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The influence of broiler chicken's breeder age on egg parameters

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Abstract: This study aimed to determine the effects of the breeder (Cobb - 500® lineage) age on egg parameters, such as egg weight, weight at transfer, chick weight at hatch, egg weight loss, egg weight/chick weight, and hatch rate. A total of 1440 eggs from the breeders of different weeks of age were used. The eggs underwent the same hatchery practice conditions, including management, disinfection, storage, and incubation. The experimental design was completely randomized with three treatments (30, 40 to 53 weeks of age) and five replicates of 96 eggs each, totaling 1440 incubated eggs. Three eggs were weighed during the experimental period: before incubation, at transfer to the hatchery, and 21 days after (504 experimental hours). The results were subjected to analysis of variance and, when significant, to Tukey's test (5%). The breeder's age influenced ($p<0.001$) the egg weight ($r = +0.98$), transfer weight ($r = +0.98$), and chick weight at hatching ($+0.91$), establishing a positive correlation, where older breeders produced heavier eggs and chicks. There was also an influence at the breeder age in hatch rate, where younger birds showed a higher hatchability than older breeders ($p<0.05$). It was concluded that the breeder's age influences the weight of the egg and the broiler chick and that younger animals have higher hatchability compared to older animals.

Keywords: Chick development; Egg quality; Hatchability; Reproductive performance.

1. Introduction

The poultry segment holds significant economic relevance both nationally and internationally, to the food industry, especially in chicken meat production, being the second most produced protein in the world with 103.83 million tons (USDA, 2024). This product begins even before the broiler chickens are reared, with the production of the breeders and the production of quality embryonated eggs (Medina et al., 2020). These, when incubated, result in the formation of birds destined for meat production. Hatching weight is directly related to egg weight and the influence exerted by the initial weight can extend throughout the entire rearing period, affecting animal performance (Castro et al., 2020). Thus, the study of factors that interfere with broiler chick production is of great interest to the poultry industry.

The age of the breeder has a major influence on the quality and composition of eggs (Moreno, 2019). As breeders advance in age in weeks, transitioning from the onset of production at 22-28 weeks of age to peak production starting at 30 weeks, there is an increase in lipoprotein synthesis and an extension of the intervals between ovulation cycles, leading to an increase in the proportion of yolk and, consequently, heavier eggs (over 65 grams) (Aviagen, 2018; Nasri et al., 2020). However, this factor occurs while the percentages of eggshell and albumen tend to decrease, culminating in the production of lower-quality eggs (Garcia et al., 2015). The deterioration in eggshell quality in broiler breeders can be largely correlated with a decrease in intestinal calcium absorption, a process that worsens as the birds age. Recent studies indicate that, in addition to reduced calcium absorption, the imbalance between mineral deposition in the shell and the increase in egg size significantly contributes to the decline in shell quality (Zhang et al., 2022). As breeders age, the demand for calcium for shell formation is not efficiently met, resulting in thinner and more fragile shells (Yang et al., 2021).

Egg weight and its physical properties (internal egg quality) are elements that interfere with the proper development of the embryo (Santos, 2014). Higher egg weights result in heavier broiler chicks (Iqbal et al., 2016; Perić et al., 2022), as well as higher broiler chick length at hatching (Nowaczewski et al., 2022). The evaluation of broiler chick quality can be performed based on the body weight of these animals at hatch. Despite the significant linear relationship between egg weight during the incubation phase and chick weight at hatch, there is controversy regarding whether the higher weight of a one-day-old chick is a reliable indicator of its better post-hatch performance (Ulmer-Franco et al., 2010).

Studies indicate that in 25-28-week-old (young) breeders, eggs have an average weight of around 55 grams, and chicks at hatching weigh approximately 40 grams. In breeders aged 40-50 weeks, the average egg weight increases to 65 grams, and the chicks' weight rises to 45 grams. In older breeders, at 60 weeks of age, the eggs reach an average weight of 70 grams, resulting in chicks that weigh an average of 50 grams at hatching (Yassin et al., 2008; Moreno, 2019). These data demonstrate a positive relationship between the breeders' age and the egg and chick weight parameters, highlighting the importance of this factor for optimizing incubation procedures and maximizing batch productivity.

The uniformity of one-day-old chicks is increasingly relevant to the economic value of the batch. Therefore, it is necessary to increasingly understand the factors that ensure egg quality and consequently broiler chick quality (Santos, 2014). Moreover, it is established in the poultry sector that the use of eggs with similar weights results in good weight uniformity of the broiler batch (Rocha et al., 2008). This study aimed to evaluate the influence of breeder age on the physical parameters of eggs and chick weight at hatching.

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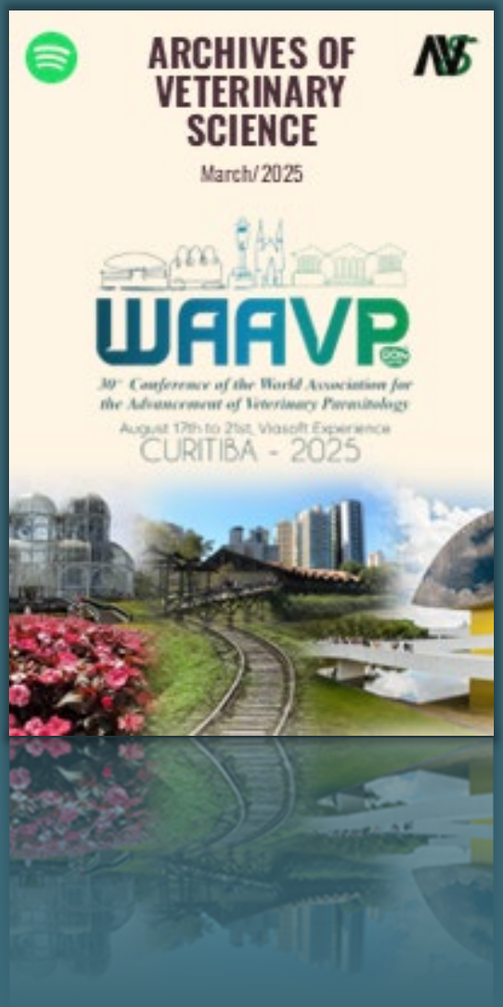

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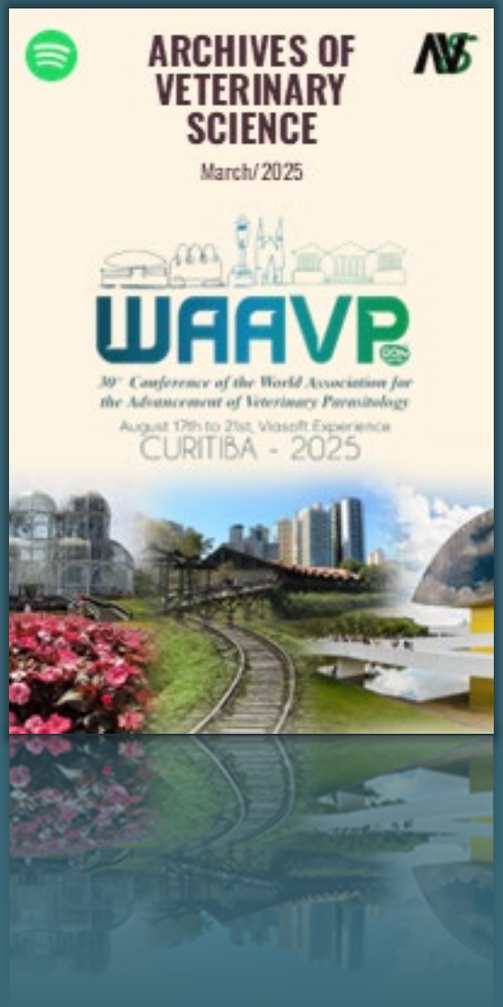

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2. Materials e Methods

A total of 1440 eggs from Cobb-500® (Cobb-Vantress, Inc., Siloam Springs, Arkansas, USA) breeders aged 30, 40, and 53 weeks were used, with 480 eggs from each breeder age group. The eggs were placed in Petersime trays, weighed, identified, and separated into categories according to the breeder's age. Before incubation, the eggs were classified as hatchable, discarding cracked, deformed, dirty, or otherwise unsuitable eggs. The eggs were stored in the stock room for two days at a temperature of 19°C. Before incubation, the eggs were pre-warmed for 5 hours at a temperature of 30°C and then transferred to a multi-stage incubator (Pas Reform, Zeddam, Netherlands), where they were subjected to a temperature of 37.5°C with controlled humidity and ventilation. On day 19 of incubation, the eggs were taken to the transfer area to be weighed, and then the contaminated, infertile, and embryonic mortality eggs were removed. Afterward, the eggs were vaccinated against Marek's disease, Avian Bouba, and Gumboro, (Elanco Animal Health, Greenfield, USA) along with disinfection of the site where the egg was punctured to prevent possible contamination. At the end of the process, the eggs were moved to the hatcher (Pas Reform, Zeddam, Netherlands) and kept at a temperature of 36.5 to 37°C. At 504 hours (day 21 of incubation), after the broiler chicks had hatched, the hatchers were opened and the birds were sent to the classification and counting room. Then, the waste was eliminated, and the birds were weighed.

3. Statistical analysis

The experimental design was completely randomized with three treatments (30, 40, and 53 weeks of breeder age) and five replicates of 96 eggs each. The period analyzed was 21 days (504 hours). The eggs were weighed before incubation, at transfer, and after 504 hours to obtain the values of egg weight (g), transfer weight (g), and chick weight at hatch (g). Egg weight loss (%) was determined by the difference between the egg weight at the beginning and the end of the experimental period, followed by dividing the initial egg weight and multiplying by one hundred. The ratio between egg weight and chick weight (%) was calculated by dividing the egg weight by the chick weight at the hatch. Hatch rate (%) was determined by the total number of incubated eggs and the number of fertile eggs, evaluated on the 19th day of incubation through candling. The data were subjected to analysis of variance (Shapiro-Wilk), and for the characteristics where the values were significant, the means were compared using Tukey's test at a 5% significance level. Furthermore, the analyzed variables were subjected to Pearson correlation analysis, considering a significance level of 5%. The interpretation of the correlation coefficients followed the following classification: very low correlation (0 to 0.2), low correlation (0.2 to 0.4), moderate correlation (0.4 to 0.6), high correlation (0.6 to 0.8), and very high correlation (0.8 to 1.0). All statistical procedures were performed using the Linear Mixed-Effects Models package (Bates, 2015) in R version 4.4.0 (R Core Team, 2024) (Vienna, Austria).

4. Results

The data regarding egg weight (g), transfer weight (g), chick weight at hatch (g), egg weight loss (%), egg weight/chick weight ratio (%), and hatchability rate (%) as influenced by different breeder ages (30, 40, and 53 weeks) are presented in Table 1, along with Pearson correlation coefficients. A very high positive correlation was identified between egg weight and breeder age ($r = +0.98$; $p<0.001$), indicating that older breeders produce heavier eggs. This pattern was maintained through the transfer stage, with eggs from older breeders remaining heavier ($r = +0.98$; $p<0.001$). At hatch, a very high positive correlation was observed between chick weight and breeder age ($r = +0.91$; $p<0.001$), where lighter chicks originated from younger breeders and heavier chicks were derived from older breeders.

Although a high positive correlation was found between hatchability rate and breeder age ($r = +0.61$; $p<0.05$), the average hatchability rate of eggs from 40-week-old breeders did not differ significantly from that of the other ages ($p<0.05$). No statistical differences were observed between breeder ages for the egg weight/chick weight ratio or egg weight loss percentage ($p>0.05$). However, egg weight loss showed a moderate correlation with breeder age ($r = +0.53$; $p<0.05$).

Characteristic	Age of the breeder (weeks)			SEM	Tukey's p-value	Pearson correlation (r-value)
	30	40	53			
Egg weight (g)	56.95 c	64.97 b	70.26 a	1.47	<0.001	0.98
Transfer weight (g)	51.48 c	58.22 b	62.79 a	1.25	<0.001	0.98
Chick weight at hatch (g)	43.58 c	49.04 b	53.95 a	1.23	<0.001	0.91
Egg weight loss (%)	9.60	10.39	10.63	0.21	0.100	0.53
Egg weight/chick weight (%)	76.53	75.47	76.78	0.70	0.750	0.05*
Hatch rate (%)	89.50 a	88.95 ab	82.71 b	1.26	0.036	0.61

SEM: Standard error of the mean. Averages followed by different lowercase letters on the same line differ according to the Tukey test (5%).

*Not significant ($p>0.05$)

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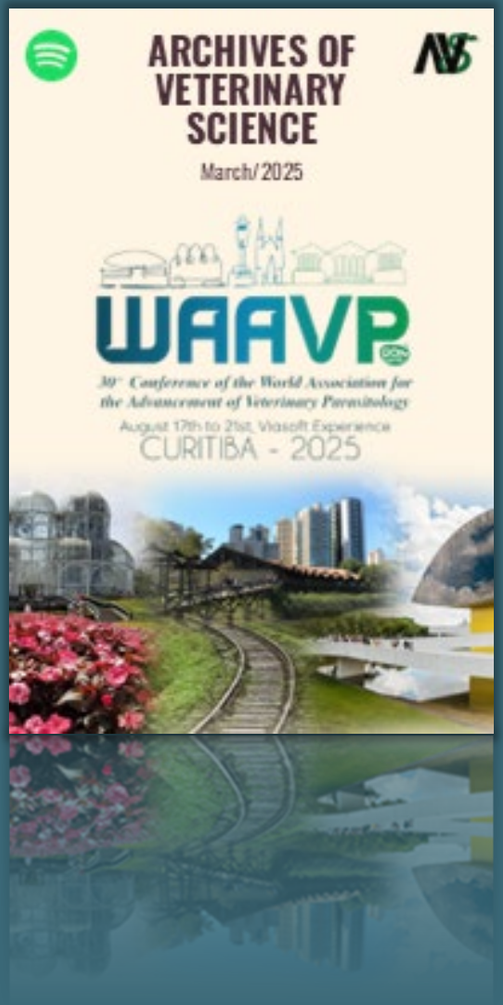

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Table 1 – Effect of breeder age (30, 40, and 53 weeks) on egg weight (g), transfer weight (g), chick weight at hatch (g), egg weight loss (%), egg weight/chick weight (%), and hatch rate (%).

5. Discussion

The relationship between increased egg weight and breeder age is consistent with data reported in the literature (Fernandes et al., 2014; Santos, 2014). Breeder aging affects follicular production, resulting in a decrease, whether due to follicular atresia, internal laying, reduced follicle sequence, or decreased ovulation rate (Lara et al., 2005). As a consequence of this process, larger follicles are produced, leading to eggs from such breeders containing larger yolks. This phenomenon is reflected in the proportional increase in yolk size relative to the total egg weight, contributing predominantly to the overall increase in egg dimensions (Santos, 2014).

Traldi et al. (2018) used Ross breeders of different ages (29 and 55 weeks) in two experiments and observed a positive correlation between egg weight and yolk weight with breeder age. A significant increase in egg weight was observed during the transfer process, in line with the increase in breeder age. Damasceno et al. (2017), who worked with Rhode Island Red breeders (35 and 70 weeks of age), also reported that eggs from younger breeders were smaller and had a greater weight loss at transfer compared to those from older breeders. Castro et al. (2020) used Cobb 500 breeders (32 and 62 weeks of age) and identified a direct positive relationship between broiler chick weight at hatch and breeder age. The same result was found by Luquetti et al. (2004); Ulmer-Franco et al. (2010); Fernandes et al. (2014); Perić et al. (2022).

Broiler chicks from older breeders had greater hatch weights compared to those from eggs of younger breeders. Zocche et al. (2016), in a comparative study with broiler chicks from breeders aged 60, 37, and 27 weeks, reported that chicks from older breeders had body weights at hatching 5.8% and 19.7% higher ($p<0.001$) compared to those from 37- and 27-week-old breeders, respectively. This weight difference remained significant during the early stages of development, including at 108 and 156 hours of age, indicating a continuous influence of breeder age on the initial growth of the chicks. Heavier chicks at hatch exhibit higher growth rates, and greater resilience, and are potentially heavier at the end of the rearing period. The increased yolk production due to the breeder's age is responsible for the greater availability of nutrients for embryo development (Damasceno et al., 2017).

Egg weight loss should be maintained within the range of 6.5 to 14.0% of the initial egg weight to ensure appropriate development of the air cell before internal embryo pipping (Molenaar et al., 2010). The egg weight loss results observed in the present study remained within this range, with no interaction between the values and breeder age. However, the data contradict Perić et al. (2022), who reported a significant effect ($p<0.05$) of egg weight loss with breeder age. The present study indicated a negative correlation between breeder age and hatch rate, suggesting that the efficiency of this process declines as birds age. Similar results were found by Iqbal et al. (2016), where Hubbard Classic breeders at 60 weeks of age exhibited lower fertility (83.87%) compared to those at 30 and 45 weeks of age (92.89 and 93.44%, respectively) and a lower hatchability. Furthermore, the reproductive efficiency of broiler breeders declines with age, a phenomenon associated with changes in the internal composition of the egg, increased egg weight, reduced eggshell quality, and higher incidence of embryonic mortality.

In a comparative study involving breeders aged 29 and 64 weeks, Périć et al. (2022) observed that older breeders exhibited a higher percentage of egg weight loss (6.3%), lower hatchability (10.3%), and greater chick weight at hatching (32.7%) ($p<0.05$) compared to younger breeders. These results highlight the negative impacts of breeder aging on reproductive parameters and embryonic viability. Although older breeders produce heavier eggs, these eggs have thinner eggshells, a higher number of pores, and reduced albumen percentages, resulting in lower quality eggs, which may account for the lower hatch rate (Tona et al., 2004; Carvalho et al., 2007; Molenaar et al., 2010).

6. Conclusion

The results of this study show that the breeder's age had a significant impact on variables related to egg weight, transfer weight, and chick weight at hatch. It was observed that older breeders and heavier eggs are associated with chicks of greater weight at hatching. In contrast, younger breeders demonstrated higher hatchability compared to older breeders.

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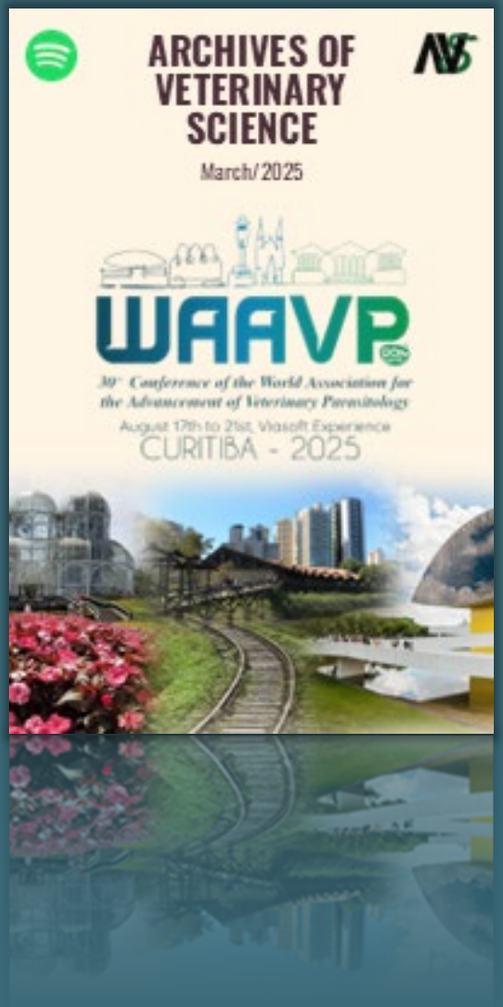

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