73) | 11.57±0.52 (7) |

However, when viewed from the number of eggs, the normal egg shape index gave better results for hatching weight and the percentage of hatchability. The normal hatching weight was 86 (86.87%) compared to the oval hatching weight of 6 (6.06%) and 7 round hatching (7.07%). Likewise, for the percentage of hatchability, the normal egg shape index gave a percentage of hatchability of 86.90% compared to the oval and round egg shape index, 4.74% and 8.33%, respectively. This shows that quail eggs based on the egg shape index in this study have almost uniform shapes leading to normal.

### 3.3. Egg surface area

Based on the category of egg surface area, broad eggs showed significantly different results (P <0.05) with narrow and medium egg categories on the parameters of hatching weight and hatchability (Table 3). The results obtained are comparable to reports of Suselowati et al. (2019) which stated that broad egg categories provide a higher hatching weight compared to narrow and medium egg categories [18]. However, when viewed from the number of eggs, the hatching weight included in the medium egg category showed better results compared to the narrow and wide egg category, each 64 (64.65%) vs 8 (8.08%) vs. 27 items (27.27%). The same thing happened to the average percentage of hatchability, the medium egg category gave a better percentage of hatchability (65.48%) compared to the narrow egg category (7.14%) and broad eggs (27.38%).
Table 3. Hatching weight and hatchability of quail eggs seen from the egg surface area.

| Parameter          | Egg surface area |
|--------------------|------------------|
|                    | Narrow           | Medium          | Large            |
| Hatching weight (g) | 11.36±1.27 (8)   | 11.79±0.64 (64) | 13.18±0.49 (27)  |
| Hatchability (%)   | 11.55±0.90 (6)   | 11.77±0.57 (55) | 13.17±0.49 (23)  |

Different letter superscripts on the same line indicate significantly (P<0.05).

Total eggs used in the study, for medium (egg weight and surface area) and normal (egg shape index) categories showed more eggs than other categories. This is probably because medium and normal-sized eggs are eggs that are in the average group of eggs, so the number will be higher because the average is a number that represents a set of data. However, the egg shape index factor that best gave value to the parameters of hatching weight and hatchability of quail eggs with a percentage above 80%. Meanwhile, egg weight and egg surface area only gave a percentage of less than 65%.

4. Conclusion

The weight and hatchability of quail eggs are influenced by egg weight and large surface area, but not influenced by egg index and narrow and medium surface area.

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