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Effects of Shell Thickness, Shell Porosity, Shape Index and Egg Weight Loss on Hatchability in Japanese Quail (Coturnix coturnix japonia)

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Summary

This study was conducted to determine the effects of shell thickness, shell porosity, shape index and egg weight loss on hatchability on Japanese quail eggs. For that purpose 402 eggs were used. All eggs were weighted individually on 5, 10, and 15-18 days of incubation for determining weight losses. Percentage egg weight loss during 0-5, 5-10, 10-15, 15-18 and days of incubation were found as 4.3%, 4.1%, 8.4%, 2.8%, 11.2%, 7.6%, 18.8%, respectively. The greatest egg weight loss (24.2%) was determined in the late dead eggs during the 0 to 18 days of incubation. The effect of porosity in various egg types (infertile, early dead embryos, late dead embryos and hatched) for large end, equator and small end on hatchability were found statistically significant (P<0.001), whereas the average pore concentration in the large end, equator and small end were found as 10.4, 8.9 and 7.3 per 0.25 cm^2, respectively.

Keywords: Japanese quail, egg weight loss, shell porosity, hatchability

Japon Bıldırcınlarında (Coturnix coturnix japonica) Yumurta Kabuk Kalınlığı, Gözenekliliği, Şekil İndeksi ve Yumurta Ağırlık Kaybının Kuluçka Sonuçlarına Etkileri

Özet

Bu çalışma Japon bıldırcınlarında yumurta kabuk kalınlığı, şekil indeksi, kabuk gözenekliliği ve yumurta ağırlık kaybının kuluçka sonuçlarına etkilerini tespit etmek amacıyla yapılmıştır. Bu amaçla 402 yumurta kullanılmıştır. Ağırlık kayıplarının tespit edilebilmesi için kuluçkanın 5, 10, 15 ve 18. günlerinde tüm yumurtalar bireysel olarak tartılmıştır. Kuluçkanın 0-5, 5-10, 10-15 ve 15-18. günlerinde şekillenen ağırlık kayıpları sırasıyla %4.3, %4.1, %8.4, %2.8, %11.2, %7.6 ve %18.8 olarak saptanmıştır. 0-18 günlük dönemde en yüksek ağırlık kaybı (%24.2) geç embriyonik ölüm şekillenen yumurtalarda tespit edilmiştir. Çeşitli yumurta tiplerinin (dölsüz, çıkış olan, erken ve geç embriyonik ölüm olan) küt, yan ve sivri kabuk bölgelerindeki gözenek sayılarının kuluçka sonuçlarına etkisi istatistiksel olarak önemli bulunurken, küt, yan ve sivri uçlardaki ortalama gözenek sayısı sırasıyla 10.4, 8.9 ve 7.3/0.25 cm^2 olarak tespit edilmiştir.

Anahtar sözcükler: Japon bıldırcını, yumurta ağırlık kaybı, gözeneklilik, kuluçka

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INTRODUCTION

The success of embryonic development in poultry eggs have been related to the eggshell characteristics. Because, an egg should exchange CO_2 and O_2 and lose 12-15% of its weight as water vapour during the incubation period[1]. Hay and Spear[2] reported that egg weight loss during incubation period has great effects on hatchability in quail eggs. On the other hand, Soliman et al.[3] reported that the average egg weight loss during incubation (0-18 days) was 20.8% in quail.

Vital gas diffusion occurs through microscopic pores, which are the only means of communication between the external environment and the chorioallantoic membrane[2]. The localization and the number of the pores on egg have important effects on embryonic development[4]. Low pore numbers, shape index and increased shell permeability have been associated with increased early and late embryonic mortality in quail[4-6]. The purpose of this study was to define the relationships between shell thickness, shell porosity, shape index, egg weight loss and hatchability in Japanese quail.

MATERIALS and METHODS

This study was conducted at the Poultry Unit of Faculty of Veterinary Medicine, University of Adnan Menderes, Aydın. A total of 402 Japanese quail eggs (from quails at the age of 40 weeks) were consisted of the material. Eggs were weighted prior to setting and on days 5, 10, 15 and 18 of incubation with a balance sensitive to 0.01g.

At 18 days of incubation, remaining unhatched eggs were opened and examined macroscopically for evidence of stage of embryonic development. Eggs were defined as hatched, infertile, early dead embryos that died before 5 days, late dead embryos that died between 5 days and pipping.

After removing the eggshell membranes, Methylene blue (0.5 g 89% dye/L of 70% ethanol) was pipetted into the shell and allowed to visualize the pores externally[7]. Number of pores per 0.25 cm^2 was counted microscopically under 2x10 power magnifications. Four different areas within each of the three egg shell regions, large end, equator and small end were counted and averaged[5]. Shell thickness without membrane was also measured in three areas of each region with a micrometer sensitive to 0.1μ.

Effects of shell thickness, shell porosity, shape index and egg weight loss on hatchability were compared by one-way ANOVA using SPSS. Significant differences between groups were determined by Duncan test[8,9].

RESULTS

Percentage egg weight loss at different stages of incubation was given in Table 1.

It was determined that initial egg weights were 13.0, 12.9, 13.1 and 13.1 g in the hatched, infertile, early and late dead egg types, respectively. Initial egg weight did not vary among egg types.

The average egg weight loss was found as 4.3%, 4.1%, 8.4%, 2.8%, 11.2%, 7.6%, 18.8% for 0-5, 5-10, 0-10, 10-15, 0-15, 15-18 and 0-18 days of incubation, respectively. The greatest egg weight loss (8.6%) was determined in the hatched eggs during the 15 to 18 days of incubation The late dead egg type exhibited the greatest weight loss (24.2%) during incubation except the incubation interval of 15 to 18 days. Conversely, hatched egg type exhibited the lowest weight loss during the same incubation period except the incubation interval of 0 to 18 days. The infertile and early dead egg types were generally intermediate during the same incubation intervals.

Shell pore concentration of various egg types were shown in Table 2.

It was determined that porosity in various egg types for large end, equator and small end were found statistically significant ($P<0.001$). The average shell pore concentration in the large end, equator and small end were 10.4, 8.9 and 7.3 per 0.25 cm^2 and porosity at the large end was found greater than the other eggshell regions. Additionally, hatched eggs exhibited greater (10.9, 9.2 and 7.7 for large end, equator and small end, respectively) porosity, while late dead egg type (8.1, 6.6 and 5.3 for large end, equator and small end, respectively) has lower porosity in all egg shell regions than the other egg types.

Shape index and eggshell thickness of various egg types were given in Table 3.

Table 1. Egg weight loss on days 5, 10, 15 and 18 of incubation (%).
Tablo 1. Kuluçkanın 5, 10, 15 ve 18. günlerinde yumurtalarda şekillenen ağırlık kayıpları (%).

Days of Incubation	Egg Type					P
	Infertile	Early Embryonic Dead	Late Embryonic Dead	Hatched	Average	
	$\overline{X} \pm S\bar{x}$ n=60	$\overline{X} \pm S\bar{x}$ n=60	$\overline{X} \pm S\bar{x}$ n=60	$\overline{X} \pm S\bar{x}$ n=60	$\overline{X} \pm S\bar{x}$ n=60	
0 to 5	4.3 ± 0.3^{c}	5.6 ± 1.0^{b}	7.6 ± 0.7^{a}	4.0 ± 0.1^{c}	4.3 ± 0.1	***
5 to 10	4.6 ± 0.3^{bc}	5.0 ± 0.9^{b}	8.0 ± 0.8^{a}	3.8 ± 0.1^{c}	4.1 ± 0.1	***
10 to 15	3.4 ± 0.3^{b}	3.5 ± 0.6^{b}	4.5 ± 0.4^{a}	2.6 ± 0.1^{c}	2.8 ± 0.1	***
15 to 18[1]	4.2 ± 0.4^{c}	4.2 ± 0.3^{b}	4.1 ± 0.4^{b}	8.6 ± 0.1^{a}	7.6 ± 0.2	***
Initial egg weight (g)	12.9 ± 0.1	13.1 ± 0.3	13.1 ± 0.2	13.0 ± 0.1	13.0 ± 0.1	-

-Non significant, *** $P<0.001$, [a,b,c]Means in the same line ith no common superscript differ significantly ($P<0.05$)
[1]Values based on weight of recently hatched chicks relative to initial egg weight.

Table 2. Porosity in various egg types (n/0.25 cm^2).
Tablo 2. Değişik yumurta tiplerinde gözeneklilik değerleri (n/0.25 cm^2).

Egg Type	n	Eggshell Regions			
		Large end	Equator	Small end	Average
Infertile	59	9.4 ± 0.2^{b}	8.1 ± 0.3^{ab}	6.4 ± 0.4^{b}	7.8 ± 0.2^{b}
Early dead	11	9.1 ± 0.3^{bc}	7.8 ± 0.4^{bc}	5.4 ± 0.2^{b}	7.4 ± 0.2^{bc}
Late dead	19	8.1 ± 0.3^{c}	6.6 ± 0.3^{c}	5.3 ± 0.3^{b}	6.6 ± 0.2^{c}
Hatched	303	10.9 ± 0.1^{a}	9.2 ± 0.1^{a}	7.7 ± 0.1^{a}	9.3 ± 0.1^{a}
Average		10.4 ± 0.1	8.9 ± 0.1	7.3 ± 0.1	8.8 ± 0.2
P		***	***	***	***

*** $P<0.001$, [a, b, c]Means in the same column with no common superscript differ significantly ($P<0.05$)

Table 3. Shell thickness and shape index in various egg types.
Tablo 3. Değişik yumurta tiplerinde kabuk kalınlığı ve şekil indeksi değerleri.

Egg Type	n	Shell Thicness (μ)				Shape index (%)
		Large end	Equator	Small end	Average	
Infertile	60	16.4 ± 0.2	17.3 ± 0.2	18.6 ± 0.3	17.4 ± 0.2	78.0 ± 0.007
Early dead	12	17.0 ± 0.4	17.8 ± 0.4	18.6 ± 0.4	17.8 ± 0.3	78.1 ± 0.004
Late dead	19	16.7 ± 0.4	16.8 ± 0.4	17.7 ± 0.5	17.1 ± 0.3	76.9 ± 0.002
Hatched	311	17.1 ± 0.1	17.0 ± 0.1	17.9 ± 0.1	17.3 ± 0.1	77.6 ± 0.009
Average		17.0 ± 0.1	17.1 ± 0.1	18.0 ± 0.1	17.4 ± 0.1	78.0 ± 0.008
P		-	-	-	-	-

-non significant

No differences for shell thickness were determined in different eggshell regions. The thinnest eggshells (16.4 μ) were found in the infertile egg type. It was determined that shape index has no significant effect on hatchability in Japanese quails. However, shape index for hatched, infertile, early and late dead embryos were calculated as 77.6%, 78.0%, 78.1% and 76.9%, respectively.

DISCUSSION

Overall weight loss during 18 days of incubation increased in the following ascending order; early dead, infertile, hatched and late dead egg type. Soliman et al[3] and Akıncı et al[10] reported that hatched and late dead eggs clearly reflected the advanced stage of embryonic development compared with the infertile and the early dead egg types. During the 15-18 days of incubation, which contains internal and external pipping and hatching, the greatest egg weight loss was determined in the hatched eggs. Great egg weight loss in the hatched eggs could be explained with the increased embryonic respiration. Embryos that died before did not show this increase in weight loss. A deficiency of water loss would prevent the gas exchange (especially O_2) and thus asphyxiate the embryo[4,11,12].

Eggshell pore concentration was determined greater in the large end than the other eggshell regions. Hyankova et al[13] reported that greater porosity over the air space has been beneficial to embryonic development because of increased respiratory exchange. A deficiency in this area has been linked to late embryonic mortality[3]. Burton and Tullett[14] reported that optimum hatchability was depend upon a proper relationship between pore concentration and shell thickness, which provides the proper water (weight) loss for optimum growth. Hatched eggs exhibited greater porosity at the large, equator and small end in this study. Differences in porosity in the small end region may be caused from calcium mobilization, which may have made some small pores more passable to the dye used.

It was determined that shape index and eggshell thickness have no significant effect on hatchability. Başpınar et al[6] and Kul and Şeker[15] reported that the average shape index was 79.0% and 74.0%, respectively and has significant effect on hatchability in Japanese quail eggs. Maclaury et al[16] reported that 1% increase in shape index was resulted in 1.6% decrease in liveability in quail.

The infertile and late dead egg types exhibited the thinnest shells at the large end. In general, it was determined that hatched and late dead egg types have thinner shell than infertile and early dead ones. This finding was consistent with the removal of calcium from the shell for bone formation during the final stage of incubation[13].

Consequently, it was determined that egg weight loss and eggshell porosity have significant effects on hatchability in Japanese quails. For that reason, it was thought that hatchability success could be increased by means of advanced breeding programmes related to the shell quality.

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