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# Impact of Egg Storage Temperature and Duration on Egg Quality, Hatchability, Post-Hatch Growth Performance, and Carcass Traits of Japanese Quail

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**Abstract**

THIS investigation aimed to highlight the effects of egg storage temperature and duration on Japanese quail egg quality, hatchability, post-hatch performance, and carcass traits. A total of 2400 hatching eggs were obtained from a Japanese quail breeder flock. A 2×3 factorial design was used for this study with two egg storage temperatures, which included room temperature (24 °C) and refrigeration (7 °C), and different storage periods, which included 3, 8, and 12 days. The results of this study revealed that, eggs stored at room temperature for 12 d had the lowest yolk height and index. Albumin height of eggs stored for 3 days had a significantly ($p<0.001$) higher score compared to eggs stored for 8 and 12 days. Eggs stored at room temperature showed a decline in hatchability of fertile eggs (OR=0.56, $P < 0.001$) to refrigeration. Prolonged storage (12 days) drastically reduced the hatchability percentage while increasing embryo loss. The quails produced from 3-day-stored eggs had significantly ($p<0.05$) better growth performance, which was reflected in higher body and carcass weights, lower feed intake, and better feed conversion compared with those of chicks produced from eggs stored for 8 or more days. The highest thigh percentage was observed in quail that was produced from eggs stored for 3 days at refrigeration compared to other storage temperatures and periods. This study concluded that the best results in terms of hatch and post-hatch performance, as well as carcass characteristics, were obtained with refrigerated quail eggs and storage times of three days.

**Keywords:** Egg storage condition, Storage period, Productive performance, Carcass traits, Quail.

## Introduction

The Japanese quail (Coturnix japonica) is a popular bird model in numerous research fields because of its small body size, quick life cycle, disease resistance, low feed requirements, easy maintenance, and high egg production [1]. Regardless of their small body size, meat and eggs are commonly inquired about everywhere in the world. Consequently, they have been raised as dual-purpose birds [2]. Quail eggs have a spherical form, and their shell color has different color characteristics, ranging from dark brown to blue or white, and black and blue spots [3]. Quail eggs are rich in proteins, amino acids, vitamins, and minerals and have low levels of triglycerides and saturated fatty acids. In addition, quail egg protein is considered hypoallergenic, which makes it an alternative for people allergic to chicken egg proteins [4]. Egg consist of three main components: (a) egg yolk, (b) albumen, and (c) eggshell [5]. Egg quality is an important factor for poultry breeders and consumers. Low egg quality results in substantial economic losses for the international egg industry; for example, losses linked to low eggshell quality are estimated to be in the range–6-8% [6].

The process of incubation started when viable eggs entered the incubator and continued until the chicks hatched. To promote embryonic development from oviposition to hatching, the setter creates ideal circumstances for temperature, relative humidity (RH), ventilation, and turning [7, 8]. The storage of eggs prior to incubation is common practice in commercial hatcheries. The objectives are to minimize the expenses associated with transferring

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eggs to the hatchery, pick up enough eggs to fill the setters, and produce many chicks that hatch at the same time [9]. Regarding how long hatching eggs should be stored before incubation. Studies differ based on the species of poultry and the production system. Eggs from broiler and laying hen breeders should not be stored for longer than seven days [10].

Bakst et al. [11] reported that long storage reduced embryo weight compared with a short day of egg storage. Most studies on how egg storage duration affects hatchability and egg quality attributes have concentrated on Japanese quail and broiler breeders [12, 13]. Only a few studies have investigated the effects of egg storage temperature on hatchability and growth characteristics [14]. Therefore, this study was designed to evaluate the effects of storage period and temperature and their interactions on egg quality, hatchability traits, post-hatch growth performance, and carcass traits of the Japanese quail.

## Material and Methods

*Source of eggs*

A total of two thousand and four hundred (2400) hatching eggs were purchased from a single flock of quail birds on the farm in Dumyat. The strain is the black Japanese quail of thirteen weeks of age.

*Experimental Design and Egg Management*

Eggs were stored by adopting two egg storage methods, which include room temperature (24ºC) and refrigeration (7ºC), and for different storage periods, which include 3, 8, and 12 days, thus arranging the experiment in a completely randomized design in a 2 x 3 factorial experimental layout. Each group consisted of four hundred (400) eggs. To test the quality of the eggs, 60 were taken before incubation (10 eggs from each treatment). The remaining eggs were positioned on setting trays with their broad ends facing up in a standard incubator adjusted to 37.5°C and 50–60% relative humidity. Eight times a day, eggs were automatically rotated at a turning angle of ± 45 degrees from their vertical orientation using an automatic timer. The egg-turning process was stopped on the fifteenth day, and the eggs were moved to the hatchery at 36.5°C with a relative humidity of 75–80%. The eggs used to be hatched on the 17th or 18th day. The hatched chicks were brooded at a temperature of 38°C, which was decreased by 3°C per week until it reached 24°C in the sixth week. Thirty (30) chicks were chosen per replicate in each treatment reared on a deep litter system with a 10 cm thickness of hay. The chicks were given free access to water and were fed commercial starter meals with a 24% crude protein content and 2904 kcal/kg of metabolizable energy to meet requirements [1]. The composition and analysis of the experimental basal diet are shown in Table 1. The lighting schedule was 24 hours (2.5 foot-candles) from the first day to day seven and then lowered to 8 hours (0.5 foot-candles) until the end of the experiment.

*Data Collection*

*Egg quality parameters*

A sample from each storage treatment (n = 10) was performed on the day of incubation after the storage period to assess external and internal egg quality parameters.

*External egg quality traits*

Eggs were weighed on a digital balance (0.01-g accuracy). Egg length and breadth were calibrated using digital calipers to the nearest 0.01mm. The egg shape index was computed as breadth-to-length ratio × ×100 according to [16]. Eggshell thickness (mm) was calibrated using an electronic digital caliper, taken as the mean of measures from the equator and both ends of the egg [16]. Eggshell weight (g) was recorded using a digital balance (the Sartorius 1202 MP balance) after the shell had been dried at room temperature, and egg surface area ($cm^2$) was computed as 3.9782*(EW)0.7056 where EW = egg weight (g) [17].

*Internal egg quality traits*

The measurements of the internal qualities were recorded by gently breaking the egg using a scalpel and emptying the contents onto a flat surface. The yolk was gently separated from the albumen for weighing. Albumen weight (g) was computed as egg weight - (yolk weight + eggshell weight). The height and width (mm) of the yolk and albumen were estimated at their highest point using an electronic caliper [18]. Haugh units (HU) were calculated as HU = 100 × log (albumen height - 1.7 × egg weight 0.37+7.6), according to [19]. Yolk index (%) estimates the overall quality of yolk that determines the freshness of an egg = yolk height (cm)/yolk diameter (cm) × 100.

*Hatching Parameters*

After 18 d of incubation, the number of hatched quail chicks and unhatched eggs were recorded. Unhatched eggs were opened to count the number of non-fertilized eggs and eggs with dead embryos. Using macroscopic analysis, some extremely early deaths will probably be classified as infertile [20]. Early embryonic mortality was defined as an embryo with visible black eyes and no feathers, whereas late embryonic mortality was defined as an embryo that was dead, completely grown, and had its yolk withdrawn [21]. Fertility, hatchability of incubated eggs, hatchability of fertile eggs, and embryonic mortality were calculated as follows: Fertility % = number of fertile eggs / total number of eggs set x 100

Hatchability of incubated eggs (%) = number of hatched chicks / total number of eggs set x 100

Hatchability of fertile eggs % = number of released chicks / total number of fertile eggs x 100

Embryo mortality rate = number of dead embryos/total number of fertile eggs x 100. These parameters were recorded according to [22].

*Growth performance*

Hatching quail chicks were weighed at hatch and subsequently weekly until six weeks to determine their body weight (BW) to the closest 0.1 g using a digital balance (Sartorius 1202 MP balance, GmbH, Gottingen, Germany). The chick's body weight gain (BWG) was determined as the difference between two consecutive weights. Feed intake (FI) was computed on a replicate basis as the weekly difference between the amount of feed supplied and the residual feed, thereafter divided by the number of quails per replicate/group. The feed conversion ratio (FCR) was estimated as the quantity of feed needed to yield one gram of gain.

*Carcass Traits*

Thirty birds per treatment were chosen randomly at 6 weeks of age and fasted for twelve hours before being slaughtered. Following weighing, each quail was slaughtered with a sharp knife until it bled entirely. Carcasses were featherless and then weighed. The dressing weight percentages, breast weight %, thigh weight %, and organ weight % (heart, liver, and gizzard) were computed relative to the live weight of birds.

*Statistical analysis*

Data were expressed as mean ± standard error (SE), while categorical variables were presented as counts and percentages (%). To evaluate the effects of two independent factors and their interaction on continuous outcome variables, a two-way Analysis of Variance (ANOVA) was performed. Post-hoc comparisons were conducted using the Tukey's test. The statistical model used was: $X_{rfk} = \mu + S_r + T_f + I_{r*f} + e_{rfk}$. Where: $X_{rfk}$ = value of any observation, $\mu$ = population mean, $S_r$ = storage time effect (3, 8, and 12 d), $T_f$ = temperature effect (room and refrigeration), $I_{r*f}$ = the interaction between storage period and temperature, and $e_{rfk}$ = random error. For binary outcome variables, logistic regression analysis was employed to assess the association between predictor variables and the likelihood of the outcome. Both univariable and multivariable logistic regression models were fitted, and odds ratios (ORs) with 95% confidence intervals (CIs) were reported. Mathematical model of binary logistic regression: $log\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots \beta_m x_m$ $\pi$ indicates the probability of an event. $\beta 1,...,\beta m$ are the regression coefficients associated with the reference group. $x1,\ldots,xm$ are predictor variables (period, temperature). The reference group was represented by $\beta_0$. In logistic regression, the response or dependent variable y is the log odds (log (p/1- p), which is called the logit: $log\left(\frac{p}{1-p}\right) = a + b \times x$ a: is the intercept (constant). b is the regression coefficient of x, and x is the categorical predictor. The odds ratio of explanatory variables is the value that explains how likely a specific value of the independent variable occurs in the response variable. Statistical significance was set at $p < 0.05$. All analyses were performed using SPSS version 25.

## Results

Storage temperature and duration significantly influenced fertility, hatchability, and embryonic mortality, as shown by the odds ratios (OR). Eggs stored at room temperature (24ºC) had 65% lower odds of being fertile (OR=0.35, P < 0.001) and 58% lower odds of total egg hatchability (OR=0.42, P < 0.001) compared to the reference; hatchability of fertile eggs also decline significantly (OR=0.56, P < 0.001). While early embryonic mortality increases 2 times (OR = 1.95, P < 0.001). In contrast, shorter storage periods (3 and 8 days) significantly improved reproductive outcomes compared to 12-day storage. Eggs stored for 3 days had 1.6 times higher fertility% odds (OR= 1.6, P< 0.001) and 4 times higher odds of fertile egg hatchability% (OR= 4.04, P < 0.001), while 8-day storage increased fertility% odds by 1.2 times (OR= 1.2, P < 0.001) and fertile egg hatchability% by 2 times (OR= 2.18, P < 0.001). Additionally, early embryonic mortality % was significantly lower in shorter storage periods, with 3-day storage reducing early mortality odds by 77% (OR=0.23, P < 0.001) and 8-day storage by 57% (OR=0.44, P < 0.001). Late embryonic mortality % for 3-day storage was 42% lower than at 12 days. These findings highlight that prolonged storage (12 days) drastically reduces fertility and hatchability percentages while increasing embryo Loss. Conversely, eggs stored for 3 days had the highest odds of successful hatching (Table 2).

The fertility and hatchability percentages of eggs decline significantly as the storage time and temperature increase, while embryonic mortality rates rise. The optimal storage conditions were achieved at refrigeration for 3 days, yielding the highest fertility rate (84.6%) and hatchability (64.1% of total eggs and 75.8% of fertile eggs). In contrast, eggs stored at room temperature for 12 days exhibited a significant decline in fertility (56.4%) and hatchability (12.3% of total eggs and 21.8% of fertile eggs) accompanied by a substantial increase in early (54.5%) and late (23.6%) embryonic mortality. Refrigeration for 3 days showed reduced both early (11.2%) and late (13%) embryonic mortality (Table 3).

Eggs stored at refrigeration exhibited superior quality traits, including egg weight, shell thickness, egg surface area, albumin (weight, height), yolk (height, index), and Haugh unit scores. The yolk index and Haugh unit were significantly higher in refrigerated eggs (39.68 and 83.344, respectively) compared to room-temperature stored eggs (34.69 and 81.62, respectively). Other traits such as egg shape index, shell weight, eggshell density, yolk weight, and yolk diameter showed no significant difference between room and refrigeration storage conditions. Concerning the egg storage period, eggs stored for 3 days demonstrated superior egg quality characteristics compared to those stored for 12 days but were not significantly different from those stored for 8 days. Eggs stored for 3 days had a significantly greater albumin height (3.63 mm) compared to eggs stored for 8 and 12 days (3.320 and 2.804, $P < 0.001$, respectively). However, the storage duration had no significant impact ($P > 0.05$) on egg shape index, eggshell density, shell thickness, or yolk weight (Table 4).

There were no significant interactions between egg storage period and egg storage temperature on egg quality parameters, except for albumin height and yolk (height, diameter, and index). Regardless of egg storage temperature, the albumin height decreases after 8 days of storage. The highest yolk diameter was observed for 3 days of storage. Eggs stored at room temperature for 12 days had the lowest yolk height and index (6.35 and 26.21, respectively) (Table 5).

The effect of egg storage temperature and period on growth performance from 1st to 6th week is illustrated in Table 5. Egg storage temperature had a significant effect on body weight and feed intake at all ages studied. However, body weight gains (BWG) and feed conversion ratios (FCR) were significantly affected by egg storage temperature at all ages studied except in the 2nd and 5th week for the BWG and the 5th and 6th for the FCR. Chicks weight hatched from refrigerated eggs had significantly ($P< 0.01$) higher body weights than those stored at room temperature. At hatch, BW was (9.13 g) at refrigeration in comparison with room temperature (8.96 g). While BW in the 6th week was 238.28 g for refrigeration and 232.82 g for the room. Eggs stored at refrigeration were higher in BWG at all ages than at room temperature. Between (1-2W) and (4-5W), quail BWG showed no difference between the two egg-stored temperatures. At 4 weeks of age, the quail achieved the highest BWG at refrigeration (49.249 g). BWG at 4-5 w was nearly similar to at 0-1 w. Egg refrigeration storage had lower ($p < 0.05$) FI and FCR than room egg storage. Feed intake at 6th w was 187.25 g for room storage in comparison to refrigeration temperature (191.22 g). Similar trends for the effect of egg storage period on growth performance. Quail weight from eggs stored for 3 days was considerably higher ($p < 0.01$) than those from eggs stored for 8 and 12 days. BW at hatch day for 3 days of storage was 9.28 g. Compared to 8 and 12 days (9.04 and 8.82 g, respectively). In the 6th week, eggs that were stored for 3 days had the highest BW (246.31 g), while eggs that were stored for 8 and 12 days had a decrease in weight (235.33 and 225.008 g, respectively). Eggs stored for 3 days were higher in BWG in all weeks than at 8 and 12 days of age. Between (1-2W) and (4-5W), quail BWG showed no difference between different egg storage. The highest BWG was achieved in the 4th week for 3-day storage (51.646 g). Eggs stored for 3 days had lower ($p < 0.01$) FI and FCR than 8 and 12 days of storage. For 3 days of storage, the amount of feed consumed in the 6th week was higher (202.75 g) than for 8 and 12 days of storage (184.13 and 180.83 g, respectively) (Table 6).

The interaction between period and temperature on productive performance from week 1 to week 6 is demonstrated in Table 5. There is no significant interaction between period and temperature on chick weight at hatch, 2, and 6 weeks of age. BW decreases with increased egg storage temperature and period. Eggs stored at room temperature for 12 days were recorded with the lowest BW at 1, 3, and 4 weeks of age (35.1, 117.8, and 161.8 g, respectively). However, at 5 weeks of age, the lowest BW for 12-day storage regardless of the temperature of storage (189.85 and 194.63 g, respectively). As the temperature and duration of egg storage rise, BWG decreases. The lowest BWG at 0-1 week was observed for eggs stored at room temperature for 12 d (26.40 g), although there was no difference in BWG at 2 temperatures for 3 d storage and refrigeration for 8 d storage. Additionally, there was no significant interaction between temperature and period on BWG at 2-3, 3-4, 4-5, and 5-6 weeks of age. At 3-4 weeks, the highest BWG was at refrigeration for 3 d storage (53.29 g). Whereas those stored in a room for 12 days showed a decline in BWG (44.00 g). There was no significant interaction between storage period and temperature on FCR. Also, the same trend was observed for FI. At 6 weeks of age, the highest FI was at room temperature for 12-day storage (206.50 g), and the lowest was at refrigeration for 3-day storage (179.50 g) (Table 7).

Egg storage temperature and period had a substantial effect on live weight, carcass weight, dressing %, thigh %, and breast %. Eggs stored at refrigeration produced birds with higher significance ($P < 0.01$) BW, carcass wt, dressing %, thigh %, and breast %. Quails produced from eggs stored for 3 days showed a significant increase in BW, carcass weight, dressing %, thigh %, and breast % compared to quails obtained from eggs stored for 8 and 12 days. There is no significant difference in egg storage temperature, and period on the percentage of liver, heart, and gizzard (Table 8).

There is no discernible relationship between storage period and temperature among carcass parameters except for thigh percentage. Carcass characteristics decrease with increasing temperature and storage time. The quail generated from eggs kept for three days at refrigeration had the highest thigh percentage (33.82%).When compared to different storage temperatures and times (Table 9).

## Discussion

This trial was mainly carried out to investigate the effects of egg storage temperature and period on fertility percentage, hatchability percentage, egg quality traits, and post-hatching performance of Japanese quail. The recorded high fertility percentage of eggs stored for 3 days was in the same line with that recorded by [2 , 3]. They found that the shortest storage period produced the best fertility results. Prolonged egg storage before incubation reduced the apparent fertility % of broiler eggs [4-6]. Moreover, the fertility of Naked Neck chickens decreased from 86.67% to 40% during storage of eggs between 7 and 14 days [7]. The highly significant negative correlation between storage periods and fertility may be explained by degeneration of early embryonic cells during extended storage periods [8]. Conflicting findings were reported previously in chicken eggs [9-11], in red-legged partridge [12], and in quail eggs [13]. They found that the differences for the apparent fertility throughout storage duration were not significant. Eggs stored at room temperature (24ºC) had 65% lower odds of being fertile than those stored in refrigeration, which is consistent with the results reported by [7].

The highest hatchability percentage of the total and fertile eggs was observed at 3 days of storage. A similar trend of results was recorded by [11, 14], who indicated that eggs stored for 1 and 4 days had significantly higher hatchability % of total eggs set and hatchability of fertile eggs compared to eggs stored for 7 and 10 days. Furthermore, [15] recorded that hatchability was 78.4% for quail eggs kept for 5 days at 21°C and fell to 35.4% when the storage period was extended to 15 days at the same storage temperature. Also, [16-18] found that storing quail eggs for an extended time reduced the hatchability of viable and set eggs and increased the percentage of embryonic deaths. The results of previous studies that were performed on chickens revealed that eggs kept for more than seven days significantly lowered the hatchability percentage [9, 19, 20]. A decline in hatchability percentages due to the increasing storage duration may be related to the deterioration of internal egg quality characteristics, such as yolk and albumen parameters, which are responsible for embryos' optimal growth and development until hatching [13]. On the other hand, [2, 12, 21, 22], clarified that storage time did not affect the hatchability percentage. The present results revealed that eggs stored at refrigeration temperature have the highest hatchability of total and fertile eggs. These findings are consistent with those obtained by [23] but inconsistent with the former results obtained by [8], which revealed that the storage temperatures of 7 and 20°C showed no significant differences in hatchability of total eggs (43.27 and 35.57%, respectively) and hatchability of fertile eggs (55.50 and 45.58%, respectively).

The percentage of early embryonic death was highest after 12 days of storage at 24°C. These results were in agreement with [23], who found the early death rate for an egg kept at 18°C for 12 days was 8.89%. Moreover, [9,16] found that the percentage of early embryonic death was higher in eggs held for 14 days than in eggs stored at other times. The lowest number of dead embryos was noted during days 1 and 4 of egg storage [3, 11, 24]. Prolonged storage periods increased embryonic mortality due to some embryos not being able to begin developing immediately after normal incubation temperatures were provided or developing at a slower rate [25]. Another explanation for increasing embryonic deaths along with the elongation of the storage duration because of weak albumin quality due to the production of ammonia from the embryo may be the same reason for decreasing embryonic growth [26,27]. Late embryonic mortality increases with an increased storage period due to decreasing nutrients and antioxidant properties of yolk, and these antioxidants are necessary for the hatching of chicks, so embryos are unable to hatch [28]. However, [23] recorded no effect of the storage time on late embryonic deaths.

In this study, eggs stored for 12 days possessed the lowest Haugh unit, which is similar to the results of others [29]. Furthermore, [17, 30] reported that Haugh unit values decreased after 5 days of the storage period ($P < 0.05$). These results may be due to entering $CO_2$ through the pores during storage; the pH of the albumin rises, the complex-forming capacity of ovomucin and lysozyme declines, and the viscosity and Haugh Units fall [29]. Eggs kept in the refrigerator have greater Haugh unit values than eggs kept at ambient temperature due to the refrigeration's capacity to prevent the evaporation of carbon dioxide and water. Albumin height decreases with increased storage time [31]. In this study, eggs stored in a refrigerator have a higher albumin height than room temperature, which agrees with [32], due to increased liquefaction of egg white in room storage. In this investigation, the yolk index and shell weight decline at 12-day storage compared to 3 and 8 days. As storage time increases, the yolk index decreases because of increased water loss from the kept egg [13]. Shell weight declines with the storage period [33]. On the other hand, [34] reported the shell weight was not influenced by the storage period. Eggshell thickness is not affected by the storage period. Such results are in agreement with those reported previously [35, 36] but inconsistent with the former results obtained by [29]. Egg weight and albumen weight were lower in eggs stored for 12 days. While yolk weight was not affected by the storage period, it is supported by studies on broilers [27]. Egg weight, albumin weight, and albumin height had relatively higher scores in eggs stored at refrigeration than at room temperature. In collaboration with the results reported by [37]. The respiratory activity of the egg, which produces water vapor, $CO_2$, ammonia, nitrogen, and hydrogen sulfide gas in the surrounding environment, is linked to this decrease in egg weight at room temperature [38]. The egg weights, eggshell thickness, and dry eggshell weight were not different in the interaction of storage temperature and egg storage duration [7]. On the other hand, [33] recorded a significant interaction of storage temperature and egg storage duration on egg weight loss, eggshell weight and percentage, albumen weight and percentage, and yolk weight and percentage.

The chick weight characteristic of eggs stored for 3 days was superior to those stored for 8 or 12 days. These findings are in agreement with [39]. Additionally, [9, 11, 15, 17] recorded that a long egg storage duration was related to the decrease in chick weight. These results might have originated from the fact that egg weight was the primary determinant of chick weight. The decrease in chick weight was probably caused by the evaporation of water from the egg due to an extended period of storage, which will decrease egg weight [40]. On the other hand, [2, 5, 41] documented no significant effects of the egg storage period on BW at hatch. This could be because the research mentioned above used different breeds, different storage systems, varying weights of eggs, and short storage periods. Interaction between the storage period and the storage temperature has not influenced chick weight at hatch [12]. The body weight and weight gain of eggs hatched from short-term storage were higher than those from longer-term storage. This was similar to [41], who found that during the whole brooding and growing phases, egg storage of more than 5 days considerably decreased the BW and BWG of Leghorn chicks. This substantial reduction in body weight gain brought on by the longer storage time may be the result of poorer egg quality and weaker chicks that perform worse in terms of growth and livability [13]. Feed intake and FCR of the quail that hatched from eggs stored for 3 days were lower than those of quail that hatched from 8-day and 12-day egg storage groups. These data are concurrent with the findings of [30], who found that guinea fowl stored for 10 days had higher feed intake and FCR than those stored for 5 days. Furthermore, [6] recorded that higher FCR was associated with longer egg storage times. Other researchers [42] found that the chicks' FI and FCR were affected by the length of time the broiler breeder eggs were stored. However, several studies [21, 43] observed that the chicks' performance was unaffected by the duration of egg storage.

Our findings showed that quail storage temperature and storage duration have a significant impact on dressing percentage and carcass weight. The dressing percentage of the different egg storage periods and temperatures in the current investigation fell between 72 and 88.1%, as revealed by [44]. However, our findings exceeded those of [45], who stated that the proportion of quail carcass yield was between 67 and 70 percent. The dressing percentage of Japanese quail is affected by the slaughter age, strain, line, and sex of quails [46]. Quails that were produced from eggs stored for 3 days exhibited a significant increase in carcass weight and dressing percentage compared to quails that were produced from eggs stored for 8 and 12 days. These findings concur with those of [14], who discovered that quails generated from eggs held for more than 7 days before incubation had significantly lower percentages of carcass and dressing ($P < 0.05$) than quails produced from eggs stored for up to 4 days. Guinea fowl from eggs held for 5 days had larger carcass yields ($P < 0.05$) than those from eggs stored for 10 days, whereas storage length did not affect the liver or heart [30].

## **Conclusion**

According to the findings of this investigation, increasing the storage period by more than 3 days significantly decreased albumen height, hatchability percentage, body weight gain, feed conversion ratio, and dressing percentage. Moreover, eggs stored at refrigeration exhibited higher hatchability than room eggs and produced heavier chicks. It can be concluded that refrigerated egg storage and storage periods of 3 days were preferable, as they gave the best results for hatch and post-hatch performance and carcass traits.

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*Declaration of Conflict of Interest*

The authors declare no competing interests exist.

*Ethical of approval*

This study follows the ethics guidelines of the Faculty of Veterinary Medicine, Zagazig University, Egypt (ethics approval number; 27/11/2024).

**TABLE 1. Ingredients and nutrient contents of the basal diet of Japanese quail**

| Ingredients | Percentages |
|---|---|
| **Yellow corn** | 52.50 |
| **Soybean meal** | 38.20 |
| **Corn-gluten 60%** | 4.30 |
| **Cotton seed oil** | 1.60 |
| **Di-calcium phosphate** | 1.60 |
| **Limestone** | 1.10 |
| **NaCl** | 0.30 |
| **Premix[1]** | 0.30 |
| **L-lysine** | 0.03 |
| **D-L methionine** | 0.07 |
| **Total** | 100.00 |
| **Nutrient levels[2]** | |
| **CP %** | 24.15 |
| **ME kcal/kg** | 2,904.11 |
| **Ca %** | 0.87 |
| **P% (Avail, P.)** | 0.46 |
| **Lysine %** | 1.31 |
| **Methionine %** | 0.50 |
| **Met+ Cys. %** | 0.82 |

CP, crude protein; ME, metabolizable energy; P%, Av. Phosphorus.

[1] Growth vitamin and mineral premix each kilogram contains of: vitamin A, 10,000 IU; vitamin D3, 2,750 IU; vitamin E, 30 IU; vitamin K3, 2 mg; vitamin B1, 1.5 mg; vitamin B2, 6 mg; vitamin B6, 3 mg; vitamin B12, 12 mg; nicotinic acid, 40 mg; pantothenic acid, 12 mg; folic acid, 0.8 mg; biotin, 0.2 mg; Zn, 100 mg; Mn, 150 mg; Fe, 95 mg; Cu, 10 mg; I, 1.25 mg; Se, 0.3 mg. 2.

[2] Calculated according to NRC [15].

**TABLE 2. Regression analysis results for fertility%, hatchability% of total egg, fertile egg and embryonic mortality%**

<table>
<tr><th rowspan="3">Item</th><th colspan="2">Storage temperature</th><th colspan="5">Egg storage period (day)</th></tr>
<tr><th colspan="2">Room</th><th>12d</th><th colspan="2">3d</th><th colspan="2">8d</th></tr>
<tr><th>OR (CI)</th><th>P- value</th><th></th><th>OR (CI)</th><th>P- value</th><th>OR (CI)</th><th>P- value</th></tr>
<tr><td>Fertility%</td><td>0.35 (0.29-0.43)</td><td>< 0.001</td><td rowspan="5">Ref.</td><td>1.61 (1.28-2.04)</td><td>< 0.001</td><td>1.25 (0.99-1.56)</td><td>< 0.001</td></tr>
<tr><td>Hatchability of total egg %</td><td>0.42 (0.35-0.50)</td><td>< 0.001</td><td>3.44 (2.78-4.27)</td><td>< 0.001</td><td>2.01 (1.62-2.48)</td><td>< 0.001</td></tr>
<tr><td>Hatchability of fertile egg %</td><td>0.56 (0.46-0.69)</td><td>< 0.001</td><td>4.04 (3.14- 5.19)</td><td>< 0.001</td><td>2.18 (1.71-2.77)</td><td>< 0.001</td></tr>
<tr><td>Early Embryonic mortality %</td><td>1.95 (1.54-2.47)</td><td>< 0.001</td><td>0.23 (0.17-0.32)</td><td>< 0.001</td><td>0.44 (0.33-0.58)</td><td>< 0.001</td></tr>
<tr><td>Late embryonic mortality %</td><td>1.13 (0.88-1.45)</td><td>>0.05</td><td>0.58 (0.43-0.80)</td><td>< 0.001</td><td>0.84 (0.63-1.12)</td><td>>0.05</td></tr>
</table>

OR= odds ratio, CI= confidence interval, Ref.= Reference

**TABLE 3. The effect of interactions between egg storage period and egg storage temperature on fertility%, hatchability% of total egg, fertile egg and embryonic mortality%.**

| Item | Egg storage period *temperature | | | | | |
|---|---|---|---|---|---|---|
| | 3 days | | 8 days | | 12 days | |
| | Room (24ºC) | Refrigeration (7ºC) | Room (24ºC) | Refrigeration (7ºC) | Room (24ºC) | Refrigeration (7ºC) |
| **Fertility(%)** | 71.8 | 84.6 | 64.1 | 83.3 | 56.4 | 82.6 |
| **Hatchability(%) of total egg** | 51.3 | 64.1 | 38.5 | 51.3 | 12.3 | 46.7 |
| **Hatchability(%) of fertile egg** | 71.4 | 75.8 | 60 | 61.5 | 21.8 | 56.5 |
| **Early Embryonic mortality (%)** | 13.6 | 11.2 | 21.2 | 19.7 | 54.5 | 23.3 |
| **Late Embryonic mortality (%)** | 15 | 13 | 18.8 | 18.8 | 23.6 | 20.2 |

**TABLE 4. Effect of egg storage temperature and period on quail external and internal egg quality(Means ± S. E).**

| Item | Egg storage temperature | | P-value | Egg storage period (day) | | | P- value |
|---|---|---|---|---|---|---|---|
| | Room (24°C) | Refrigeration (7°C) | | 3 | 8 | 12 | |
| **Egg weight (g)** | 10.77±0.27 | 11.70±0.27 | <0.001 | 11.95±0.33[a] | 11.45±0.33[a] | 10.30±0.33[b] | <0.001 |
| **Egg shape index** | 78.81±0.43 | 77.97±0.43 | >0.05 | 78.73±0.53 | 77.90±0.53 | 77.34±0.53 | >0.05 |
| **Shell weight (g)** | 1.03±0.07 | 1.17±0.07 | >0.05 | 1.20±0.09[a] | 1.20±0.09[a] | 0.90±0.09[b] | <0.001 |
| **Egg shell density** | 47.99±2.97 | 51.34±2.97 | >0.05 | 52.09±3.64 | 53.67±3.64 | 43.24± 3.64 | >0.05 |
| **Shell thickness (mm)** | 0.23±0.01 | 0.27±0.01 | <0.001 | 0.25±0.02 | 0.26±0.02 | 0.24±0.02 | >0.05 |
| **Egg surface area** | 21.22±0.37 | 22.53±0.37 | <0.001 | 22.87±0.45[a] | 22.18±0.45[a] | 20.58±0.45[b] | <0.001 |
| **Albumin weight (g)** | 5.64±0.15 | 6.23±0.15 | <0.001 | 6.41±0.18[a] | 6.05±0.18[a] | 5.35±0.18[b] | <0.001 |
| **Albumin height (mm)** | 3.06±0.07 | 3.44±0.07 | <0.001 | 3.63±0.09[a] | 3.32±0.09[b] | 2.80±0.09[c] | <0.001 |
| **Yolk weight (g)** | 4.10±0.15 | 4.30±0.15 | >0.05 | 4.35±0.18 | 4.20±0.18 | 4.05±0.18 | >0.05 |
| **Yolk height (mm)** | 8.57±0.06 | 9.76±0.06 | <0.001 | 9.89±0.07[a] | 9.67±0.07[a] | 7.94±0.07[b] | <0.001 |
| **Yolk diameter (mm)** | 24.65±0.05 | 24.61±0.05 | >0.05 | 24.85±0.06[a] | 24.82±0.06[a] | 24.21±0.06[b] | <0.001 |
| **Yolk index** | 34.69±0.25 | 39.68±0.25 | <0.001 | 39.81±0.31[a] | 38.96±0.31[a] | 32.78±0.31[b] | <0.001 |
| **Haugh unit** | 81.62±0.52 | 83.34±0.52 | <0.001 | 84.35±0.64[a] | 82.72±0.64[a] | 80.37±0.64[b] | <0.001 |

[a,b,c] Values within a row with different superscripts differ by Tukey test at $P < 0.05$.

**TABLE 5. The effect of interactions between egg storage period and egg storage temperature on external and internal egg quality traits of Japanese quail(Means ± S. E).**

| Item | Egg storage period *temperature | | | | | | P-value |
|---|---|---|---|---|---|---|---|
| | 3 days | | 8 days | | 12 days | | |
| | Room (24°C) | Refrigeration (7°C) | Room (24°C) | Refrigeration (7°C) | Room (24°C) | Refrigeration (7°C) | |
| **Egg weight (g)** | 11.5±0.46 | 12.40±0.46 | 11.10±0.46 | 11.8±0.46 | 9.70±0.46 | 10.9±0.46 | >0.05 |
| **Egg shape index** | 80.25±0.75 | 77.22±.75 | 77.90±0.75 | 77.90±0.75 | 78.27±0.75 | 76.40±0.75 | >0.05 |
| **Shell weight (g)** | 1.14±0.13 | 1.25±0.13 | 1.15±0.13 | 1.25±0.13 | 0.80±0.13 | 1.00±0.13 | >0.05 |
| **Egg shell density** | 51.25±5.15 | 52.93±5.15 | 52.99±5.15 | 54.34±5.15 | 39.73±5.15 | 46.75±5.15 | >0.05 |
| **Shell thickness (mm)** | 0.23±0.03 | 0.29±0.03 | 0.22±0.03 | 0.28±0.03 | 0.24±0.03 | 0.25±0.03 | >0.05 |
| **Egg surface area** | 22.25±0.64 | 23.49±0.64 | 21.71±0.64 | 22.65±0.64 | 19.71±0.64 | 21.45±0.64 | >0.05 |
| **Albumin weight (g)** | 6.06±0.26 | 6.75±0.26 | 5.85±0.26 | 6.25±0.26 | 5.00±0.26 | 5.70±0.26 | >0.05 |
| **Albumin height (mm)** | 3.50 ±0.07[a] | 3.75±0.07[a] | 3.47±0.07[a] | 3.67±0.07[a] | 2.50±0.07[b] | 2.61±0.07[b] | < 0.001 |
| **Yolk weight (g)** | 4.30±0.25 | 4.40±0.25 | 4.10±0.25 | 4.30±0.25 | 3.90±0.25 | 4.20±0.25 | >0.05 |
| **Yolk height (mm)** | 10.07±0.01[a] | 10.04±0.01[a] | 9.30±0.01[c] | 9.72±0.01[ab] | 6.35±0.01[d] | 9.52±0.01[bc] | < 0.001 |
| **Yolk diameter (mm)** | 25.27±0.08[a] | 25.18±0.08[a] | 24.47±0.08[b] | 24.44±0.08[b] | 24.23±0.08[b] | 24.20±0.08[b] | < 0.001 |
| **Yolk index** | 39.86±0.43[a] | 39.76±0.43[ab] | 38.01±0.43[b] | 39.93±0.43[ab] | 26.21±0.43[c] | 39.35±0.43[ab] | < 0.001 |
| **Haugh unit** | 83.94±0.91 | 84.74±0.91 | 81.94±0.91 | 83.50±0.91 | 78.96±0.91 | 81.79±0.91 | >0.05 |

[a,b,c] Values within a row with different superscripts differ by Tukey's test at $P < 0.05$.

**TABLE 6. Effects of egg storage temperature and period on growth performance of Japanese quail(Means ± S. E).**

| Item | Egg storage temperature | | P- value | Egg storage period | | | P- value |
|---|---|---|---|---|---|---|---|
| | Room (24°C) | Refrigeration (7°C) | | 3d | 8d | 12d | |
| **Body weight (g)** | | | | | | | |
| **At hatch** | 8.96±0.06 | 9.13±0.05 | < 0.001 | 9.28±0.04[a] | 9.04±0.08[b] | 8.82±0.01[c] | < 0.001 |
| **1W** | 36.82±0.14 | 37.51±0.12 | < 0.001 | 38.23±0.08[a] | 37.52±0.11[b] | 35.75±0.23[c] | < 0.001 |
| **2W** | 77.39±0.11 | 77.94±0.17 | < 0.001 | 78.85±0.12[a] | 78.09±0.16[b] | 76.06±0.33[c] | < 0.001 |
| **3W** | 122.10±0.18 | 123.48±0.15 | < 0.001 | 126.37±0.11[a] | 123.04±0.15[b] | 118.97±0.31[c] | < 0.001 |
| **4W** | 169.41±0.28 | 172.73±0.23 | < 0.001 | 178.02±0.17[a] | 170.91±0.23[b] | 164.28±0.47[c] | < 0.001 |
| **5W** | 198.01±0.51 | 201.33±0.42 | < 0.001 | 206.66±0.31[a] | 200.01±0.41[b] | 192.24±0.85[c] | < 0.001 |
| **6W** | 232.82±1.13 | 238.29±0.95 | < 0.001 | 246.31±0.68[a] | 235.34±0.91[b] | 225.01±1.89[c] | < 0.001 |
| **Body weight gain (g)** | | | | | | | |
| **0-1W** | 27.87±0.11 | 28.38±0.09 | < 0.001 | 28.95±0.07[a] | 28.48±0.09[b] | 26.93±0.19[c] | < 0.001 |
| **1-2W** | 40.57±0.15 | 40.43±0.13 | >0.05 | 40.62±0.09 | 40.57±0.13 | 40.31±0.26 | >0.05 |
| **2- 3W** | 44.71±0.12 | 45.54±0.10 | < 0.001 | 47.52±0.07[a] | 44.95±0.01[b] | 42.91±0.20[c] | < 0.001 |
| **3-4W** | 47.31±0.29 | 49.25±0.24 | < 0.001 | 51.65±0.18[a] | 47.87±0.24[b] | 45.32±0.49[c] | < 0.001 |
| **4-5W** | 28.51±0.35 | 28.60±0.29 | >0.05 | 28.64±0.21 | 29.19±0.28 | 27.96±0.58 | >0.05 |
| **5-6W** | 34.812±0.72 | 36.96±0.61 | < 0.001 | 39.66±0.44[a] | 35.24±0.58[b] | 32.77±1.21[c] | < 0.001 |

| Item | Egg storage temperature | | P- value | Egg storage period | | | P- value |
|---|---|---|---|---|---|---|---|
| | Room (24ºC) | Refrigeration (7ºC) | | 3d | 8d | 12d | |
| **Feed intake (g/bird)** | | | | | | | |
| **1W** | 32.67±0.48 | 31.44±0.42 | < 0.001 | 30.08±0.42$^{c}$ | 32.00±0.56$^{b}$ | 34.08±0.66$^{a}$ | < 0.001 |
| **2W** | 85.61±0.46 | 83.81±0.40 | < 0.001 | 82.50±0.40$^{c}$ | 84.88±0.52$^{b}$ | 86.75±0.63$^{a}$ | < 0.001 |
| **3W** | 137.28±0.44 | 135.19±0.38 | < 0.001 | 133.42±0.38$^{c}$ | 136.54±0.45$^{b}$ | 138.75±0.60$^{a}$ | < 0.001 |
| **4W** | 113.00±0.46 | 109.33±0.40 | < 0.001 | 107.2±50.40$^{c}$ | 112.00±0.53$^{b}$ | 114.25±0.63$^{a}$ | < 0.001 |
| **5W** | 147.56±0.41 | 145.22±0.35 | < 0.001 | 142.92±0.35$^{c}$ | 146.00±0.47$^{b}$ | 150.25±0.56$^{a}$ | < 0.001 |
| **6W** | 191.22±0.47 | 187.25±0.41 | < 0.001 | 180.83±0.41$^{c}$ | 184.13±0.54$^{b}$ | 202.75±0.64$^{a}$ | < 0.001 |
| **Feed conversion ratio (g feed/g gain)** | | | | | | | |
| **1W** | 1.177±0.02 | 1.11±0.02 | < 0.001 | 1.04±0.02$^{c}$ | 1.12±0.02$^{b}$ | 1.27±0.03$^{a}$ | < 0.001 |
| **2W** | 2.11±0.02 | 2.07±0.01 | < 0.001 | 2.03±0.01$^{c}$ | 2.09±0.02$^{b}$ | 2.15±0.02$^{a}$ | < 0.001 |
| **3W** | 3.079±0.01 | 2.98±0.01 | < 0.001 | 2.81±0.01$^{c}$ | 3.04±0.01$^{b}$ | 3.24±0.02$^{a}$ | < 0.001 |
| **4W** | 2.41±0.05 | 2.24±0.04 | < 0.001 | 2.08±0.04$^{c}$ | 2.34±0.06$^{b}$ | 2.54±0.07$^{a}$ | < 0.001 |
| **5W** | 5.23±0.24 | 5.15±0.21 | >0.05 | 5.06±0.21 | 5.07±0.28 | 5.44±0.33 | >0.05 |
| **6W** | 5.75±0.44 | 5.29±0.38 | >0.05 | 4.89±0.38 | 5.31±0.50 | 6.36±0.60 | >0.05 |

$^{a,b,c}$ Values within a row with different superscripts differ by Tukey test at P < 0.05.

**TABLE 7. The effect of Interaction between egg storage period and egg storage temperature on growth performance of Japanese quail(Means ± S. E).**

| Item | Egg storage period*temperature | | | | | | P-value |
|---|---|---|---|---|---|---|---|
| | 3 days | | 8 days | | 12 days | | |
| | Room (24ºC) | Refrigeration (7ºC) | Room (24ºC) | Refrigeration (7ºC) | Room (24ºC) | Refrigeration (7ºC) | |
| **Body weight (g)** | | | | | | | |
| **At hatch** | 9.15±0.05 | 9.41±0.05 | 9.02±0.07 | 9.05±0.06 | 8.70±0.15 | 8.933±0.12 | >0.05 |
| **1W** | 38.13±0.12$^{ab}$ | 38.33±0.12$^{a}$ | 37.23±0.17$^{cd}$ | 37.80±0.15$^{bc}$ | 35.10±0.36$^{e}$ | 36.40±0.29$^{de}$ | < 0.001 |
| **2W** | 78.88±0.17 | 78.82±0.17 | 77.86±0.24 | 78.32±0.21 | 75.45±0.52 | 76.67±0.42 | >0.05 |
| **3W** | 126.07±0.16$^{a}$ | 126.67±0.17$^{a}$ | 122.44±0.23$^{c}$ | 123.63±0.11$^{b}$ | 117.80±0.48$^{e}$ | 120.13±0.39$^{d}$ | < 0.001 |
| **4W** | 176.07±0.24$^{b}$ | 179.96±0.24$^{a}$ | 170.36±0.34$^{c}$ | 171.46±0.30$^{c}$ | 161.80±0.73$^{e}$ | 166.77±0.59$^{d}$ | < 0.001 |
| **5W** | 204.81±0.44$^{b}$ | 208.51±0.43$^{a}$ | 199.36±0.62$^{c}$ | 200.84±0.54$^{c}$ | 189.85±1.31$^{d}$ | 194.63±1.07$^{d}$ | < 0.001 |
| **6W** | 243.18±0.98 | 249.45±0.96 | 233.22±1.38 | 237.45±1.11 | 222.05±2.93 | 227.97±2.39 | >0.05 |
| **Body weight gain (g)** | | | | | | | |
| **0-1W** | 28.98±0.01$^{a}$ | 28.92±0.01$^{a}$ | 28.21±0.14$^{b}$ | 28.75±0.12$^{a}$ | 26.40±0.29$^{c}$ | 27.47±0.24$^{bc}$ | < 0.001 |
| **1-2W** | 40.75±0.13 | 40.50±0.13 | 40.62±0.19 | 40.52±0.16 | 40.35±0.40 | 40.27±0.33 | >0.05 |
| **2- 3W** | 47.191±0.11 | 47.85±0.10 | 44.589±0.15 | 45.32±0.13 | 42.350±0.32 | 43.47±0.26 | >0.05 |
| **3-4W** | 50.01±0.25$^{b}$ | 53.29±0.25$^{a}$ | 47.91±0.36$^{c}$ | 47.83±0.31$^{c}$ | 44.00±0.75$^{d}$ | 46.63±0.62$^{cd}$ | < 0.001 |
| **4-5W** | 28.98±0.01 | 28.92±0.01 | 28.21±0.14 | 28.75±0.12 | 26.40±0.29 | 27.47±0.24 | >0.05 |
| **5-6W** | 38.37±0.63 | 40.94±0.61 | 33.87±0.88 | 36.61±0.77 | 32.20±1.88 | 33.33±1.53 | >0.05 |
| **Feed intake (g/bird)** | | | | | | | |
| **1W** | 30.50±0.59 | 29.67±0.59 | 33.00±0.84 | 31.00±0.73 | 34.50±1.03 | 33.67±0.84 | >0.05 |
| **2W** | 83.33±0.56 | 81.67±0.56 | 86.00±0.79 | 83.75±0.69 | 87.50±0.97 | 86.00±0.79 | >0.05 |
| **3W** | 134.00±0.53 | 132.83±0.53 | 138.33±0.76 | 134.75±0.65 | 139.50±0.92 | 138.00±0.76 | >0.05 |
| **4W** | 109.50±0.56 | 105.00±0.56 | 114.00±0.79 | 110.00±0.69 | 115.50±0.97 | 113.00±0.79 | >0.05 |
| **5W** | 144.17±0.50 | 141.67±0.50 | 147.00±0.70 | 145.00±0.61 | 151.50±0.86 | 149.00±0.70 | >0.05 |
| **6W** | 182.17±0.57$^{c}$ | 179.50±0.57$^{d}$ | 185.00±0.81$^{b}$ | 183.25±0.70$^{b}$ | 206.50±0.99$^{a}$ | 199.00±0.81$^{ab}$ | < 0.001 |
| **Feed conversion ratio (g feed/g gain)** | | | | | | | |
| **1W** | 1.05±0.02 | 1.03±0.023 | 1.17±0.03 | 1.08±0.03 | 1.31±0.04 | 1.23±0.03 | >0.05 |
| **2W** | 2.05±0.02 | 2.02±0.02 | 2.12±0.03 | 2.07±0.02 | 2.17±0.03 | 2.14±0.03 | >0.05 |
| **3W** | 2.84±0.02 | 2.78±0.02 | 3.10±0.02 | 2.98±0.02 | 3.29±0.03 | 3.18±0.02 | >0.05 |
| **4W** | 2.19±0.06 | 1.97±0.06 | 2.38±0.09 | 2.31±0.08 | 2.64±0.11 | 2.43±0.09 | >0.05 |
| **5W** | 5.08±0.30 | 5.04±0.30 | 5.14±0.42 | 4.10±0.36 | 5.47±0.51 | 5.40±0.42 | >0.05 |
| **6W** | 5.061±0.54 | 4.71±0.54 | 5.56±0.76 | 5.05±0.66 | 6.62±0.93 | 6.11±0.76 | >0.05 |

$^{a,b,c}$ Values within a row with different superscripts differ by Tukey's test at P < 0.05.

**TABLE 8. Effect of egg storage temperature and period on carcass traits of Japanese quail(Means ± S. E).**

| Item | Egg storage temperature | | P-value | Egg storage period | | | P-value |
|---|---|---|---|---|---|---|---|
| | Room (24ºC) | Refrigeration (7ºC) | | 3 days | 8 days | 12 days | |
| **Live weight(g)** | 228.58±1.97 | 235.36±1.68 | < 0.001 | 241.68±1.75$^{a}$ | 232.12±1.75$^{b}$ | 222.12±3.00$^{c}$ | < 0.001 |
| **Carcass weight (g)** | 179.63±2.47 | 188.11±2.01 | < 0.001 | 196.40±2.18$^{a}$ | 183.57±2.18$^{b}$ | 171.78±3.75$^{c}$ | < 0.001 |
| **Dressing %** | 78.36±0.38 | 79.79±0.32 | < 0.001 | 81.11±0.34$^{a}$ | 78.94±0.336$^{b}$ | 77.17±0.58$^{c}$ | < 0.001 |
| **Thigh %** | 31.01±0.01 | 32.04±0.08 | < 0.001 | 33.32±0.08$^{a}$ | 31.14±0.08$^{b}$ | 30.12±0.14$^{c}$ | < 0.001 |
| **Breast %** | 41.12±0.16 | 41.96±0.14 | < 0.001 | 42.62±0.14$^{a}$ | 41.45±0.14$^{b}$ | 40.56±0.25$^{c}$ | < 0.001 |
| **Liver%** | 1.82±0.03 | 1.85±0.02 | >0.05 | 1.83±0.03 | 1.85±0.03 | 1.82±0.04 | >0.05 |
| **Heart%** | 0.51±0.03 | 0.50±0.03 | >0.05 | 0.55±0.03 | 0.52±0.03 | 0.44±0.05 | >0.05 |
| **Gizzard%** | 1.49±0.03 | 1.50±0.03 | >0.05 | 1.50±0.03 | 1.48±0.03 | 1.51±0.05 | >0.05 |

$^{a,b,c}$ Values within a row with different superscripts differ by Tukey's test at P < 0.05.

**TABLE 9. The effect of interactions between egg storage period and temperature on carcass traits of Japanese quail (Means ± S. E).**

| Item | Egg storage period*temperature | | | | | | P-value |
|---|---|---|---|---|---|---|---|
| | 3 days | | 8 days | | 12 days | | |
| | Room (24ºC) | Refrigeration (7ºC) | Room (24ºC) | Refrigeration (7ºC) | Room (24ºC) | Refrigeration (7ºC) | |
| **Live weight (g)** | 238.40±2.48 | 244.97±2.48 | 229.97±2.48 | 234.27±2.48 | 217.38±4.79 | 226.86±3.62 | >0.05 |
| **Carcass weight (g)** | 192.90±3.09 | 199.90±3.09 | 180.37±3.09 | 186.77±3.09 | 165.63±5.98 | 177.93±4.52 | >0.05 |
| **Dressing %** | 80.75±0.48 | 81.47±0.48 | 78.29±0.48 | 79.58±0.48 | 76.03±0.92 | 78.31±0.70 | >0.05 |
| **Thigh %** | 32.81±0.12$^{b}$ | 33.824±0.12$^{a}$ | 30.21±0.12$^{d}$ | 32.079±0.12$^{c}$ | 30.00±0.23$^{d}$ | 30.23±0.17$^{d}$ | < 0.001 |
| **Breast %** | 42.27±0.20 | 42.96±0.203 | 41.11±0.20 | 41.79±0.20 | 39.98±0.39 | 41.14±0.30 | >0.05 |
| **Liver%** | 1.82±0.04 | 1.84±0.035 | 1.86±0.04 | 1.85±0.04 | 1.78±0.07 | 1.86±0.05 | >0.05 |
| **Heart%** | 0.54±0.04 | 0.56±0.04 | 0.53±0.04 | 0.52±0.04 | 0.47±0.07 | 0.42±0.05 | >0.05 |
| **Gizzard%** | 1.49±0.042 | 1.50±0.04 | 1.467±0.04 | 1.48±0.04 | 1.50±0.08 | 1.52±0.06 | >0.05 |

$^{a,b,c}$ Values within a row with different superscripts differ by Tukey's test at P < 0.05.

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## تأثير درجة حرارة تخزين البيض ومدته على جودة البيض، وقابلية الفقس ، وأداء النمو بعد الفقس، وخصائص الذبيحة للسمان الياباني

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**الملخص**

هدفت هذه الدراسة إلى تسليط الضوء على تأثيرات درجة حرارة تخزين البيض ومدته على جودة بيض السمان الياباني، وقابلية الفقس، والأداء بعد الفقس، وسمات الذبيحة. تم استخدام 2400 بيضة تفقيس من قطيع تربية السمان الياباني التجاري الذي يبلغ عمره 13 أسبوعًا وتم تخزينه وفقًا للمعالجات. تمت مقارنة المعالجة بتصميم عاملي 2 × 3 مع درجتي حرارة تخزين البيض، والتي تشمل درجة حرارة الغرفة (24 درجة مئوية) والتبريد (7 درجات مئوية)، ولفترات تخزين مختلفة، والتي تشمل 3 و8 و12 يومًا. كشفت نتائج الدراسات أن البيض المخزن في درجة حرارة الغرفة لمدة 12 يومًا كان له أدنى ارتفاع ومؤشرللصفار. وكان ارتفاع الألبومين في البيض المخزن لمدة 3 أيام أعلى بكثير مقارنة بالبيض المخزن لمدة 8 و12 يومًا.انخفضت نسبة الفقس للبيض المخصب في البيض المخزن في درجة حرارة الغرفة مقارنة بالتبريد. يقلل التخزين المطول (12 يومًا) نسبة الفقس بشكل كبير مع زيادة فقدان الأجنة. كان للسمان المنتج من البيض المخزن لمدة 3 أيام أداء نمو أفضل بشكل ملحوظ والذي انعكس في زيادة أوزان الجسم والذبيحة، وقلة تناول العلف، وتحسين معامل التحويل مقارنة بتلك الخاصة بالكتاكيت المنتجة من البيض المخزن لمدة 8 أيام أو أكثر.سُجِّلت أعلى نسبة أفخاذ في السمان المُنتَج من بيض مُخزَّن لمدة 3 أيام في الثلاجة مُقارنةً بدرجات حرارة وفترات تخزين أخرى. ونستنتج من ذلك أن أفضل النتائج من حيث أداء الفقس وما بعد الفقس، بالإضافة إلى خصائص الذبيحة، قد تم الحصول عليها باستخدام بيض السمان المُبرَّد وأوقات تخزين لمدة 3 أيام.

**الكلمات الدالة:** درجة حرارة تخزين البيض ، فترة التخزين ، الأداء الإنتاجي ، صفات الذبيحة ، السمان.