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THE EFFECT OF CAGE ENRICHMENT ON EGG WEIGHT, HATCHABILITY AND HATCH WEIGHT OF PADJADJARAN PARENT STOCK QUAIL

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ABSTRACT

Parent stock quails require special attention in cage management to prevent stress that may affect their productivity. Therefore, this study was conducted to determine the effect of environmental enrichment in cages on egg weight, hatchability, and hatch weight of Padjadjaran parent stock quails. The research was carried out from 1 February-27 April 2025 at the Padjadjaran Quail Breeding Center, Faculty of Animal Husbandry, Padjadjaran University. The research subjects consisted of 100 Padjadjaran parent stock quails, including 80 black line females and 20 brown line males. The study was conducted experimentally using a completely randomized design (CRD) with four treatments: P1 (wire ram cage), P2 (wire ram cage with litter), P3 (wire ram cage equipped with nesting facilities and synthetic grass), and P4 (wire ram cage with litter equipped nesting facilities and synthetic grass). Each treatment was repeated five times, with each replicate consisting four females and one male. The results showed that the average egg weight 11.78 g, hatchability 74.14% and hatch weight 8.18 g. Environmental enrichment of cages using litter, nesting facilities and synthetic grass had no effect on egg weight, hatchability and hatch weight of Padjadjaran parent stock quails.

Keywords : *Cage enrichment, egg weight, hatchability, hatch weight.*

Introduction

Quail is relatively small-bodied and short-legged poultry. Quail has advantages, including reproductive potential, short life cycle, good disease resistance, and rapid reproductive maturity (Batool, 2023). Commonly farmed quail species is *Coturnix coturnix japonica* or Japanese quail. Japanese quail crosses were performed on black plumage females and brown plumage males to produce Padjadjaran quail. This quail has been disseminated since 2014 at Quail Breeding Center, Faculty of Animal Husbandry, Padjadjaran University, Jatinangor, Sumedang (Tanwiriah *et al*., 2024). Crossing these two lines to increase productivity because the pure black and brown lines have different advantages. The advantage of black plumage lines is egg production, while the brown plumage is egg weight.

Quail productivity is influenced by the environmental conditions in which quail perform activities, such as eating, drinking and laying eggs. Cage type, density, and size are important factors in cage construction. Cage models generally do not provide free space for quail to express their natural behavior. Therefore, additional cage elements are needed to maintain quail welfare so that they do not experience stress, which results in a decrease in production performance. Cage construction that considers quail welfare, such as the addition of littered floor (Matur *et al*., 2015) and nesting sites that are given synthetic grass (Ramankevich *et al*., 2022). If quails feel comfortable due to the implementation of animal welfare, this result increase the egg weight and hatching weight (Batkowska *et al*., 2014).

The results of research the littered floor and nesting sites (accompanied by synthetic grass) affect the production output. The littered floor and the addition cage elements have the effect of increasing egg weight (Zemkova *et al*, 2007; Singh *et al*., 2009). Hatchability is influenced by fertility, if cage enrichment shows a higher percentage of fertility compared to cages without enrichment (Ramankevich *et al*., 2022), it will also affect hatchability. Hatching weight is also influenced by egg weight, the larger egg weight, the larger hatching weight (Okatama *et al*.,

2018; Abou-Kassem *et al*., 2024). Eggs with additionnal elements in the cage showed a higher fertility rate compared to the control treatment (Ramankevich *et al*., 2022), which was directly affect hatchability.

Freedom of expression will result in reduced stress levels due to comfortable environmental conditions. Reduced stress has a positive impact on immunity and reproductive hormones that affect productivity. Physical and psychological balance will be maintained if a comfortable cage environment is provided. Therefore, research was conducted to determine the effect of environmental enrichment in cages on egg weight, hatchability, and hatch weight of Padjadjaran parent stock quails.

Materials and Methods

The research was conducted at Padjadjaran Quail Breeding Center, Padjadjaran University. A total of 100 quails were used, consisting of 80 females and 20 males. The quails were reared from one day old (DOQ) to 12 weeks. Feeding was offered twice a day with ad libitum water. The cage used was a wire ram battery cage with a length of 50 cm, width of 40 cm, and height of 25 cm. The cage size was adjusted to the cage density of 25 birds per m^2. Experimental cage units were made as many as 20 units, each unit was filled with 5 quails consisting of 4 females and 1 male.

The study was experimentally using a completely randomized design (CRD) with four treatments, T1 (wire ram cage), T2 (wire ram cage with litter), T3 (wire ram cage equipped with nesting facilities and synthetic grass), and T4 (wire ram cage with litter equipped nesting facilities and synthetic grass). The variables observed in this research are:

1. **Egg Weight**
   Data collection was done by weighing using digital scales. Weighing was carried out on all eggs contained in each experimental unit at 8 weeks, 10 weeks and 12 weeks of production, then the average egg weight was calculated.
2. **Hatchability**
   Hatchability is known by the number of eggs that hatch divided by the number of incubated eggs (calculated as a percentage). The hatchability calculation formula according to Karousa (2015):
   Hatchability of total eggs (%)

$$= \frac{\text{no.of hatch quails}}{\text{no.of inkubated eggs}} \text{ x } 100\%$$

3. **Hatch Weight**
   Hatch weight was determined by weighing newly hatched quail using digital scale. Then, the average hatch weight of the quail was calculated.

Results and Discussion

The results data of the effect of environmental enrichment in various treatments cages (T1: wire ram cage; T2: wire ram cage with litter; T3: wire ram cage equipped with nesting facilities and synthetic grass; and T4: wire ram cage with litter equipped with nesting facilities and synthetic grass) on egg weight, hatchability, and hatch weight showed at Table 1.

Tabel 1. The average of egg weight, hatchability and hatch weight of Padjadjaran parent stock quail

Variables	Treatments			
	T1	T2	T3	T4
Egg Weight (g)	11.72	11.72	11.99	11.67
Hatchability (%)	72.92	76.95	67.84	78.85
Hatch Weight (g)	7.96	8.43	8.21	8.13

Note: T1: Wire ram cage; T2: Wire ram cage with litter; T3: Wire ram cage equipped with nesting facilities and synthetic grass; and T4: Wire ram cage with litter equipped nesting facilities and synthetic grass.

1. **Egg Weight**

The average egg weight of Padjadjaran parent stock quail in the various treatments is presented in Table 1. According to Table 1, the average egg weight of Padjadjaran quail was 11.67-11.99 g. The results of the analysis of variance showed that different cage models had no significant effect on egg weight ($P>0.05$).

The egg weight is higher than the research of Alawiyah *et al*. (2016), which is 11.18 g. The research (Sugiyanto *et al*., 2016) showed that the average egg weight of brown and black crossbred quail was 11.4 grams. The average egg weight of this study is accordance with the quality standards of hatch egg weight, which is at least 10 g (Direktorat Perbibitan Ternak, 2011). Research by Padmakumar *et al*., (2000) showed that littered cages had no significant difference in weight and egg production at the age of 5-50 weeks. Research by Wengerska *et al*., (2022) regard-

ing the enrichment of the cage environment using laying facilities and scratching mats (grass) had no significant difference to egg weight. The results of El-Sheikh's research (2016) also showed no significant effect of cage enrichment on egg weight.

In this study, the amount of feed intake was the same for each treatment which was closely related to egg weight. As stated by Schreiter *et al*. (2020), enriched cage provides quails to express their natural behavior so that they feel comfortable, but it does not affect feed intake. Since feed intake was not signify-cantly different, it is likely that the egg weight produced was also not significantly different. This is in line with the opinion of Listiyowati & Roospitasari (2005) that the amount and quality of feed are environmental factors that affect egg weight.

Eggs contain protein, fat, vitamins, minerals and bioactive substances that are influenced by the ration consumed (Kuang *et al*., 2018). If the supply of one of these nutrients is deficient, it will decrease egg weight. The protein for the layer phase in this study used 20.44%, accordance with SNI 01-3907-2006, which is 20-22% (Standar Nasional Indonesia, 2006). The use of 18-22% protein can increase egg weight because protein affects albumen viscosity (Ardiansyah *et al*., 2016). Ration consumption is influenced, among others, by light intensity which correlates with the production and weight of eggs produced (Erensoy *et al*., 2021). Light intensity that is too low or too high disrupts feeding activity, so nutrient intake is not optimal.

Egg weight is influenced by genetics, natural patterns of egg production, and feed (North & Bell, 1990). The heritability value of egg weight is high, indicating that the inheritance rate of the trait is caused by genetics (Masili & Dako, 2019). Egg weight is also influenced by yolk size, which is affected by the growth of the parent's ovarian follicles (Wibawati *et al*., 2024). If follicular growth is abnormal, the size of the yolk produced will be small and affect the overall egg weight. This is influenced by the age of the parent, the older age, the larger ovaries will produce eggs with a large size as well.

2. Hatchability

The average hatchability of Padjadjaran parent stock quail in the various treatments is presented in Table 1. According to Table 1, the average hatchability of Padjadjaran quail was 67.84%-78.85%. Data transformation using Arcsin transformation, then analyzed for variance. The results of the analysis of variance showed that different cage models had no significant effect on hatchability (P>0.05).

The average of hatchability in all treatments was 74.24%. The average is in accordance with the guidelines of the Direktorat Perbibitan Ternak (2011), which is a minimum hatchability of 70%. Hatchability based on the total eggs incubated in the study (Khurshid *et al*., 2004) obtained results of 55.14%, lower than this study. Likewise, the research of Daikwo *et al*., (2011) showed a lower was 61.31%. However, the results of Uçar's research (2024) obtained higher hatchability results, which amounted to 75.62%. This study is accordance with the research of Uçar (2024) and Damaziak *et al*., (2021), states that there is no significant effect of enrichment cage on hatchability.

Enrichment cages provide to express the natural behavior of quail, thus reducing aggressive behavior, especially in male quail. This decrease in aggressive behavior causes the frequency of mating to increase (Roshdy *et al*., 2010), thus increasing fertility. Enrichment using litter did not affect hatchability, but was able to reduce the frequency of feather pecking (Hossain *et al*., 2024). This decrease was due to the attention of the quail being distracted by scratching using artificial grass and dust bathing using litter. Closed and dark nesting facilities did not affect hatchability, but provided comfort (Struelens *et al*., 2008) because quail like to be isolated and away from the flock when laying eggs (Riber 2013).

In this study, all cage models were still able to maintain good levels of comfort for the quails. Although previous studies suggest that enriched cages provide superior comfort, such differences do not necessarily affect egg hatchability. Sufficient comfort minimizes stress, which is closely associated with eggshell thickness (Widyantara *et al*., 2017). Reduced stress is typically reflected by lower corti-costerone levels (Son *et al*., 2022), allowing the normal production of estrogen and progesterone. The stability of these hormones supports optimal calcium carbonate deposition in the uterus for shell formation (Yan *et al*., 2022). An ideal shell thickness helps regulate water, CO_2, and gas exchange for proper evaporation (Riyanti *et al*., 2004), ensuring healthy embryo development and successful hatching.

Small eggs have lower hatchability than medium or large eggs (King'ori, 2011). Even very large eggs have low hatchability (Duman & Şekeroğlu, 2017) because the embryo produces excess heat that cannot be released optimally (Dassidi *et al*., 2022). In this study, eggs with the highest average weight had the lowest hatchability rate. This was because the incubated eggs were not selected based on weight, resulting in eggs ranging from 9.78-16.04 g. Eggs weighing more than 12.1 grams have decreased hatchability compared to egg weights of 10.1-11 g (Adeyanju *et al*., 2014).

Other factors that affect hatchability are humidity, temperature, and turning position (Adame & Ameha, 2023). Temperature and humidity affect the level of moisture loss of eggs which has an impact on the vitality of the embryo (Adriaensen *et al*., 2022). The results of the break out analysis of eggs that failed to hatch, namely most of the embryos died at a late stage (late death). This happens because the temperature and humidity of the hatcher machine are too high (Wilson, 2004) which causes temperature stress (Masia *et al*., 2024). The death of these embryos causes a decrease in hatchability due to internal factors of the hatching machine.

3. Hatch Weight

The average hatch weight of Padjadjaran parent stock quail in the various treatments is presented in Table 1. According to Table 1, the average hatch weight of Padjadjaran quail was 7.96-8.43 g. The results of the analysis of variance showed that different cage models had no significant effect on egg weight (P>0.05).

This study produced hatch weights that were similar to those reported by Shabirah *et al*. (2016), which amounted to 8.11 and 8.14 g. Similarly, Ismail *et al*. (2025) stated that the hatch weight of Padjadjaran quail eggs was between 8.16-8.23 g. The hatch weight of this study is in accordance with the quality standards of quail hatch weight, which is 8 grams (Direktorat Perbibitan Ternak, 2011). Previous research by El-Sheikh (2016) and Damaziak *et al*. (2021) stated that there was no significant effect of cage enrichment on hatch weight. However, enriched cage environments can reduce stress, as indicated by lower blood corticosterone levels (Son *et al*., 2022). This reduction in stress does not affect hatch weight, but improved welfare and comfort of quail during the rearing period.

Hatching weight is influenced by egg weight, the larger egg weight, the larger hatch weight (Adeyanju *et al*., 2014; Okatama *et al*., 2018). In this study, the egg weight from quails reared in enriched cages did not differ from each other. Egg weight and size determine the amount and quality of nutrients available for embryonic development (Dassidi *et al*., 2022). Large eggs have larger yolk and albumen than small eggs, so that more nutrients are available for embryo development, will be large hatch weights. Genetic factors also affect quail hatch weight, the heritability value is high which indicates the inheritance of traits caused by genetics (Masili & Dako, 2019). Padjadjaran quail genetics are able to provide higher hatching weight results than the hatching weight of their parents, black and brown quail strains (Ismail *et al*., 2025).

Other factors that affect hatch weight are temperature and humidity of hatching machine. Too high temperatures and too low humidity causes small hatch weight because it reduces the metabolic rate and increases water evaporation in the eggs (Wilson, 2004). The higher temperature, the larger egg shrinkage due to heat loss through evaporation (Neonnub *et al*., 2019). If this shrinkage is excessive, dehydration occurs and causes small hatching weights.

Conclusion

Environmental enrichment of cages using litter, nesting facilities and synthetic grass had no effect on egg weight, hatchability and hatch weight of Padjadjaran parent stock quails. The results showed that the average egg weight 11.67-11.99 g, hatchability 67.84%-78.85% and hatch weight 7.96-8.43 g. It is recommended to use wire ram cage with litter because they support animal welfare and produce competitive egg weight, hatchability, and hatch weight compared to other types of cages.

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