Effect of Egg Storage Periods and Broiler Grandparent Stock Age on Chick Quality

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ABSTRACT

The objective of this study was to examine the effect of egg storage periods and the age of broiler grandparent stock on chick quality. The experiment was conducted using a 4x3 factorial design in a Randomized Complete Block Design (RCBD). It involved four different egg storage periods (7, 14, 21, and 28 days) and three age groups of broiler grandparent stock (30, 40, and 50 weeks old). The experiment took place in two houses within a closed system (blocks). A total of 6,048 eggs per house were collected from broiler grandparent stock. There were 12 treatment combinations, and each combination had 3 replicates with 168 eggs per replicate. The data were statistically analyzed using ANOVA, and the differences among the mean values were compared using Duncan's New Multiple Range Test. The findings indicated that eggs stored for 7 days had the highest Pasgar score ($p<0.05$). Eggs stored for 14 days resulted in the longest chicks, while eggs stored for 28 days led to the heaviest chicks and the highest chick yield percentage ($p<0.05$). Additionally, the eggs from grandparent stock at 30 weeks of age had the highest Pasgar score ($p<0.05$). The eggs from grandparent stock at 50 weeks of age had the highest chick weight, chick yield percentage, and chick length ($p<0.05$). In conclusion, hatching eggs should be stored for no more than 14 days and can be collected from broiler grandparent stock at 30, 40, and 50 weeks of age because this will result in the optimum quality of chicks including chick weight, chick length, chicken yield, and Pasgar score.

Keywords: Egg storage periods, Broiler grandparent stock age, Chick quality

INTRODUCTION

Chick quality is critical for the success of hatcheries and poultry productivity. Hatcheries aim to maximize hatchability and chick production. The total length of egg storage can vary between 1-3 weeks due to varying market demands for day-old chicks in the poultry industry and maximum hatchery capacity (Hassan et al., 2005; Kuurman et al., 2002). The quality of day-old chicks is influenced by pre-incubation and incubation factors. Pre-incubation factors include breeder's age, strain, health, nutrition, egg quality, disinfectants, and egg storage periods (Elibol, Peak, & Brake, 2002; Tona et al., 2005). Incubation factors include temperature, humidity, ventilation, and egg-turning frequency (Elibol & Brake, 2006). The duration of egg storage is crucial for both hatchability and chick quality. Therefore, it's important to store the eggs in an optimal environment. If the storage period is less than 4 days, keep the temperature between 20-25℃. For storage periods of 4-7 days, maintain a temperature of 16-17℃, and for storage periods longer than 7 days, the temperature should be 10-12℃ (Meijerhof, 1994). The relative humidity in the storage room should be between 70-85%.

Tercic et al. (2016) studied the effect of egg storage periods on chick quality and found that egg storage periods longer than 7 days had the lowest chick weight and length compared to storage periods of less than 7 days ($p<0.05$). In a study by Decuypere & Bruggeman (2007), it was found that longer periods of egg storage can affect various physiological parameters of embryonic development. These include heat production, metabolism, gas exchange (O2 and CO2), as well as hormonal balances related to thyroid hormones (triiodothyronine, T3; thyroxine, T4; triiodothyronine: thyroxine ratio) and corticosterone. These factors are crucial for the development and survival of the embryo during the incubation period. In addition, the breeder's age influenced chick quality because it affected egg weight, embryo weight, and embryo organ weight. These factors had an impact on chick

quality. In a study by Christensen et al. (2001), it was found that egg weight and egg storage periods have the most significant influence on chick weight after hatching. Additionally, Rifkhan, Gamlath & Adikari (2016) investigated the effect of breeder's age on chick quality and found that older breeders (more than 45 weeks of age) had higher chick weight compared to prime and young breeders ($p<0.05$). The majority of research studies focus on the effect of egg storage periods and broiler parent stock age on chick quality (Peebles et al., 2000; Hamidu et al., 2011; Tercic & Pestotnik, 2016; Jabbar & Yousaf, 2017). However, there are very few research studies on the broiler grandparent stock. Therefore, this research was conducted to study the effect of egg storage periods and broiler grandparent stock age on chick quality.

MATERIALS AND METHODS

Experimental Design

A total of 6,048 eggs per house were collected from broiler grandparent stock. The experiments followed a 4x3 factorial design within a randomized complete block design (RCBD), with four different egg storage periods (7, 14, 21, and 28 days) and three different ages of the broiler grandparent stock (30, 40, and 50 weeks). The experiments took place in two houses within a closed system (blocks). There were 12 different treatment combinations, each with 3 replicates, and 168 eggs per replicate. The broiler grandparent stock was housed in a closed system with an evaporative cooling system (EVAP). The male to female ratio was 1:10, and the broiler grandparent stock was kept under similar environmental and management conditions, including temperature program, ventilation system, lighting schedule, water, and feeding program.

Data Collected

Chick weight and chick yield

After pulling the hatch, 30 chicks per replicate were randomly selected for each treatment combination. The weight and yield of the chicks were then individually measured and calculated according to the following formulas (Aviagen, 2024a, 2024b):

$$\text{Average chick weight (g/bird)} = \frac{\text{Total chick weight (g)}}{\text{Number of chick}}$$

$$\text{Chick yield (\%)} = \frac{\text{Total chick weight (g)}}{\text{Total egg weight (g)}} \times 100$$

Chick length

For each treatment combination, 30 chicks were selected at random for each replicate. A 30-centimeter ruler was used to measure the length of the chicks. The length was measured by placing the tip of the beak at the zero mark of the ruler and stretching the chick along the ruler to the end of its middle toe (Hill, 2001). The average chick length was calculated using the following formulas:

$$\text{Average chick length (cm./bird)} = \frac{\text{Total chick length (cm.)}}{\text{Number of chick}}$$

Pasgar score

In each treatment combination, 30 chicks per replicate were randomly selected and scored using the Pasgar scoring system (Boerjan, 2006). The Pasgar score is based on a list of criteria outlined in Table 1. The highest chick quality is indicated by a total score of 10 points, with one point deducted for each

abnormality recorded in each criterion. The average Pasgar score was calculated using the following formulas:

$$\text{Average Pasgar score (score)} = \frac{\text{Total Pasgar score (score)}}{\text{Number of chick}}$$

Table 1 Criteria used to downgrade chicks for the analysis of the Pasgar score

Category	Criteria for downgrading
Reflex	Chicks need more than two seconds to turn from lying on their back to a normal position.
Navel	Navel closed with small white knob; small black knob; large black knob; remnants of yolk; open navel; down is smeared with albumen, knob.
Legs	Red hooks, swollen hooks, malformations.
Beak	Red dot, nostrils contaminated with albumen; malformed beak.
Yolk	No yolk left, the yolk sac is too large.

Source: Boerjan. (2006).

Statistical Analysis

The data was analyzed using Analysis of Variance (ANOVA). The differences in mean values for chick weight, chick yield percentage, chick length, and Pasgar score were compared using Duncan's New Multiple Range Test (Duncan, 1955). Statements of significance were based on $p<0.05$.

RESULTS AND DISCUSSION

Chick weight was significantly affected ($p<0.05$) by the interaction between egg storage periods and broiler grandparent stock age (Table 2). The eggs from grandparent stock at 50 weeks of age and storage of 7, 14, 21, and 28 days resulted in significantly higher chick weights ($p<0.05$) compared to the eggs from grandparent stock at 30 and 40 weeks of age with storage periods of 7, 14, 21, and 28 days. Meanwhile, the eggs from grandparent stock at 30 weeks of age and storage of 14, 21, and 28 days showed the lowest chick weights ($p<0.05$).

The study revealed that the interaction between the storage periods of eggs and the age of the broiler grandparent stock had an impact on the weight of chicks. The weight of chicks improved with the age of the broiler grandparent stock due to differences in egg weight, embryo weight, and embryo organ weight. According to Christensen et al. (2001), egg weight and storage duration were the most influential factors affecting chick weight after hatching. Williams (1994) also noted that larger eggs contained more nutrients than smaller eggs, resulting in developing embryos from larger eggs having more nutrients for their growth.

The findings agree with Okur, Eleroglu, & Turkoglu (2018) who reported that chick weight was significantly affected ($p<0.05$) by the interaction between egg storage periods and broiler parent stock age. However, these results differed from the findings of Alsobayel, Almarshade, & Albadry (2013), who reported no significant interaction ($p>0.05$) between egg storage periods and broiler parent stock age on chick weight. They observed that chick weight was highest when the eggs were stored for 0 days, while eggs from broiler parent stock aged 50-55 weeks resulted in the highest chick weight. Similarly, other studies have also reported that eggs from broiler parent stock older than 50 weeks had the highest chick weight ($p<0.05$) (Iqbal et al., 2016; Jabbar & Ditta, 2017; Mohammed & Ali, 2019; Rifkhan et al., 2016).

Table 2 Effect of egg storage periods and broiler grandparent stock age on chick weight (gram)

Grandparent stock age (Weeks)	Egg storage periods (Days)			
	7	14	21	28
30	36.55^{e}± 0.066	36.92^{de}± 0.196	38.03^{d}± 0.217	37.33^{de}± 0.426
40	43.12^{c}± 0.726	43.03^{c}± 1.324	42.76^{c}± 0.494	42.87^{c}± 0.348
50	44.85^{b}± 0.415	45.96^{ab}± 0.400	46.19^{a}± 0.193	46.88^{a}± 0.509

Means ± SE

^{a,b,c,d,e} Means with different superscripts differ significantly ($p<0.05$)

The percentage of chick yield was significantly affected by the interaction between the age of the broiler grandparent stock and the storage period of the eggs (Table 3). Eggs from 50-week-old grandparent stock stored for 28 days had the highest chick yield percentage (69.82 ± 1.105%). The eggs from 50-week-old grandparent stock also had the highest egg weight and yolk proportion compared to eggs from 30 and 40-week-old grandparent stock. Moreover, eggs stored for 28 days showed decreased embryo development and nutrient utilization from the yolk. The study discovered that eggs from grandparent stock at 50 weeks of age, stored for 28 days, had the lowest Pasgar score. This was due to the chicks having a closed navel with a small white or black knob and a yolk sac that was too large.

Aviagen (2017) suggests that the ideal chick yield percentage should be 68-69%. For each week of egg storage, 0.5% should be added to this percentage. Considering that the eggs in the present study were stored for a maximum of 28 days, the chick yield percentage should range from 67-70%. The results of this study indicate that all egg storage periods and broiler grandparent stock ages led to optimal chick yield percentages.

The findings of Alsobayel, Almarshade & Albadry (2013) differ from these results. They reported no interaction ($p>0.05$) between egg storage periods and broiler parent stock age on chick yield percentage. In their study, egg storage periods increased and resulted in the lowest chick yield percentage. However, other studies align with our results, showing that eggs from broiler parent stock more than 50 weeks of age had the highest chick yield percentage ($p<0.05$) (Iqbal et al., 2016; Jabbar & Ditta, 2017; Rifkhan, Gamlath & Adikari, 2016).

Table 3 Effect of egg storage periods and broiler grandparent stock age on chick yield (%)

Grandparent stock age (Weeks)	Egg storage periods (Days)			
	7	14	21	28
30	$68.00^{ab}\pm 0.650$	$68.07^{ab}\pm 1.694$	$69.28^{ab}\pm 1.044$	$69.71^{a}\pm 0.301$
40	$68.79^{ab}\pm 0.117$	$68.91^{ab}\pm 1.624$	$68.10^{ab}\pm 0.282$	$69.41^{ab}\pm 0.419$
50	$67.46^{b}\pm 0.504$	$68.88^{ab}\pm 0.412$	$69.21^{ab}\pm 0.391$	$69.82^{a}\pm 1.105$

Means ± SE

^{a,b} Means with different superscripts differ significantly ($p<0.05$)

The length of chicks was significantly affected ($p<0.05$) by the interaction between egg storage periods and the age of the broiler grandparent stock (Table 4). The eggs from the 50-week-old grandparent stock, stored for 14 days, resulted in the longest chick length (19.60 ± 0.106 cm), which was significantly longer ($p<0.05$) than others. However, there was no significant difference in chick length ($p>0.05$) when compared to the eggs from grandparent stock at 40 and 50 weeks of age with a storage period of 7 days. On the other hand, eggs from the 30-week-old grandparent stock, stored for 21 days, produced the shortest chick length (17.86±0.023 cm) ($p<0.05$). However, there was no significant difference in chick length ($p>0.05$) compared to the eggs from the 30-week-old grandparent stock

with storage periods of 28 days, and from the 40-week-old grandparent stock with storage periods of 21 and 28 days.

In a study by Hill (2001), it was observed that chick length increased as the breeder's age increased. Decuypere & Bruggeman (2007) noted that factors such as heat production, metabolism, hormonal balances (specifically thyroid hormones T3 and T4, as well as the T3:T4 ratio), corticosterone, and gas exchange (O_2 and CO_2) played a significant role in embryonic development and survival during incubation. Additionally, Tona et al. (2004) found that egg storage periods had an impact on embryo physiology. Specifically, eggs stored for 3 days exhibited higher concentrations of T3, T4, and T3:T4 ratio compared to eggs stored for 18 days ($p<0.05$).

The findings align with those reported by Rifkhan, Gamlath & Adikari (2016), who discovered that eggs from broiler parent stock aged 46-65 weeks yielded the longest chick length compared to those from broiler parent stock at 26-35 and 36-45 weeks of age ($p<0.05$). Iqbal et al. (2016) noted that eggs from broiler parent stock at 60 weeks of age produced the longest chick length ($p<0.05$) compared to those from broiler parent stock at 30 and 45 weeks of age. Gharib (2013) found that an egg storage period of 4 days resulted in the longest chick length ($p<0.05$) compared to storage periods of 7, 10, and 14 days. Moreover, Goliomytis, Tsipouzian & Hager-Theodorides (2015) reported that an egg storage period of 4 days resulted in the longest chick length compared to a storage period of 16 days ($p<0.05$).

Table 4 Effect of egg storage periods and broiler grandparent stock age on chick length (cm.)

Grandparent stock age (Weeks)	Egg storage periods (Days)			
	7	14	21	28
30	$18.19^{de} \pm 0.047$	$18.33^{d} \pm 0.018$	$17.86^{f} \pm 0.023$	$18.15^{def} \pm 0.127$
40	$19.40^{ab} \pm 0.205$	$19.27^{b} \pm 0.026$	$17.95^{ef} \pm 0.059$	$18.16^{def} \pm 0.045$
50	$19.38^{ab} \pm 0.007$	$19.60^{a} \pm 0.106$	$19.19^{b} \pm 0.141$	$18.82^{c} \pm 0.330$

Means ± SE

^{a,b,c,d,e,f} Means with different superscripts differ significantly ($p<0.05$)

The Pasgar score was significantly affected ($p<0.05$) by the interaction between egg storage periods and broiler grandparent stock age (Table 5). The eggs from the grandparent stock at 30 weeks of age, stored for 7 days, had the highest Pasgar score (9.87 ± 0.049), which was significantly different ($p<0.05$). However, there was no significant difference in Pasgar score ($p>0.05$) between the eggs from the grandparent stock at 30 weeks of age, stored for 7 days, and the eggs from the same stock stored for 14 days, as well as the eggs from the grandparent stock at 40 weeks of age stored for 7, 14, and 21 days. On the other hand, the eggs from the grandparent stock at 50 weeks of age, stored for 28 days, had the lowest Pasgar score (8.59 ± 0.299), which was significantly different ($p<0.05$).

The study discovered that longer egg storage periods and older broiler grandparent stock were associated with the lowest Pasgar score ($p<0.05$). Specifically, eggs from grandparent stock at 50 weeks of age and storage periods of 28 days had the lowest Pasgar score. The extended storage periods impacted embryonic development, leading to slower hatching, reduced nutrient absorption and utilization from the yolk sac, and increased heat production.

Boerjan (2006) found that the best chick quality was associated with a Pasgar score of 10 points. Eggs from broiler parent stock at 35 weeks of age had a higher Pasgar score compared to eggs from broiler parent stock at 45 weeks of age. This was due to the higher number of chicks with navel and beak contamination from residual albumen. These findings differed from those reported by Iqbal et al. (2016), who found that the age difference of the breeders did not significantly affect Pasgar scores ($p>0.05$).

Table 5 Effect of eggs storage periods and broiler grandparent stock age on Pasgar score (score)

Grandparent stock age (Weeks)	Egg storage periods (Days)			
	7	14	21	28
30	$9.87^{a} \pm 0.049$	$9.75^{ab} \pm 0.084$	$9.54^{bc} \pm 0.019$	$9.49^{bc} \pm 0.096$
40	$9.66^{ab} \pm 0.045$	$9.71^{ab} \pm 0.030$	$9.69^{ab} \pm 0.049$	$9.50^{bc} \pm 0.011$
50	$9.37^{c} \pm 0.014$	$9.34^{c} \pm 0.212$	$9.06^{d} \pm 0.038$	$8.59^{e} \pm 0.299$

Means ± SE

^{a,b,c,d,e} Means with different superscripts differ significantly ($p<0.05$)

CONCLUSIONS

The study found that eggs stored for 7 days received the highest Pasgar score. Eggs stored for 14 days resulted in the longest chicks, while those stored for 28 days produced the heaviest chicks and highest chick yield percentage. Eggs from broiler grandparent stock at 30 weeks of age had the highest Pasgar score, while those from broiler grandparent stock at 50 weeks of age had the heaviest chicks, highest chick yield percentage, and longest chicks. In summary, chick quality was influenced by both egg storage periods and the age of the broiler grandparent

stock. Therefore, hatching eggs should be stored for no more than 14 days and can be collected from broiler grandparent stock at 30, 40, and 50 weeks of age because this will result in the optimum quality of chicks including chick weight, chick length, chicken yield, and Pasgar score.

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