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Research Article

Effects of Egg Weight and Length of Storage Period on Hatchability and Subsequent Laying Performance of Quail

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Abstract: This study was carried out to investigate the effects of hatching egg weight and length of egg storage period on hatchability and subsequent laying performance of quails. Eggs were collected from a quail flock (*Coturnix coturnix* Pharaoh) aged 17 weeks and classified into 4 groups on the basis of storage period 1, 3, 5, or 7 d. Prior to egg storage, the eggs in each group were further divided into egg weight treatment (small: <10.51 g; medium: 10.51-11.50 g; large: 11.51-12.50 g; and jumbo: >12.51 g). Hatchability of total and fertile eggs was affected significantly by hatching egg weight ($P < 0.05$) but was not affected significantly by the length of egg storage period. There was a decrease in egg production associated with increase in hatching egg weight. Egg production of quails hatched from stored eggs for 3 days was greater than the other groups. There was a significant interaction between hatching egg weight and length of egg storage for egg production. It was concluded that medium eggs can be hatched satisfactorily after 3 days storage for optimum egg production in quails.

Key Words: Quail, egg weight, storage period, egg production traits

Bıldırcınlarda Kuluçkalık Yumurta Ağırlığı ve Depolama Süresinin Kuluçka ve Yumurta Verim Özelliklerine Etkileri

Özet: Bu çalışma bıldırcınlarda kuluçkalık yumurta ağırlığı ve depolama süresinin kuluçka sonuçları ve yumurta verim özelliklerine etkisini belirlemek amacı ile yapılmıştır. 17 haftalık yaştaki bir bıldırcın sürüsünden (*Coturnix coturnix* Pharaoh) elde edilen yumurtalar 4 gruba ayrılarak 1, 3, 5 ve 7 gün süreyle depolanmış, depolama öncesi her bir gruptaki yumurtalar ağırlıklarına göre 4 ayrı gruba (küçük: <10,51 g; orta: 10,51-11,50 g; ağır: 11,51-12,50 g; ve en ağır: >12,51 g) ayrılarak depolanmışlardır. Kuluçka randımanı ve çıkım oranı kuluçkalık yumurta ağırlığından önemli düzeyde etkilenmiş ($P < 0,05$), depolama süresinin bu özellikler üzerine önemli bir etkisi bulunmamıştır. Kuluçkalık yumurta ağırlığının artması ile yavruların yumurta verimi azalmış, 3 gün depolanan yumurtalardan elde edilen bıldırcınların yumurta verimleri diğerlerinden daha yüksek bulunmuştur. Yumurta verimi yönünden kuluçkalık yumurta ağırlığı ve depolama süresi arası interaksiyonlar önemli bulunmuştur. Sonuç olarak bıldırcınlarda optimum yumurta verimi için orta ağırlıktaki yumurtaların 3 gün depolamadan sonra inkübe edilmesinin daha uygun olduğu saptanmıştır.

Anahtar Sözcükler: Bıldırcın, yumurta ağırlığı, depolama süresi, yumurta verim özellikleri

Introduction

There are strong positive correlations among pre-incubation egg weight, storage periods, chick weight and subsequent performance of different kinds of poultry (1-5). The size of newly hatched chicks is directly related to the size of the hatching egg (6) and there is a progressive increase in egg production related to hatching egg weight (7). Quails that were hatched from large eggs lay heavier (8). The survival rate of birds hatched from small eggs was lower than those of larger eggs (9). Longer egg storage results in a decreased hatchability (10,11) and the age of hatching egg affects day-old chick quality and mature weight (12,13).

Most studies related to egg storage, hatching egg weight and subsequent performance in quail have focused on Japanese quail (*Coturnix coturnix* Japonica). However, these parameters have not been fully examined in Pharaoh quail, which is a different strain belonging to the Coturnix family (14). Hence, the objective of the present study was to examine the effect of hatching egg weight and length of egg storage period on hatchability and subsequent egg production traits of Pharaoh quail.

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Materials and Methods

A total of 2304 eggs were collected from a 17-week-old quail flock of the Pharaoh strain (*Coturnix coturnix* Pharaoh). Eggs were classified into 4 groups on the basis of storage period 1, 3, 5 or 7 d. Prior to egg storage, the eggs in each group were further divided into 4 egg weight treatments (small: < 10.51 g; medium: 10.51-11.50 g; large: 11.51-12.50 g; and jumbo: >12.51 g).

Management

Eggs were stored at 18 ºC and 75% RH and turned twice a day. One hundred forty-four eggs from each treatment groups were incubated in a commercial hatchery. Forty-eight eggs formed a replicate in each treatment group. Trays representing all egg weight and storage period treatment groups were distributed in the setter and hatcher. The setter was operated at 37.5 ± 0.5 ºC dry bulb temperature and 29.0 ± 0.5 ºC wet bulb temperature. The hatcher was operated at 37.0 ± 0.5 ºC dry bulb temperature and 31.0 ± 0.5 ºC wet bulb temperature. Eggs in the incubator were turned 15 times per day. The newly hatched chicks from all groups were reared under the standard growing conditions in battery cages. 40 female quails (separated from male according to thoracic feather color) from each treatment groups (40 x 16 = 640 quails) were transferred randomly at the 4th wk of age from the growing cages to laying cages (100 cm wide, 45 cm deep, 21 cm high in front, and 17 cm high in the rear, 112.5 cm2 per bird) and housed there until the end of the research. Photoperiod was increased from 12 h at 4 wk of age to 16 h at 8 wk of age, and thereafter remained constant at 16 h. A commercial layer ration (160 g/kg protein and 2600 kcal/kg ME) was used during the laying period. All birds had ad libitum access to feed and water. Production data in each group were collected between the age of 50% production and 42 wk of age. The age at 50% production was accepted as the beginning of laying period, as described previously (12).

Data and Statistical Analysis

At the time of removing the chicks from the hatchers all unhatched eggs were opened and examined macroscopically to determine percentage fertility, percentage hatchability of fertile and total eggs. Hatchability of fertile or total eggs was calculated as the number of chicks hatched per fertile or total eggs set and the fertility results were reported as “apparent fertility” (15).

Individual body weights of quail were measured at 0 and 42 days of age to determine body weight at hatch and the beginning of laying period, respectively. Egg production and feed consumption were recorded on daily and biweekly basis, respectively. Mortality was recorded on per group basis as it occurred. Average egg weights were measured on all eggs collected in a 1-day period, weekly. The egg production and feed intake of the quail in the groups were calculated on the basis of number of quail at the beginning of laying period (quail-housed) as previously described (12). Results for the body weight, egg production and egg weight are expressed as mean values ± SEM.

The results for apparent fertility, hatchability of fertile and total eggs, body weight, egg production and egg weight were analyzed by ANOVA. When differences among the groups were significant, means were separated using the Tukey test. Arc sine transformation was performed on apparent fertility, hatchability of fertile and total eggs, and egg production data prior to analysis. Kruskal-Wallis non-parametric ANOVA and Dunn’s multiple comparisons tests were applied to indicate differences among the main groups for the age 50% egg production, daily feed intake and feed conversion. Survival rates among the groups were analyzed by the chi-square test procedure (16). All analyses were performed using SPSS® computer software 10.00 (17). Setting egg weight and length of egg storage period were the main effects.

Results

The results of apparent fertility, hatchability of total and fertile egg, body weight at hatch and 42 day of age are shown in Table 1. Apparent fertility was affected significantly by the length of egg storage period ($P < 0.05$) and it was found as 86.54%, 90.03%, 90.05% and 92.12% in small, medium, large and jumbo eggs, respectively. Hatchability of fertile and total eggs, body weight at hatch and 42 d of age was not affected by the length of storage but they were affected significantly by the hatching egg weight. In this study, there were no hatching egg weight x length of egg storage period interactions on apparent fertility, hatchability of total and fertile eggs, body weight at hatch and 42 d of age.

The main and interactive effects of the length of storage period and hatching egg weight on subsequent

Table 1. The effects of hatching egg weight and length of egg storage on hatchability and subsequent body weight at hatch and 42 d of age.

Storage period (d)	Hatching egg weight	Apparent fertility (%)	Hatchability		Body weight at (g)	
			Total eggs (%)	Fertile eggs (%)	Hatch $\bar{X}$ ± SEM	42 d $\bar{X}$ ± SEM
Interactive Groups						
1	Small	88.31	81.82	92.65	6.82 ± 0.08	188.4 ± 10.0
	Medium	87.50	84.38	96.43	7.84 ± 0.06	187.5 ± 12.3
	Large	89.58	87.50	97.67	8.50 ± 0.06	195.9 ± 13.1
	Jumbo	92.71	89.58	96.63	9.45 ± 0.10	202.0 ± 11.2
3	Small	92.54	86.57	93.55	6.85 ± 0.08	189.1 ± 13.1
	Medium	94.79	90.63	95.60	7.86 ± 0.04	183.6 ± 12.5
	Large	92.71	85.42	92.13	8.59 ± 0.05	197.2 ± 11.7
	Jumbo	92.71	90.63	97.75	9.60 ± 0.10	193.1 ± 12.1
5	Small	81.54	72.31	88.68	6.81 ± 0.09	179.3 ± 11.7
	Medium	94.68	90.43	95.51	7.94 ± 0.06	186.2 ± 12.4
	Large	88.54	83.33	94.14	8.60 ± 0.07	192.3 ± 12.0
	Jumbo	92.63	89.47	96.59	9.47 ± 0.09	197.5 ± 13.4
7	Small	83.78	77.03	91.69	6.77 ± 0.09	178.4 ± 14.2
	Medium	83.16	77.89	93.67	8.01 ± 0.06	192.4 ± 15.3
	Large	89.47	88.42	98.82	8.63 ± 0.05	199.8 ± 13.4
	Jumbo	90.43	86.17	95.29	9.09 ± 0.14	202.6 ± 12.5
Main Groups						
1		89.52^{ab}	85.82	95.84	8.15 ± 0.08	193.5 ± 1.72
3		92.93^{a}	88.31	94.75	8.20 ± 0.09	190.8 ± 1.63
5		89.34^{ab}	83.88	93.73	8.20 ± 0.08	188.8 ± 1.73
7		86.71^{b}	82.37	94.93	8.12 ± 0.09	193.3 ± 1.90
	Small	86.54	79.43^{b}	91.70^{b}	6.81 ± 0.05^{d}	183.8 ± 1.40^{b}
	Medium	90.03	85.83^{a}	95.30^{a}	7.92 ± 0.03^{c}	187.4 ± 1.93^{b}
	Large	90.05	86.16^{a}	95.69^{a}	8.56 ± 0.04^{b}	196.3 ± 1.57^{a}
	Jumbo	92.12	88.96^{a}	96.56^{a}	9.39 ± 0.06^{a}	198.8 ± 1.82^{a}
ANOVA						
Storage		*	n.s	n.s	n.s	n.s
Egg Weight		n.s	*	*	*	*
Storagex Egg Weight		n.s.	n.s	n.s	n.s	n.s

(Small: < 10.51 g; medium: 10.51-11.50 g; large: 11.51-12.50 g; and jumbo: >12.51 g), There were three replicate trays for all interaction means.
[a-b] within columns, values with different superscript differ significantly (* P < 0.05, n.s.; not significant).

laying performance of quail are presented in Tables 2 and 3. Egg production and survival rate of quail was significantly affected by the main effects of hatching egg weight (P < 0.01) and length of storage period (P < 0.001). But, the feed intake and feed conversion of progeny were not affected by the main effects. There was a significant hatching egg weight and storage period interaction on egg production (P < 0.01).

Table 2. Main effects of hatching egg weight and length of egg storage on age of 50% egg production, egg production (mean ± SEM), average egg weight (mean ± SEM), daily feed intake, feed conversion and survival rate in quails hatched from these eggs.

Storage period (d)	Hatching egg weight	Age of 50% egg production (d)	Egg production (%)	Average egg weight (g)	Feed intake (g/quail/day)	Feed conversion (g feed:egg)	Survival Rate (%)
1		59	66.93 ± 0.90^{b}	12.26 ± 0.07	32.37	48.42	77.50^{b}
3		60	69.87 ± 0.80^{a}	12.29 ± 0.05	31.48	45.04	87.50^{a}
5		59	65.96 ± 1.01^{b}	12.22 ± 0.07	29.60	44.98	86.75^{a}
7		59	65.94 ± 1.00^{b}	12.32 ± 0.09	30.25	46.72	76.25^{b}
	Small	57	71.05 ± 1.14^{a}	12.01 ± 0.11^{b}	33.23	47.11	76.25^{a}
	Medium	59	68.68 ± 1.25^{a}	12.14 ± 0.12^{b}	29.80	43.35	90.25^{b}
	Large	58	66.10 ± 1.26^{b}	12.16 ± 0.08^{b}	30.97	46.85	84.50^{ab}
	Jumbo	62	62.87 ± 1.14^{c}	12.51 ± 0.09^{a}	29.69	47.87	77.00^{a}
ANOVA							
Storage Period			***	n.s.	n.s.	n.s.	*
Egg Weight			**	**	n.s.	n.s.	*
Storage period x Egg weight			**	n.s.			

(small: < 10.51 g; medium: 10.51-11.50 g; large: 11.51-12.50 g; and jumbo: >12.51 g)
$^{a-d}$ within columns, values with different superscript differ significantly (* P < 0.05, **P < 0.01, ***P < 0.001, n.s.; not significant).

Table 3. Interaction of hatching egg weight and length of egg storage on age of 50% egg production, egg production (mean ± SEM), average egg weight (mean ± SEM), feed intake per bird, feed conversion and survival rate in experiment.

Storage period	Hatching egg weight	Age of 50% egg production (d)	Egg production* (%)	Average egg weight (g)	Feed intake (g/quail/day)	Feed conversion (g feed:egg)	Survival Rate (%)
1 day	Small	56	66.62 ± 1.29	11.89 ± 0.08	36.25	56.97	63.00
1 day	Medium	60	66.22 ± 1.22	12.41 ± 0.21	27.85	42.05	85.00
1 day	Large	58	68.20 ± 1.31	12.37 ± 0.13	35.13	48.63	92.00
1 day	Jumbo	60	66.68 ± 1.24	12.40 ± 0.14	30.25	46.03	70.00
3 days	Small	58	76.97 ± 1.49	12.22 ± 0.11	34.38	44.66	84.00
3 days	Medium	59	71.30 ± 1.45	12.07 ± 0.22	33.32	46.72	86.00
3 days	Large	58	66.25 ± 1.25	12.46 ± 0.16	28.74	44.05	83.00
3 days	Jumbo	64	64.97 ± 1.50	12.42 ± 0.22	29.51	44.73	97.00
5 days	Small	57	69.75 ± 1.44	11.95 ± 0.15	31.01	44.45	90.00
5 days	Medium	59	65.45 ± 1.37	12.61 ± 0.22	27.54	42.72	97.00
5 days	Large	59	64.45 ± 1.22	11.81 ± 0.15	29.97	49.58	69.00
5 days	Jumbo	62	64.19 ± 1.43	12.49 ± 0.24	29.88	43.19	91.00
7 days	Small	58	70.88 ± 1.52	12.01 ± 0.14	31.31	42.38	68.00
7 days	Medium	58	71.77 ± 1.44	12.48 ± 0.13	30.51	41.92	93.00
7 days	Large	60	65.50 ± 1.37	12.03 ± 0.21	30.04	45.17	94.00
7 days	Jumbo	60	55.64 ± 1.17	12.76 ± 0.15	29.14	57.53	50.00

(small: < 10.51 g; medium: 10.51-11.50 g; large: 11.51-12.50 g; and jumbo: >12.51 g)
* Significant interactions: Egg production: hatching egg weight x storage period (P < 0.01).

Discussion

The present study and the work of Elibol et al. (18) have demonstrated that the long period egg storage, except for 1 day, prior to incubation decreased apparent fertility. Although apparent fertility increased with hatching egg weight, there was no significant effect of hatching egg weight on it. Hatchability of fertile and total eggs was significantly increased ($P < 0.05$) due to hatching egg weight but it was not affected by the length of egg storage period. The small eggs hatched significantly less well ($P < 0.05$). This was probably due to more proportional weight loose in small eggs, which may result in increased chick mortality (10,12). Hatchability of total and fertile eggs decreased (except for 1 day) with increasing length of egg storage period (not significantly) as the early and the late embryonic mortalities increased because of water loss and albumen degradation during storage. This result was expected to be consistent with previous reports (10,11,19,20). There was no main effect on body weight at hatch and 42 d of age because of the length of storage period. These results are in contrast to the findings of Sachdev et al. (21), who reported that the body weight of quail hatched from eggs stored over a short period was enhanced. But, it was found that hatching egg weight, chick weight and chick growth are interrelated. These data are concurrent with findings of Farooq et al. (6). Small and medium hatching eggs produced smaller offspring and the body weight at 42 d of age of these groups were found to be lower compared to that from the large and jumbo eggs.

In this study, quail in the groups started egg production approximately at the same time. Egg production of quails hatched from eggs stored 3 days was found to be greater than for the other counterparts. There was a decrease in egg production with increasing hatching egg weight. This is not accordance with the findings of Sarica and Soley (7), who reported that a progressive increase in egg production was related to hatching egg weight. In general, longer egg storage (except for 1 day) and greater hatching egg weight resulted in poorer egg production (Table 2). Longer storage conditions affected chick quality and their performance (12). There was a significant interaction of hatching egg weight x length of egg storage period on egg production. This interaction suggested that quail hatched from smaller eggs lay more eggs than quail hatched from larger eggs and was clearly more beneficial for eggs stored for a longer period ($P < 0.05$).

In this study, quails hatched from 1-day egg storage and small eggs consumed more feed (Table 2). Feed conversion ratio, one of the most important factors of economic productivity, of these groups was paralleled by feed consumption pattern. Interaction between hatching egg weight and length of storage period, although not significant, have revealed a numerical increase in daily feed consumption and feed conversion of quail hatched from small and 1 day stored eggs (Table 3).

There were significant differences for the average egg weights of quails hatched from different weights of eggs. Average egg weight increased with increasing hatching egg weight as reported previously (8). Differences for the body weight at 42 d of age resulted in egg weight difference among the hatching egg weight groups as mean egg weight is partly determined by body weight at sexual maturity (22). Egg weight of quail hatched from jumbo eggs was statistically greater than those of the others. In this study, the average egg weights of quail hatched from eggs of different storage time were found to be similar.

There were significant differences for the survival rate among the main groups (Table 2). The survival rates of quails hatched from 3 and 5 d stored eggs were found statistically superior to eggs stored for 1 and 7 d. In general, the survival rate of quails hatched from smaller eggs (except for small egg) was found to be higher than that of quails from heavier eggs. This is concurrent with the finding of Among et al. (9). The highest survival rate was found when eggs were stored for 3 days with jumbo eggs and for 5 days with medium eggs (Table 3).

The results of this study clearly demonstrated that hatching egg weight and length of egg storage affected hatchability and subsequent egg production traits of the Pharaoh quail. Although the quails hatched from small eggs produced more eggs, the results of hatchability, feed consumption and survival rate of this group were worse. Therefore, eggs under 10.51 g should not be set in hatcheries. Eggs with medium weight could be hatched satisfactorily after 3 days storage for optimum egg production in the Pharaoh quail.

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