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Effects of High Light Intensity on Egg Weight Loss, Hatchability, Embryonic Mortality, and Supply Organ Weight at Hatch in Quail Hatching Eggs during Incubation

Talha Seçim KAYA[1], Ali AYGÜN[1,*]

[1]Selçuk University, Faculty of Agriculture, Department of Animal Science, Konya, Turkey

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ABSTRACT

The aim of this study is to investigate the effects of high light intensity on egg weight loss, hatchability, embryonic mortality, and supply organ weights at hatch in Japanese quail (*Coturnix coturnix japonica*) eggs. A total of 640 hatching eggs were randomly distributed into 2 groups. The first group of eggs were continuously incubated in the dark (Control; C), the second group of eggs were incubated in continuous light(L), the third group of eggs were incubated in the dark for the first five days of incubation (D5), and the last group were incubated in the light for the first five days in the eggs (L5). The light intensity at the surface of the eggshell varied from 5000 to 6000 lux as measured with a luxmeter. No significant differences were found in egg weight loss, hatchability, and supply organ weight among treatments. Embryonic mortality were higher in the L5 group than in the control group at 10 to 16 days of incubation. These results demonstrate that high light application during incubation affected the embryonic mortality negatively except hatchability and egg weight loss.

1. Introduction

Hatching eggs are generally incubated in a dark environment condition in commercial incubators. However, in recent years, many studies have been carried out about lighting programs during incubation. There are studies reporting that hatchery lighting application has a positive effect on some properties such as reducing stress parameters (Ozkan et al. 2012a; Huth and Archer 2015), decreasing hatching time (Farghly and Abdelfattah 2018; Maman et al. 2018), improve hatchability (Huth and Archer 2015), behavioral traits (Sabuncuoğlu et al. 2018), optimum post-hatch performance (Rozenboim et al. 2004; Ozkan et al. 2012a; Farghly and Abdelfattah 2018). The light intensity applied at the incubation was 150 lux (Farghly and Abdelfattah 2018), 250 lux (Huth and Archer 2015; Archer 2017), 550 lux (Archer et al. 2009b; Archer and Mench 2013), 300 lux (Ozkan et al. 2012b), 1650 lux (Sabuncuoğlu et al. 2018), 1790 lux (Shafey 2004), 2080 lux (Shafey et al. 2005), 2900 lux (Maman et al. 2018). The aim of this study is to investigate the effects of high light intensity on egg weight loss, hatchability, embryonic mortality, and supply organ weights in Japanese quail (*Coturnix coturnix japonica*) eggs.

2. Materials and Methods

In total, fresh eggs were obtained from Japanese quail (*Coturnix coturnix japonica*) that were raised on a local commercial farm. The eggs were randomly assigned into 4 groups of 160 eggs. The first group of eggs were continuously incubated in the dark (Control; C), the second group of eggs were incubated in continuous light(L), the third group of eggs were incubated in the dark for the first five days of incubation (D5), and the last group were incubated in the light for the first five days in the eggs (L5). The light intensity at the surface of the eggshell varied from 5000 to 6000 lux as measured with a luxmeter. To determine the egg weight loss, a total of 40 eggs from each treatment was numbered and weighed at the beginning and on d 14 of incubation. Eggs containing dead embryos and unfertile eggs were excluded from the calculation percentage of egg weight loss. The eggs were turned 12 times a day until the last three days of incubation. The hatched chicks were checked and

* Corresponding author email: *aaygun@selcuk.edu.tr*

recorded every 3 h between 372 and 414 h of incubation. After completion of the hatching, unhatched eggs were opened, and embryos were assessed according to the method determined by Aygun et al. (2012) to establish the stage of embryonic mortality. Fertility was calculated as the percentage of set eggs. Hatchability was calculated as both set eggs and fertile eggs. After completion of the hatching, 7 chicks from each group every three hours were killed by cervical dislocation. The chick, yolk sac, liver, and heart weight were determined with a balance with sensitivity ± 0.01 g. Organ weights were expressed as a percentage of chick BW.

Statistical analysis

Data were analyzed using the One way analysis of variance (ANOVA). The significant differences between means were obtained by Tukey test. All analyses were carried out using Minitab Version 16.

3. Results and Discussion

The results of set egg weight, transfer egg weight, and egg weight loss during the incubation of 0 to 14 d of embryonic development are shown in Table 1. No significant differences were found in set egg weight, transfer egg weight, and egg weight loss among treatments. The egg weight loss during incubation is important for a good incubation management. During the incubation, high water loss from the egg has a negative effect on the development of the embryo (Geng and Wang 1990; Mo et al. 2007). The egg weight loss during incubation may vary from 6.5 to about 12% without affecting hatchability in poultry eggs (Hays and Spear 1951; Aygun et al. 2012; Caglayan et al. 2014; Yildirim et al. 2015; Alasahan et al. 2016).

Table 1
Effects of high light intensity on egg weight loss during incubation.

Treatment	Set egg weight (g)	Transfer egg weight (g)	Egg weight loss (%)
C	11.76	10.41	11.46
L	11.19	9.97	10.99
D5	11.65	10.21	12.43
L5	11.46	10.10	11.83
SEM	0.192	0.179	0.483
P-value	0.169	0.325	0.259

C: Eggs were incubated in dark until 14 d of incubation, L: Eggs were incubated in light until 14 d of incubation; D5: Eggs were incubated in dark until 5 d of incubation, and in light until 14 d of incubation; L5: Eggs were incubated in light until 5 d of incubation, and in dark until 14 d of incubation.

The treatment's effect on hatchability and embryonic mortality are presented in Table 2. There were no differences in the hatchability of set eggs (C, 64.61%; L, 56.23%; D5, 64.61%; and L5, 70.82%) or hatchability of fertile eggs (C, 88.42%; L, 80.85%; D5, 91.19%; and L5, 93.82%) among treatment groups. These results are similar to previous studies indicating that light application during incubation did not significantly affect the hatchability (Shafey et al. 2005; Huth and Archer 2015; Maman et al. 2018). We did not find significant increase in embryonic mortality at any stage of incubation among all treatment groups except the 10^{th} to 16^{th} day of incubation. The highest embryo deaths were detected in the L group at 10^{th} to 16^{th} days of incubation. This result is incompatible with the study of (Shafey 2004) reporting that light application (1230 to 1790 lux) during incubation decreases embryo mortality. On the other hand, there were similar studies in which light application did not affect embryo mortality (Archer et al. 2009a; Huth and Archer 2015; Maman et al. 2018). This difference may be due to the fact that the light intensity applied in our study is higher than the intensity and type of lighting applied in this study. No significant differences were found among C, D5, and L5 treatments groups at 10^{th} to 16^{th} days of incubation for embryonic mortality.

Hatching began at 387, 387, 384, and 390 h of incubation duration in C, L, D5, and L5 groups, respectively (Figure 1). Hatching ended in the C, L, and L5 at 408 h of incubation except D5 group. The hatching in D5 was completed at 405 h of incubation. No significant differences were observed among C (91.14%), L (89.93%) and D5 (44.78%) groups, but C and L had significantly higher hatching than L5 (32.62%) at 393 h of incubation. There were no significant differences between C, L, D5, and L5 groups at 384, 387, 396, 399, 402 and 405 h of incubation. Reducing the size of the spread is more important for poultry sectors because the chicks will have homogeneity. If the chick hatching times is longer, it will delay the time for the chicks to eat and access to water.

Table 2
Effects of high light intensity on fertility, hatchability, and embryonic mortality (%)

Treatment	Fertility (%)	Hatchability of set eggs (%)	Hatchability of fertile eggs (%)	Embryonic mortality (% of fertile eggs)		
				1 to 9 d	10 to 16 d	17 to 18 d
C	73.07	64.61	88.42	4.19	2.55[b]	0.81
L	69.24	56.23	80.85	8.02	9.11[a]	2.02
D5	70.97	64.61	91.19	5.46	3.35[ab]	0.00
L5	75.39	70.82	93.82	3.49	2.69[b]	0.00
SEM	3.767	4.460	3.520	2.190	1.402	0.725
P-value	0.691	0.200	0.106	0.503	0.017	0.212

[a,b] Means within a column with different superscripts differ significantly (P<0.05).
C: Eggs were incubated in dark until 14 d of incubation, L: Eggs were incubated in light until 14 d of incubation; D5: Eggs were incubated in dark until 5 d of incubation, and in light until 14 d of incubation; L5: Eggs were incubated in light until 5 d of incubation, and in dark until 14 d of incubation.

This may lead to negative results in dehydrated chicks, post-hatch performance and immune response (Becker 1960; Pinchasov and Noy 1993; Casteel et al. 1994; Bigot et al. 2003; Gonzales et al. 2003; Tona et al. 2003; Careghi et al. 2005).

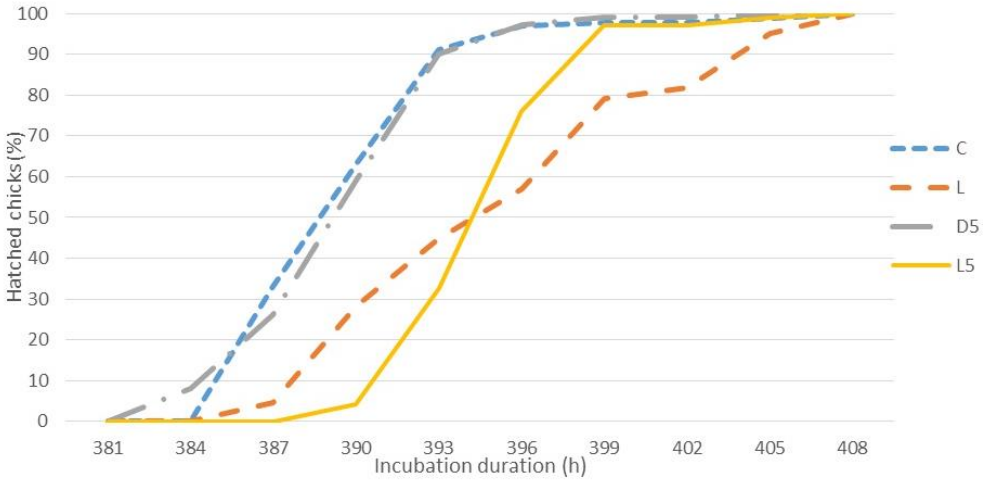

Figure 1
Effects of high light intensity on spread of hatch.
C: Eggs were incubated in dark until 14 d of incubation, L: Eggs were incubated in light until 14 d of incubation; D5: Eggs were incubated in dark until 5 d of incubation, and in light until 14 d of incubation; L5: Eggs were incubated in light until 5 d of incubation, and in dark until 14 d of incubation

There were significant differences among treatments for chick weight (C, 8.03 g; L, 8.35 g; D5, 8.32 g; L5, 8.07 g), yolk sac weight (C, 8.50%; L, 8.62%; D5, 7.59%; L5, 6.81%), heart weight (C, 0.93%; L, 0.92%; D5, 0.87%; L5, 0.81%), and liver weight (C, 2.62%; L, 2.26%; D5, 2.49%; L5, 2.41%; Table 3). Our result the chick hatching weight agree with the study of Bayram and Özkan (2010); (Sabuncuoğlu et al. 2018) about the effect of lighting application during incubation did not effect on the chick weight. Ozkan et al. (2012a) reported that lighting during incubation did not effect on yolk sac weight (%), heart weight (g), and liver weight (g).

Table 3
Effects of high light intensity on chick weight and supply organ weights

Treatment	Chick weight (g)	Yolk sac weight (%)	Heart weight (%)	Liver weight (%)
C	8.03	8.50	0.93	2.62
L	8.35	8.62	0.92	2.26
D5	8.32	7.59	0.87	2.49
L5	8.07	6.81	0.81	2.41
SEM	0.265	0.794	0.058	0.107
P-value	0.758	0.392	0.484	0.173

C: Eggs were incubated in dark until 14 d of incubation, L: Eggs were incubated in light until 14 d of incubation; D5: Eggs were incubated in dark until 5 d of incubation, and in light until 14 d of incubation; L5: Eggs were incubated in light until 5 d of incubation, and in dark until 14 d of incubation.

4. Conclusion

As a result, high light application during incubation has no negative effect on egg weight loss, hatchability, and supply organ weights. Continuous high light application increased embryo mortality compared to control group. Periodic light application may be more useful instead of continuous light application during incubation.

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