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PRE-HATCH PERFORMANCE OF JAPANESE QUAIL EGG WEIGHT CATEGORIES INCUBATED AFTER SEVERAL STORAGE PERIODS

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ABSTRACT: One thousand, two hundreds and sixty eggs of Japanese quail (*Coturnix coturnix* Japonica) were set into the incubator maintaining 12 treatment groups in a factorial design experiment (3 × 4) including three categories of incubated quail weight eggs (lower than 11 g., light weight (L), 11–12 g., medium weight (M) and above 12 g., heavy (H)), and four egg storage periods (1, 4, 7 and 10 days). The traits studied were egg weight loss (%) during incubation, embryonic mortality percentage, incubation time, and fertility percentages. Results obtained revealed that, there was a significant ($P<0.01$) increase in egg weight loss (%) with increasing egg weight during incubation while, egg storage period was insignificantly affected on the same trait. Embryonic mortality percentage during the whole incubation period (1-17 days) was significantly ($P< 0.05$) affected by egg weight categories as it decreased by egg weight increase where the best result was obtained with heavy eggs (H) which recorded 22.01%. A significant ($P< 0.01$) effect on incubation time per hour due to quail egg weight was shown while, each of the egg storage periods and interaction effects were insignificant. A significant effect ($P< 0.05$) on fertility percentage due to quail egg weight, egg storage period ($P< 0.01$), while the interaction was insignificant. The best results were with medium (M) egg weight or storage period of 1 day while the highest values (95.83 and 95.12%) were obtained by interaction of 1 day storage period with each of medium (M) or Heavy (H) weights of incubated quail eggs, respectively. Conclusively, it can be concluded that, medium quail eggs and storage periods of 1 day or 4 days gave the best results of pre-hatch performance of Japanese quail under Egyptian conditions.

Key words: Quail, incubation, egg weight, storage period, performance.

INTRODUCTION

Japanese quail research measured by the number of published papers has gradually diminished over the past 10 years, and the trend appears to be due to the decrease of works using Japanese quail as an animal model or of biological studies (Minvielle, 2004). However, quail meat and eggs are very good sources of animal protein that is very low in fat and cholesterol as compared to all other poultry species, which makes it the choice of people who suffering from high blood pressure (Rogerio, 2009). The commercial operations depend on the hatcheries for the supply of day old chicks, while the subsistence farmers hatch their chicks by natural incubation (King'Ori, 2011).

Egg weight in Japanese quail ranged from 8.31 to 13.00g, as reported by Havenstein *et al.* (1988). Taskin *et al.* (2015) illustrated that, fertility percentage significantly ($P < 0.001$) affected with quail egg weight categories, and the highest value was 91.06% with heaviest group of >13.00g. Moreover, optimization of storage period and conditions of hatching eggs are essential for hatching industry.

Iqbal *et al.* (2016) found a significant difference ($P \leq 0.05$) in egg weight loss of different egg sized groups at mid stage of production period. They added that, there is no significant difference between small and medium egg sized groups and the minimum egg weight loss was in large egg size group at different incubation periods, where it varied between 3.27% and

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11.32%, during incubation in different egg size groups.

There is no information or recommendation on the optimum pre-incubation holding period for quail eggs to be hatched (Uddin *et al.,* 1994).

Egbeyale *et al.* (2013) revealed that the egg weight loss of the pullet eggs during incubation influenced by different storage periods, and it decreased as the pre-incubation storage period increased.

There was a significant effect ($P < 0.05$) of main effect of quail egg storage period lengths at 3, 7, 10 and 14 days on embryonic mortality percentage, and the corresponding values were 41.57, 50.31, 42.54 and 63.42%, respectively (Hassan and Abd-Alsattar, 2015). Therefore, the present study aimed to investigate the effect of quail egg weight categories and pre-incubation storage periods on some traits of pre-hatch performance under Egyptian conditions.

MATERIALS AND METHODS

This work was carried out at Poultry Research Farm, Poultry Department, Faculty of Agriculture, Zagazig University, Zagazig, Egypt, during November (2014).

A factorial experiment (3 × 4) as shown in Table 1 was performed including three categories of incubated quail eggs (lower than 11 g., light (L), 11 – 12 g., medium (M) and above 12 g., heavy (H), according to normal distribution and four egg storage periods (1, 4, 7 and 10 days) at 15 - 18°C and 70 – 75% humidity to study the effect of egg weight and egg storage period as a two main factors and their interactions on the pre-hatch performance of Japanese quail eggs.

Twelve experimental groups were used in the present study, during incubation (1-17 days) and fertility percentages were determined.

The experimental material comprised hatching eggs of Japanese quail of laying type purchased from a private farm whereas, birds began laying in the 7th week of age at (230 g). mean body weight. Quail layers were kept in cages and fed *ad libitum* by a complete diet contained of 2900 K.Cal/Kg diet metabolized energy, 20% crude protein and 2.50% calcium according to NRC (1994).

A total number of 1260 eggs (105 eggs for each treatment group) of Japanese quail eggs divided into 12 treatment groups, each of 3 replicates (35 eggs for each replicate), were incubated.

Hatched chicks were counted and non-hatched eggs were broken to determine fertility (%).

Fertility (%) were calculated as equation follow:

$$\text{Fertility (\%)} = \frac{\text{No. of fertile eggs}}{\text{Total eggs set}} \times 100$$

All eggs were set on the tray based on their egg weight groups and storage period groups before placed into the incubator. The eggs were set on 37.5°C and humidity (50 – 60%) while increased to 80 – 90% in hatcher for the period from 1until 15 days of incubation and thereafter reduced by 1.0°C. The temperature and ventilation were automatically adjusted. The eggs were turned around automatically once every two hours per day. The turning of eggs was stopped on 15th day of incubation prior to hatching. The cabinet incubator was used for incubating the eggs.

The quail eggs were transferred from setting tray to hatching tray on 15th day of incubation where, the eggs used to be hatched within 17-18th day. The number of newly quail chicks hatched and the eggs that not hatched were counted.

Un-hatched eggs were opened in order to determine the number of non-fertilized eggs, eggs with dead embryos and with un-hatched chicks.

The eggs were weighed before setting and on the 15th day, incubation weight loss was determined using the below formula:

Weight loss (g) = Initial weight – final weight

$$\text{Weight loss (\%)} = \frac{\text{Weight loss (g)}}{\text{Initial weight (g)}} \times 100$$

To determine the incubation time, eggs were moved into a hatching unit on day 15 of incubation. Because of space constraints, we placed eggs in each individual holding compartment, however we positioned eggs so that they had minimal contact with each other so that between embryo synchronization would not affect hatching times.

Table 1. Experimental design

Treatment group	Factors	
	Egg weight	Egg storage period/day
1	Light < 11.0 g.	1
2		4
3		7
4		10
5	Medium 11 – 12 g.	1
6		4
7		7
8		10
9	Heavy > 12.0 g.	1
10		4
11		7
12		10

Data were statistically analyzed on a 3 × 4 factorial design basis according to Snedecor and Cochran (1982) using the following model:

$Y_{ijk} = \mu + A_i + S_j + AS_{ij} + e_{ijk}$

Where:

Y_{ijk} = An observation, μ = The overall mean, A_i = Effect of egg storage periods (i = 1 to 4), S_j = Effect egg weight categories (j = 1 to 3), AS_{ij} = The interaction between egg weight categories and egg storage periods (ij = 1 to 12) and e_{ijk} = Random error. Differences among means within the same factor were tested using Duncan's New Multiple Rang test (Duncan, 1955).

RESULTS AND DISCUSSION

Egg Weight Categories Effect

Results in Table 2 show a significant (P<0.01) increase in egg weight loss (%) with increasing quail egg weight during first week, second week and all incubation period. The highest egg weight loss value (22.41%) was with heavy quail egg (H). Egg weight loss is an important parameter for incubation and it has been used to estimate vital gas exchange (Rahn *et al.,* 1979), and it has been correlated with embryo metabolism and development rates as reported by Burton and Tullet (1983). Gonzalez *et al.* (1999) illustrated that egg weight loss may be correlated with the surface area of egg, where it increased by increasing of egg weight and most of the energy needed for the embryonic development is taken from the stored fat in the yolk, and for every gram of fat burned, an almost equal mass of metabolic water is generated. They added that incubation egg weight losses are a function of egg characteristics (shell structure, membrane structure and initial egg weight) and interacting incubation conditions (temperature, humidity and air velocity) under which the eggs were set.

Results presented in Table 3 show that the embryonic mortality percentage, during the whole incubation period (1-17 days) was significantly (P< 0.05) affected by egg weight categories and the best result obtained with the heavy eggs (H) which recorded 22.01%.

These results are in agreement with those obtained by Nowaczewski *et al.* (2010) who showed that, heavy quail eggs group (H, 11.51-12.50g.) was characterized by the best hatchability results and the proportions of dead embryos and un-hatched chicks during hatching as compared with the other groups (S, lower than 10.50; M, 10.51-11.50 and XL, higher than 12.51g.), respectively.

Table 2. Egg weight loss percentage ($\bar{x} \pm$ SE) as affected by quail egg weight categories, egg storage period and their interactions

Trait / Factor	Egg weight loss (%) from set to 7th day	Egg weight loss (%) from 7 to 15th day	Egg weight loss (%) at 15th day
Egg weight categories (g.)			
Light	6.78±0.68c	10.97±0.50a	17.33±0.37c
Medium	7.87±0.72b	11.80±0.61b	19.67±0.17b
Heavy	9.13±0.62a	13.28±0.64a	22.41±0.47a
Significance	**	**	**
Egg storage period (day)			
1 day	8.41±0.09	12.59±0.16	20.78±0.33
4 days	8.14±0.19	12.16±0.11	20.07±0.31
7 days	7.94±0.81	11.85±0.60	19.68±0.29
10 days	7.22±0.11	11.47±0.31	18.69±0.21
Significance	NS	NS	NS
Interaction			
Light			
1 day	5.92±0.29	10.40±0.15	16.32±0.48
4 days	6.75±0.38	10.84±0.18	17.25±0.29
7 days	7.05±0.56	11.13±0.35	17.52±0.44
10 days	7.40±0.15	11.52±0.35	18.25±0.19
Medium			
1 day	7.09±0.54	11.36±0.34	18.44±0.41
4 days	7.81±0.36	11.63±0.67	19.44±0.25
7 days	8.22±0.46	11.90±0.27	20.12±0.17
10 days	8.35±0.66	12.32±0.29	20.68±0.52
Heavy			
1 day	8.64±0.58	12.66±0.48	21.31±0.19
4 days	9.27±0.71	13.08±0.36	22.35±0.48
7 days	9.14±0.58	13.44±0.28	22.58±0.25
10 days	9.48±0.59	13.93±0.32	23.40±0.30
Significance	NS	NS	NS

Means in the same column within each classification bearing different letters are significantly ($P<0.05$) different.
** $P < 0.01$ and NS = Not significant.

Table 3. Total embryonic mortality percentage, incubation time and fertility percentage ($\bar{x}$ ± SE) as affected by quail egg weight categories, egg storage period and their interactions

Factor / Trait	Embryonic mortality (%)	Incubation time (hours)	Fertility (%)
	Egg weight (g.)		
Light	25.73 ±1.35a	389.58 ±2.36b	85.42 ±1.14b
Medium	22.45 ±0.74b	392.67 ±2.03b	90.21 ±1.58a
Heavy	22.01 ±0.89b	409.92 ±1.56a	90.19 ±1.78a
Significance	*	**	*
	Egg storage period (day)		
1 day	21.71±0.97c	391.67±4.14	93.33±1.38a
4 days	21.48±0.89c	393.56±3.46	91.94±1.23b
7 days	23.32±0.73b	399.78±3.37	86.94±0.69c
10 days	27.07±1.55a	404.56±2.96	82.22±0.77d
Significance	**	NS	**
	Interaction		
	Light		
1 day	22.55±4.24	381.33±9.29	88.33±2.89
4 days	22.84±2.57	386.00±3.00	87.50±2.50
7 days	25.24±1.53	392.67±3.79	85.83±1.44
10 days	32.28±1.04	398.33±2.52	80.00±2.50
	Medium		
1 day	21.70±3.65	388.00±7.00	95.83±1.24
4 days	21.27±2.96	388.67±7.77	94.17±1.44
7 days	22.87±0.65	394.00±2.00	87.50±2.50
10 days	23.97±2.64	400.00±4.36	83.33±1.44
	Heavy		
1 day	20.87±0.31	405.67±2.52	95.12±1.44
4 days	20.34±2.90	406.00±2.65	94.16±1.43
7 days	21.86±2.73	412.67±4.04	84.33±2.49
10 days	24.95±4.15	415.33±5.13	83.32±1.40
Significance	NS	NS	NS

Means in the same column within each classification bearing different letters are significantly ($P<0.05$) different.

* $P < 0.05$, ** $P < 0.01$ and NS = Not significant.

The results in Table 3 show a significant ($P< 0.01$) effect on the incubation time per hour due to quail egg weight categories. The early hatched eggs were the light one (L) which recorded 389.58 hrs., value, while the heavy (H) eggs were lately hatched as recorded 409.92 hrs estimate. This indicates that, incubation time per hour increased by increasing of quail egg weight. The present result agreed with Parsons (1972) who found that, eggs larger than average of the Herring Gull (*Larus argentatus*) took 16 hrs longer to hatch than that eggs which was lighter than the mean. On the other hand, Ricklefs and Smeraski (1983) reported that, incubation time was not affected by egg mass, but it was related to the yolk content in eggs of both the parental and the offspring birds. The results showed that quail egg weight had a significant ($P< 0.05$) effect on fertility percentage as shown in Table 3. However, the best result was obtained with medium (M) egg weight of incubated quail eggs. These results agreed with Taskin *et al.* (2015) who found that, fertility percentage was significantly ($P <0.001$) affected with quail eggs weight categories of EW1(<9.99g), EW2 (10.00-10.99g), EW3 (11.00-11.99g), EW4 (12.00-12.99g) and EW5 (>13.00g), and the highest value (91.06%) was recorded with group of EW5 (>13.00g). This result is contrast to the findings of Esen and Ozcelik (2002), who reported that, there was not significant effect of egg weight of Japanese quail on fertility percentage.

Egg Storage Periods Effect

Results in Table 2 show that, egg storage periods were insignificantly affected on egg weight loss percentage during incubation, while it increased with decreasing of storage period giving the highest value with 1 day storage period (20.78%). These result agreed with Romao *et al.* (2008) who reported that, Japanese quail eggs stored for longer periods presented lower levels of weight loss during incubation as compared to fresh incubated eggs or those that were subjected to a few days of storage. Also recently, Egbeyale *et al.* (2013) revealed that, the egg weight loss of the pullet eggs, during incubation was significantly ($P <0.05$) influenced by different storage periods of (0 , 3, 6, 9 and 12 days), and they added that, egg weight loss decreased as the pre-incubation storage period increased.

Most of the water of the egg is initially in the albumin which declines continuously during incubation as a result of water loss to the ambient air and movement to the compartments (Romanoff, 1967).

Results in Table 3 show that, embryonic mortality percentage during the whole incubation period (1-17 days) was significantly ($P< 0.01$) affected by egg storage period and the best results were found with 1 and 4 days storage periods. This result agreed with Othman *et al.* (2014) who indicated that, the egg storage period had highly significant ($P< 0.01$) effect on embryo mortality rate of quail eggs set for incubation. They added that, percentage of dead embryo based on fertile eggs varied within the range of 28.51 to 45.96%, while the shortest egg storage period group was significant ($P< 0.05$) lowest dead embryos. As a result of extended storage period, embryos mortality rates increased because of water loss and albumen degradation during storage.

The effect of egg storage period on incubation time (hours) were insignificant as shown in Table 3, giving the long period with egg storage period of 10 days while, its decreased with decreasing of storage period. This result is disagreed with Dymond *et al.* (2013) who found that, the treatment consisted of four 4 hr., pre-incubations at 4 to 5 days intervals during egg storage, reduced the incubation time.

The results in Table 3 show a significant ($P< 0.01$) effect on fertility percentages due to storage period of quail eggs. However, the best result was noted with the shortest storage period of 1 day of incubated quail eggs.

Similarly, Elibol *et al.* (2002) and Petek *et al.* (2003) demonstrated that, the long period egg storage, except for 1 day, prior to incubation decreased apparent fertility percentage of broiler eggs. Also, Uddin *et al.* (1994) in Bangladesh noticed that, storage period of quail eggs before incubation had a significant ($P <0.01$) effect on fertility rates of eggs set. They added that, the effect of storage periods in that experiment may be explained by the degeneration of early embryonic cells during long time storage before incubation.

Interaction Effect

The interactions of the previous two main factors (egg weight categories and storage periods) were not significantly affected on egg weight loss percentage, during all incubation period as shown in Table 2.

Reversely, results in Table 3 show that, the interactions between quail egg weight categories and egg storage period were insignificant on embryonic mortality percentage and incubation time per hour. The present results showed that fertility percentage was affected insignificant due to the interaction between main factors studied as shown in Table 3. However, the highest values were (95.88%) and (95.83%) at 1 day storage period with medium (M) and heavy (H) weights respectively, of incubated quail eggs.

Conclusively, it can be concluded that, medium quail eggs and storage periods of 1 day or 4 days gave the best results of pre-hatch performance of Japanese quail under Egyptian conditions.

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أداء قبل الفقس لأقسام بيض السمان المفرخ بعد تخزينه لفترات مختلفة

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استخدم عدد ١٢٦٠ بيضة سمان للتفريخ تم وضعها فى ١٢ مجموعة تجريبية فى تجربة عاملية ٣ × ٤ تحتوى على ٣ أقسام من وزن بيض السمان (صغير أقل من ١١ جرام، متوسط من ١١-١٢ جرام و كبير أعلى من ١٢ جرام) و ٤ فترات لتخزين البيض (١ ، ٤ ، ٧ و ١٠ أيام) وكانت أهم الصفات المدروسة نسب الخصوبة ، النسبة المنوية للفقد فى وزن البيض خلال التفريخ، نسب النفوق الجنينى، مدة التفريخ وكانت أهم النتائج المتحصل عليها ما يلى: وجدت زيادة معنوية على مستوى (٠,٠١) لنسبة الفقد فى وزن البيضة خلال التفريخ بزيادة وزن البيضة بينما أثرت فترات تخزين البيض بصورة غير معنوية على نفس الصفة، تأثرت نسب النفوق الجنينى معنويا على مستوى (٠,٥) خلال فترة التفريخ الكلية (١-١٧ يوم) بأقسام وزن البيض المفرخ حيث انخفضت بزيادة وزن البيض حيث أعطى البيض الكبير أفضل النتائج مسجلا ٢٢,٠١%، لوحظ وجود تأثير معنوى على مستوى (٠,٠١) لوزن البيض على مدة التفريخ بينما لم يؤثر كلا من فترات تخزين البيض والتداخل على نفس الصفة، وجد تأثيرا معنويا على مستوى (٠,٥) لكلا من وزن البيضة وفترات تخزين البيض على نسب الخصوبة بينما لم تتأثر معنويا بالتداخل بين العوامل المدروسة، أفضل النتائج تم الحصول عليها مع البيض متوسط الحجم أو مع البيض المخزن ليوم واحد بينما كانت أعلى القيم (٩٥,٨٣ و ٩٢,١٢%) ناتجة من التداخل بين التخزين لمدة يوم واحد مع البيض المفرخ متوسط أو كبير الحجم، مما سبق يمكن استخلاص أن البيض متوسط الوزن المخزن لفترة يوم أو ٤ أيام أعطى أفضل النتائج لأداء ما قبل الفقس للسمان اليابانى تحت الظروف المصرية.

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