



Asian Journal of **Poultry Science**

ISSN 1819-3609



Academic
Journals Inc.

www.academicjournals.com

Pre and Post Hatch Performance of Different Japanese Quail Egg Colors Incubated under Photostimulation

¹M.F.A. Farghly, ²Kh. M.A. Mahrose and ²D.E. Abou-Kassem

¹Department of Poultry Production, Faculty of Agriculture, Assiut University, Assiut, Egypt

²Department of Poultry, Faculty of Agriculture, Zagazig University, Zagazig, Egypt

Corresponding Author: Khalid M.A. Mahrose, Department of Poultry, Faculty of Agriculture, Zagazig University, Zagazig, Sharkia, 44511, Egypt

ABSTRACT

The present experiment was carried out using 900 Japanese quail eggs to study the pre and post hatch performance of different egg colors incubated either under darkness or lighting conditions. All eggs were classified into 3 categories according to shell colors (white, spotted violet and spotted brown) and incubated under darkness or lighting. The results showed that the effect of egg shell color on embryonic weight was significant ($p \leq 0.05$) at 10, 12 and 14 days of incubation. The spotted brown eggs showed significantly ($p \leq 0.05$) the higher percentages of hatchability even when incubated under darkness or lighting. The chick weight at hatch was significantly ($p \leq 0.05$) heavier in group of spotted brown egg color even incubated in darkness or lighting (7.94 and 7.96 g, respectively) than the other groups of eggs. Each of chick weight loss (%), chick sex and chick quality were not influenced by egg shell color. Furthermore, chicks are produced from spotted brown eggs showed significantly the higher values of body weight gain (3.86 and 3.85 g) even when incubated under lighting or darkness. There are no significant differences in egg mass, feed conversion ratio, plumage conditions, leg problems and mortality (%) from hatch to 20 weeks of age. Therefore, it could be concluded that selecting eggs of spotted brown and spotted violet of colored shell to get the best possible pre and post hatching performance, which positively reflect on the profit which could be gained by the producers.

Key words: Egg shell color, pre and post hatch performance, Japanese quail

INTRODUCTION

In the hatching egg industry, incubation conditions are the most important factors for the success of both hatching and embryonic development that is extremely sensitive to light (Archer *et al.*, 2009). In the incubator, eggs are often incubated commercially in complete darkness. However, light has been considered as an important environmental factor during the embryonic life because of their light sensitive pineal gland (Zeman *et al.*, 2004). There are a number of studies reported that lighting stimulates embryo growth, accelerates hatching time and post-hatch performance of birds (Ghatpande *et al.*, 1994; Fairchild and Christensen, 2000; Shafey *et al.*, 2004, 2005; Khalil, 2009; Farghly, 2012; Farghly and Mahrose, 2012).

In addition to the previous factors, egg shell color in relation to their egg quality, may affect late-term embryonic development during hatching process as well as in post hatch development of chick until feed consumption is initiated (Farghly, 2012). Japanese quail egg shells are

characterized by a variety of color patterns, ranging from dark brown, blue and white to buff, each heavily mottled with black, brown and blue (Narahari *et al.*, 1988). The egg shell pigments of the quail egg were found to be ooporphyrin, biliverdin and protoporphyrin (Butcher and Miles, 1995; Duval *et al.*, 2013). Recently, it has been proposed that egg shell pigmentation could be strongly related to female physiological condition (Soliman *et al.*, 2000; Duval *et al.*, 2013). The pigmentation of the egg is very important in determining the spectral characteristics of egg shells (Shafey *et al.*, 2005).

It was found that egg pigmentation affected the spectral transmittance of light into the egg (Ghatpande *et al.*, 1994; Shafey *et al.*, 2004). Kozuszek and Kontecka (2005) found that hatching results were better for pheasant eggs with dark-brown shells in comparison with those of light-brown and blue shells. However, the relationship between the Japanese quail egg shell colors and hatchability incubated under darkness or continuous lighting has not been adequately explained. So, the objective of the present study was to investigate embryo development, pre and post hatch performance of Japanese quail eggs of different colors incubated either under darkness or continuous lighting.

MATERIALS AND METHODS

The present experiment was carried out at the research poultry farm in the Poultry Production Department, Faculty of Agriculture, Assiut University, Assiut, Egypt. All experimental procedures were carried out according to the Local Experimental Animal Care Committee and approved by the ethics of our institutional committee of Department of Poultry, Faculty of Agriculture, Assiut University, Assiut, Egypt.

Nine hundred eggs of Japanese quail (*Coturnix coturnix japonica*) were used to study the embryonic development, pre and post hatch performance of quail eggs of different shell colors incubated under darkness or lighting. Eggs were randomly divided into three categories according to egg shell color (white, spotted violet or spotted brown eggs, 300 eggs per each group). All eggs within each group of egg shells color were classified into two separated treatments (150 eggs were incubated under darkness and the other 150 were eggs incubated under lighting during incubation process). All eggs were incubated under the recommended conditions of the quail eggs. Light intensity was 20-25 Lux at egg shell level using incandescent bulbs for all groups under continuous lighting.

All eggs were incubated under the same conditions (37.5°C and 60% RH). Before incubation, eggs were individually weighed (to 0.01 g) to determine initial egg weight and re-weighed at 14 days of incubation to determine egg weight loss (%). The time of setting eggs in the incubator was recorded for the experiment to obtain the hatch time exactly in hours and is considered as zero time of experiment.

Egg quality traits: Twelve eggs from each category of egg shell colors representing the three experimental categories were randomly taken to determine and evaluate the egg quality traits. Eggs were individually weighed and egg shape index was calculated for each egg. Then the eggs were broken out individually on a flat glass plate and the thick albumen and yolk heights were measured to the nearest millimeter, with a tripod micrometer. The diameter of the yolk was recorded to the nearest millimeter with a caliper. These data were used to estimate the yolk index. The yolk was separated from the albumen, then it was weighed then the albumen weight was estimated by subtraction, to the nearest 0.1 g, to estimate their percentages from the egg weight. The shell was

also weighed individually to the nearest milligram and shell thickness was measured in micrometer using a micrometer. The egg components were expressed as a percentage of the egg weight. Haugh units were calculated by using the following equation:

$$\text{Haugh units (HU)} = 100 \log (H + 7.57 - 1.7 W^{0.37})$$

where, H is height of the albumen (mm) and W is egg weight (g). A total number of thirty eggs were used to study the chemical composition of the egg according to the AOAC (1990) procedures.

Embryonic development: Thirty six eggs from each group of egg shell color (18 eggs from those incubated under darkness and the other 18 eggs incubated under continuous lighting) were taken randomly at setting and weighed individually. These eggs (having normal embryos) were taken at 4, 6, 8, 10, 12 and 14 days of setting and examined for embryonic development. The eggs were broken gently and embryos were separated as described by Asmar *et al.* (1972). Thus, the embryo was weighed and placed in a forced-air draft oven at 70°C until the constant weight was reached and recorded to the nearest 0.1 mg. The dried material was grounded thoroughly. The powder was packed in tightly closed bottles and stored in the refrigerator for chemical analysis. The protein content was determined using Kjeldahl method and the fat content using Soxhlet method as described by AOAC (1990).

Hatching performance: At hatching, all live chicks were recorded and un-hatched eggs were opened for recording embryonic mortality classifications. Hatching time and chick body weight at hatch was monitored every 4 h after the hatch of first chicks (chicks were considered hatched when they were completely emerged and free from the shell). Hatchability percent was based on fertile eggs and was calculated for the all groups.

Chick quality: Hatched chicks were removed, wing-banded, weighed to the nearest 0.1 g and recorded as chick body weight at hatch then placed again in the incubator after recording the time of hatch.

$$\text{Chick weight loss (\%)} = \frac{\text{Chick weight at hatch} - \text{Chick weight at pull out}}{\text{Chick weight at hatch}} \times 100$$

Chick quality were measured at hatch, all the hatched chicks were examined macroscopically in order to identify the different characteristics. The chick quality scores were using a scale from 1 (poor quality) to 5 (good quality).

Productive performance post hatching: All chicks were brooded on floor and weighed individually again at 8 weeks of age. All experimented chicks were fed diet containing 24% crude protein and 2600 kcal kg⁻¹ of diet as a starter diet until 8 weeks of age and 18% crude protein and 2600 kcal kg⁻¹ of diet for the rest of experimented period during laying period (3 months). The newly hatched chicks were exposed to continuous lighting for 24 h day⁻¹ during the first 3 days of age. Thereafter, the photoperiod was decreased gradually (1 h week⁻¹) to be adjusted to 12 h (growing) and 16 h (laying) lighting regimens with light intensities of 10 and 20 Luxes,

respectively. Daily body weight gain was calculated for the whole period of growth (from hatch to 8 weeks of age) depending on the difference between the recorded initial and final body weight then divided by the number of days. Feed Conversion Ratio (FCRg): (g feed g⁻¹ gain) was calculated for the whole period of growth by dividing the total feed consumed (g) in a pen by the total body weight gain (g day⁻¹) of its birds. Also, the feed conversion ratio during laying period (g feed g⁻¹ egg mass, FCR_e) were calculated from 8 to 20 weeks of age as a whole period. The egg mass was calculated as a bulk from 8 to 20 weeks of age. Plumage scores were measured as a gross mean for the period from 4 to 20 weeks of age. The area of the body feathering was using a scale from 1 (completely feathered) to 5 (featherless). Dead birds and leg problems were recorded daily and expressed as percentage during the experimental period.

Statistical analysis: Data collected were subjected to ANOVA by applying the General Linear Model (GLM) procedure of SAS software (SAS., 1998). The differences among means of different groups were detected by Duncan test. Before analysis, all percentages were subjected to arcsine transformation to approximate normal distribution.

RESULTS

The studied traits of egg quality and chemical composition of Japanese quail for the three categories of egg shell colors are found in Table 1. It is obvious that the spotted brown eggs had significantly ($p \leq 0.05$) thicker egg shell (19.70) than those of spotted violet (18.88) and white (18.20).

The mean percentages obtained for embryo weight at days 4, 6, 8, 10, 12 and 14 of incubation period are presented in Table 2. The effect of egg shell color on embryonic weight was significant ($p \leq 0.05$) at 10, 12 and 14 days of incubation. Embryos from spotted violet eggs incubated under lighting conditions were heavier than those from the other eggs, followed by spotted brown eggs incubated even under darkness or lighting.

Table 1: Means±SE of egg quality traits of Japanese quail as affected by eggshell color

Traits	Egg shell colors		
	White	Spotted violet	Spotted brown
Physical			
Egg weight (g)	10.88±0.39	11.00±0.22	11.14±0.42
Egg shape index	75.56±1.24	76.22±1.11	75.94±0.86
Egg yolk index	62.92±1.06	62.60±0.76	62.52±0.50
Haugh units	91.66±1.13	91.82±1.00	91.54±1.26
Shell thickness (×0.01 mm)	18.20±0.03 ^b	18.88±0.02 ^{ab}	19.70±0.03 ^a
Albumen (%)	56.00±1.13	55.87±1.33	55.90±1.56
Yolk (%)	32.78±1.00	32.81±1.50	32.70±1.24
Shell (%)	11.12±0.59	11.32±0.49	11.40±0.88
Chemical			
Moisture (%)	71.00±0.27	71.92±0.39	71.66±0.42
Protein (%)	13.00±0.12	13.16±0.14	13.20±0.18
Fat (%)	9.78±0.06	9.96±0.08	9.84±0.07
Ash (%)	0.83±0.05	0.85±0.07	0.84±0.04

^{a,b}Means in a row with no common superscript differ ($p \leq 0.05$)

Table 2: Means±SE of embryo weight (%) of Japanese quail as affected by egg shell colors and incubation light

Traits	Treatments					
	Dark			Light		
	White	Spotted violet	Spotted brown	White	Spotted violet	Spotted brown
4th day	0.28±0.02	0.29±0.02	0.31±0.02	0.30±0.03	0.30±0.03	0.31±0.01
6th day	3.10±0.13	3.07±0.06	3.08±0.09	3.14±0.15	3.17±0.18	3.21±0.05
8th day	11.07±0.31	10.98±0.34	11.13±0.37	11.10±0.13	11.17±0.44	11.22±0.15
10th day	19.30±0.29 ^b	21.00±0.39 ^{ab}	21.96±0.40 ^a	21.00±0.28 ^{ab}	22.94±0.39 ^a	21.92±0.60 ^a
12th day	31.71±0.30 ^b	31.88±0.22 ^b	33.98±0.42 ^a	34.00±0.24 ^a	34.11±0.19 ^a	33.93±0.17 ^a
14th day	48.50±1.92 ^b	50.69±0.62 ^{ab}	52.09±0.99 ^a	51.80±1.0 ^a	52.00±0.98 ^a	51.70±0.62 ^a

^{a,b} Means in a row with common superscript significantly differ ($p \leq 0.05$)

Table 3: Means±SE of embryo chemical composition of Japanese quail as affected by egg shell colors and incubation light

Traits (%)	Treatments					
	Dark			Light		
	White	Spotted violet	Spotted brown	White	Spotted violet	Spotted brown
Moisture	83.24±0.32	83.29±0.28	83.42±0.17	83.10±0.41	83.13±0.18	83.24±0.24
Protein	43.03±0.43	42.89±0.78	43.12±0.39	43.25±0.43	43.35±0.46	43.23±0.43
Fat	4.96±0.15	5.00±0.12	5.04±0.09	4.85±0.18	4.79±0.10	4.92±0.11
Ash	0.79±0.04	0.80±0.01	0.82±0.03	0.82±0.04	0.83±0.01	0.82±0.03

Table 4: Means±SE of hatching performance of Japanese quail eggs as affected by egg shell colors and incubation light

Traits	Treatments					
	Dark			Light		
	White	Spotted violet	Spotted brown	White	Spotted violet	Spotted brown
Hatchability (%)	69.50±0.29 ^b	69.78±0.54 ^b	72.64±0.46 ^a	72.58±0.42 ^a	71.66±0.60 ^{ab}	72.69±0.52 ^a
Early death embryo (%)	12.87±0.19	13.00±0.28	12.39±0.31	12.34±0.30	12.42±0.33	12.35±0.18
Late death embryo (%)	4.64±0.22	4.53±0.24	4.29±0.28	4.48±0.18	4.49±0.24	4.38±0.28
Dead piped (%)	4.72±0.09	4.49±0.10	4.15±0.12	4.09±0.09	4.00±0.11	4.15±0.10
Live piped (%)	4.00±0.10	3.89±0.18	3.54±0.10	3.67±0.14	3.58±0.19	3.60±0.15
Dead in shell (%)	2.69±0.15	2.70±0.11	2.68±0.17	2.55±0.13	2.61±0.18	2.63±0.10
Egg weight loss (%)	15.70±0.33 ^a	14.04±0.24 ^b	15.42±0.28 ^{ab}	15.90±0.33 ^a	15.68±0.22 ^a	15.50±0.42 ^{ab}
Incubation period (h)	397.10±0.42 ^b	399.00±0.56 ^{ab}	400.40±0.48 ^a	396.60±0.60 ^b	397.00±0.57 ^b	398.80±0.50 ^{ab}

^{a,b} Means in a row with common superscript significantly differ ($p \leq 0.05$)

It is interesting to note that the data in Table 3 showed that the egg shell coloration did not influence significantly each of the moisture content of the embryos, protein, fat and ash percentages. All eggs incubated under continuous lighting showed insignificantly the higher values of the protein (%) as shown in Table 3.

Results of hatch performance due to the effect of egg shell coloration are shown in Table 4. In general, it could be seen that eggs of spotted brown showed significantly ($p \leq 0.05$) the higher percentages of hatchability (%) even the ones incubated under darkness or continuous lighting

(72.64 and 72.69%, respectively) followed by those of spotted violet and white. Early death embryo (%), late death embryo (%), dead piped (%), live piped (%) and dead in shell (%) were not significantly changed due to the egg shell colors. All eggs incubated under continuous lighting showed insignificantly the best values of the most of the mentioned traits (Table 4). It can observe that egg weight loss (%) was significantly ($p \leq 0.05$) decreased to the lowest value in the eggs of spotted violet (14.04%) incubated under darkness, followed by eggs of spotted brown incubated under darkness (15.42%) then those of spotted brown incubated under continuous lighting (15.50%) as found in Table 4. Regarding incubation period, white spotted violet eggs incubated under continuous lighting conditions followed by white eggs incubated in darkness had the shorter time of incubation period (396.6, 397.0 and 397.1 h, respectively) than those of other egg shell colors.

Results of chick quality in Table 5 showed that chick weight was significantly ($p \leq 0.05$) heavier in group of spotted brown egg color even incubated under darkness or continuous lighting conditions (7.94 and 7.96 g, respectively) than the other groups of eggs. It is clear from the results found in Table 5 that each of chick weight loss (%), chick sex and chick quality were not influenced by egg shell colors.

Body weight gain and feed conversion during growth period (g feed g^{-1} gain) as affected by egg shell colors and incubation lighting are shown in Table 6. Chicks produced from spotted brown eggs showed significantly ($p \leq 0.05$) higher values of body weight gain (3.86 and 3.85 g) even the ones incubated under continuous lighting or darkness. A slight improvement in feed conversion ratio during growth was observed in chicks produced from spotted brown egg than the other groups without significant differences. Each of egg mass and feed conversion for the egg is found in Table 6. There are no significant differences in egg mass and feed conversion ratio but with some

Table 5: Means $\pm$ SE of chick quality of Japanese quail as affected by egg shell colors and incubation light

Traits	Treatments					
	Dark			Light		
	White	Spotted violet	Spotted brown	White	Spotted violet	Spotted brown
Chick weight at hatch (g)	7.00 $\pm$ 0.04 ^b	7.60 $\pm$ 0.03 ^{ab}	7.94 $\pm$ 0.05 ^a	7.68 $\pm$ 0.03 ^{ab}	7.93 $\pm$ 0.04 ^a	7.96 $\pm$ 0.05 ^a
Chick weight loss (%)	6.26 $\pm$ 0.05	6.24 $\pm$ 0.06	6.32 $\pm$ 0.07	6.41 $\pm$ 0.05	6.39 $\pm$ 0.06	6.40 $\pm$ 0.08
Chick sex (F/M)	1.33 $\pm$ 0.32	1.16 $\pm$ 0.35	1.07 $\pm$ 0.26	0.96 $\pm$ 0.30	1.06 $\pm$ 0.41	1.16 $\pm$ 0.35
Chick quality (%)	91.52 $\pm$ 0.56	92.00 $\pm$ 0.61	92.34 $\pm$ 0.51	91.84 $\pm$ 0.48	92.30 $\pm$ 0.61	92.48 $\pm$ 0.51

^{a,b}Means in a row with common superscript significantly differ ($p \leq 0.05$)

Table 6: Means $\pm$ SE of productive performance of Japanese quail as affected by egg shell colors and incubation light

Traits	Treatments					
	Dark			Light		
	White	Spotted violet	Spotted brown	White	Spotted violet	Spotted brown
Body weight gain (g)	3.32 $\pm$ 0.12 ^b	3.38 $\pm$ 0.19 ^b	3.85 $\pm$ 0.18 ^a	3.58 $\pm$ 0.15 ^{ab}	3.85 $\pm$ 0.24 ^a	3.86 $\pm$ 0.20 ^a
Egg mass (g hen ⁻¹)	504.40 $\pm$ 8.11	512.40 $\pm$ 6.82	514.30 $\pm$ 9.66	515.80 $\pm$ 7.90	510.80 $\pm$ 6.74	508.40 $\pm$ 8.56
FCRg (g feed g ⁻¹ gain)	4.44 $\pm$ 0.15	4.54 $\pm$ 0.16	4.25 $\pm$ 0.18	4.39 $\pm$ 0.12	4.40 $\pm$ 0.19	4.20 $\pm$ 0.14
FCRe (g feed g ⁻¹ egg)	2.64 $\pm$ 0.14	2.60 $\pm$ 0.11	2.55 $\pm$ 0.12	2.58 $\pm$ 0.14	2.64 $\pm$ 0.09	2.52 $\pm$ 0.10

^{a,b}Means in a row with common superscript significantly differ ($p \leq 0.05$)

Table 7: Means±SE of plumage, leg conditions and mortality rate of Japanese quail as affected by egg shell colors and incubation light

Traits	Treatments					
	Dark			Light		
	White	Spotted violet	Spotted brown	White	Spotted violet	Spotted brown
Plumage conditions	2.00±0.26	2.16±0.38	2.33±0.22	2.16±0.33	2.33±0.22	2.33±0.26
Leg problems (%)	1.0	0.8	0.8	0.8	1.0	0.8
Mortality (%)	6.7	8.9	5.0	6.7	6.7	6.7

improvement in feed conversion ratio for chicks produced from spotted brown eggs even incubated under conditions of darkness or lighting.

It could be seen from the results found in Table 7 that egg shell color even incubated under darkness or lighting conditions had insignificant effects on each of plumage conditions, leg problems and mortality (%) from hatch to 20 weeks of age. Mortality (%) was lower (5.0%) in chicks that are produced from group of spotted brown eggs incubated in the dark than the other groups.

DISCUSSION

The egg quality traits play an important role in the processes of embryo development, chick quality and successful hatching (Senapati *et al.*, 1996; Narushin and Romanov, 2002; Copur *et al.*, 2010). Furthermore, hatchability of the egg and the production of a healthy chick depend on two main factors; first, the contents of egg at laying must supply all the water and chemical energy in the form of macronutrients needed for embryo development and second the egg shells allow into the egg sufficient oxygen to meet the demands of the embryo and the appropriate quantities of water vapor and carbon dioxide to pass out (Ar, 1991). Shell weight is affected by egg color in pheasants (Gunlu *et al.*, 2007). Kirikci *et al.* (2005) reported ratios of shell, albumen and yolk in blue, white, green and brown eggs as 13.11, 11.81, 11.74 and 12.1%; 53.7, 58.1, 56.3 and 57.0%; and 35.9, 32.0, 33.7 and 32.6%, respectively. Narahari *et al.* (1988) found that the Japanese quail eggs characterized by a variety of color patterns, ranging from dark brown, blue and white to buff, each heavily mottled black, brown and blue. The present results are in accordance with those found by Soliman *et al.* (2000) who showed insignificant differences among egg color groups for egg weight, egg shape index, albumen weight, albumen percent and albumen height values. The same author added that there were highly significant ($p \leq 0.01$) differences among egg color groups for shell thickness, where the egg of dark brown with spots or dots has the higher values of shell thickness. Mahmoud and Coleman (1967) reported the relative proportions of the quail egg to be: 47.4% albumen, 31.9% yolk and 20.7% shell and membranes. The later author added that the thickness of the shell to be 0.197 mm.

Coleman and McNabb (1975) found that the development of embryos of Japanese quail with colored shells was slower than those of uncolored shells and that depigmentation of eggs resulted in early hatching. However, Shafey *et al.* (2005) reported that egg shell color did not significantly influence the embryo percentage. The color of a pigment depends on its selective absorption and transmission of certain wavelengths of light and its reflection of others (Clifford and Philpott, 2002). The main pigment of brown egg shell is protoporphyrin (Butcher and Miles, 1995), so that our observations suggest that the intensity of protoporphyrin pigment of spotted brown egg shells altered the spectral characteristics of the transmitted light into the egg.

Eggs incubated under continuous lighting had better embryonic weights than those incubated under darkness. Many researchers reported that light plays an important role in the development and growth of birds by the regulation of the function of the hypothalamus-pituitary-thyroid axis via eyes and extra-retinal photoreceptors, the hypothalamus area secrete TSH which causes production and secretion of thyroid hormones (Shafey *et al.*, 2004, 2005; Khalil, 2009; Farghly and Mahrose, 2012; Farghly, 2012). They added that serum T₃ and T₄ concentrations increased significantly during the light period of the daily cycle and decreased during the dark period of the cycle in rats. Light-induced acceleration of embryonic development depends on the amount of light that reaches the embryo (Ghatpande *et al.*, 1994). The amount of light reaching the developing embryos triggers the stimulatory effect and consequently the amount of growth acceleration (Ghatpande *et al.*, 1994; Khalil, 2009). The embryos could obtain more calcium from the egg shell (Coleman, 1979) due to photo stimulation. Faluhelyi and Csernus (2007) proved that the acceleration of embryonic growth is likely controlled by the melatonin rhythms that develop in the embryo. The findings of the present study are in agreement with those of Walter and Voitle (1973), Abd El-Azim *et al.* (2005), Khalil (2009), Farghly and Mahrose (2012) and Farghly (2012). El-Sheikh *et al.* (2009) indicated that embryos incubated in continuous light (24L: 0D) are heavier than those incubated in continuous dark (0L: 24D) while those incubated under the diurnal light cycle (12L: 12D) have intermediate weights. On the contrast of our results, Fairchild and Christensen (2000) observed that light had no effect on embryo weight.

Coleman *et al.* (1981) demonstrated that protein synthesis in the embryo was accelerated by light as a result of stimulation of all cellular components by light. Also, Rozenboim *et al.* (1999) reported that lighting elevated embryonic plasma androgens, enhancing protein synthesis and reducing protein breakdown (Bates *et al.*, 1987). The present results are partially in agreement with those obtained by El-Sheikh *et al.* (2009). Farghly (2012) reported that insignificant differences existed in protein and fat among dark and light groups. However, moisture content of embryos from eggs incubated in the dark was higher than those of light eggs. Similar results were obtained by Yakimenko *et al.* (2002). The reason of the decrease of embryonic moisture content of illuminated eggs is the increase of evaporation as a result of secondary heating of incubated eggs exposed to light (Gold and Kalb, 1976).

Egg shell coloration could indicate that some eggs require a different incubation humidity environment than would be used for eggs with more typical coloration (Deeming, 2011). Soliman *et al.* (2000) pointed out that dark brown eggs of Japanese quail with spots or dots and both brown and violet eggs with spots or dots had significantly ($p \leq 0.01$) the higher hatchability percentages than white and light brown or violet with no spots or dots. Briggs and Williams (1975), Narahari *et al.* (1988), Rizk and Soliman (1992) and Darwish *et al.* (1997) reported a relationship between shell color and hatchability in the quail. Egg shell color affects hatchability, because it is related to the quality of hatching egg such as the internal egg composition or ratio, egg weight and shell quality, whereby the incubation condition and the development of the chick embryo are influenced. Briggs and Williams (1975) indicated that hatchability of Japanese quail pigmented eggs had increased by 10% compared to those of white eggs.

Regarding incubation period, white spotted violet eggs incubated under continuous lighting conditions followed by white eggs incubated in darkness had the shorter time of incubation period (396.6, 397.0 and 397.1 h, respectively) than those of other egg shell colors. According to Woodard *et al.* (1973), quail eggs average 380 h (15.8 days) from setting to pipping; 10 from pipping to hatch and an additional 5 for drying the chick. Time of hatch varies among strains and

inbred lines may take as long as 18 days to hatch. The importance of light exposure for the synchronization of embryonic development with the photoperiod implies a crucial role of eggshell pigmentation in the establishment of a circadian clock of pre- and peri-natal chicks of both precocial and altricial species (Zeman and Gwinner, 1993; Zeman *et al.*, 1999; Maurer *et al.*, 2011). Specifically, shell pigmentation must not completely occlude light from the egg as the circadian rhythm established in the embryo determines the timing of hatching and the hatchlings day-night rhythm until at least three days after hatching (Zeman and Gwinner, 1993; Zeman *et al.*, 1999; Maurer *et al.*, 2011).

Our results were in agreement with Farghly (2012) who found that light pulses had insignificant effect on hatch weight. Similar results were obtained by Narahari *et al.* (1988) and Soliman *et al.* (2000). On the other hand, Kicka *et al.* (1982), Abd El-Azim *et al.* (2005) and Bakir *et al.* (2005) reported that the eggs incubated under light produced heavier chicks than those incubated in the dark.

In contrast to our results, Khalil (2009) found that chicks produced from light incubation had higher weight gain ($p \leq 0.001$) than those produced from dark incubation. Also, Farghly (2012) and Farghly and Mahrose (2012) claimed that chicks produced from eggs that are exposed to light had the lower feed conversion than those of dark conditions.

The present results are partially agreed on those obtained by Farghly and Mahrose (2012) who indicated that lighting during incubation did not improve laying performance of Japanese quail after hatch. Archer *et al.* (2009) demonstrated that providing light during incubation of broiler eggs did not detrimentally affect any of the measured production parameters.

Archer *et al.* (2009) illustrated that no differences in gait scores, an indicator of leg health, were observed. Light stimulation during incubation did not have marked effects on post hatch activity rhythms as had been predicted, so the lack of difference in gait scores is not surprising. Cooper (1972) stated that poults hatched from eggs exposed to fluorescent lights appeared to be more active and had lower mortality rate than poults incubated and hatched in dark. Khalil (2009) reported that treatments of lighting during incubation had insignificant effects on mortality rate through 0-6 weeks of age. Farghly and Mahrose (2012) found that lighting treatments had insignificant effects on each of plumage conditions, leg problems and mortality (%) from hatch to 20 weeks of age. In general, the observed results indicated in the present study, that the lighting during incubation had beneficial effects on pre and post hatch performance of Japanese quail and the colored quail eggs are the best for hatching performance. According to Jones *et al.* (1964), by sorting eggs on the basis of color pattern it would be possible to distinguish the eggs of individuals in mixed clutches of quail eggs with high degree of accuracy.

CONCLUSION

It could be concluded from the present study that selecting eggs of spotted brown and spotted violet of colored shell to get the best possible pre and post hatching performance, which positively reflect on the profit which could be gained by the producer. More studies are required to get the relationship between egg shell colors and light intensity, light color, water vapor conductance and humidity of the incubator.

REFERENCES

- AOAC., 1990. Official Methods of Analysis. 13th Edn., Association of Official Analytical Chemists (AOAC), Washington, DC., USA.

- Abd El-Azim, A., G.A. Arram, N.A. Hataba and M. Abd Al-Samad, 2005. Effect of temperature and/or light during incubation on: 1-Embryonic development and hatchability in Fayoumi and Golden Montazah chickens. Proceedings of the 3rd International Poultry April 4-7, 2005, Hurghada, Egypt, pp: 530-544.
- Ar, A., 1991. Egg Water Movements during Incubation. In: Avian Incubation, Tullett, S.G. (Ed.). Butterworth-Heinemann, London, pp: 157-173.
- Archer, G.S., H.L. Shivaprasad and J.A. Mench, 2009. Effect of providing light during incubation on the health, productivity and behavior of broiler chickens. Poult. Sci., 88: 29-37.
- Asmar, J.A., P.L. Pellett, N. Hariri and M.D. Hariri, 1972. Quantitative and qualitative protein changes in the developing single comb White Leghorn chicken embryo. Poult. Sci., 51: 313-320.
- Bakir, A.A., M.A. KicKa, S.M.T. El-Tantwy and M.A.S. Ahmed, 2005. Influence of fluorescent light during incubation period on some productive characteristics. Proceedings of the 3rd International Poultry Conference, April 4-7, 2005, Hurghada, Egypt, pp: 530-544.
- Bates, P.C., L.F. Chew and D.J. Millward, 1987. Effects of the anabolic steroid stanozolol on growth and protein metabolism in the rat. J. Endocrinol., 114: 373-381.
- Briggs, D.M. and C.M. Williams, 1975. Shell strength, hatchability, egg-production and egg-shell pigmentation in Japanese-quail. Poult. Sci., 54: 1738-1738.
- Butcher, G.D. and R.D. Miles, 1995. Factors causing poor pigmentation of brown-shelled eggs. VM-94, A Series of the Veterinary Medicine-Large Animal Clinical Sciences Department, UF/IFAS Extension, Institute of Food and Agricultural Sciences (IFAS), University of Florida, USA., pp: 1-3.
- Clifford, J. and G. Philpott, 2002. Light and Sound. In: The Longman Physics 11-14, Clifford, J. and G. Philpott (Eds.). Longman, Harlow, UK., ISBN-13: 9780582447530, pp: 32-46.
- Coleman, M.A. and R.A. McNabb, 1975. Photoacceleration of embryonic development in depigmented Japanese quail eggs. Poult. Sci., 54: 1849-1855.
- Coleman, M.A., 1979. The effect of colored lights and eggs size on the hatch time and weights and embryonic mortality and abnormalities of broilers. Poult. Sci., 58: 1045-1045.
- Coleman, M.A., R.C. Smith and G.R. McDaniel, 1981. The effect of lighted incubation on ribonucleic acid, deoxyribonucleic acid and protein content of chick embryos. Poult. Sci., 60: 1089-1091.
- Cooper, J.B., 1972. Effect of light during incubation on hatchability of turkey eggs. Poult. Sci., 51: 1105-1108.
- Copur, G., M. Baylan and S. Canogullari, 2010. Egg weight but not egg shape index, determines the hatchability in Japanese Quail (*Coturnix coturnix japonica*). J. Anim. Vet. Adv., 9: 1890-1895.
- Darwish, A.A., F.A.A. Ibrahim and S.M. El-Tantawy, 1997. Effect of sex ratio, housing system, egg size and shell color on the hatching performance of Japanese quail. Proceedings of the 2nd Hungarian-Egyptian Poultry Conference, September 16-19, 1997, Godollo, Hungary, pp: 283-293.
- Deeming, C.D., 2011. A review of the relationship between eggshell colour and water vapour conductance. Avian Biol. Res., 4: 224-230.
- Duval, C., P. Cassey, I. Miksik, S.J. Reynolds and K.A. Spencer, 2013. Condition-dependent strategies of eggshell pigmentation: An experimental study of Japanese quail (*Coturnix coturnix japonica*). J. Exp. Biol., 216: 700-708.

- El-Sheikh, T.M., A.M. El-Gammal and M.N. Makled, 2009. The effect of vitamin c supplementation to breeder hens and light during incubation on embryonic development. Proceedings of the 5th International Poultry Conference, March 10-13, 2009, Taba, Egypt, pp: 1666-1681.
- Fairchild, B.D. and V.L. Christensen, 2000. Photostimulation of turkey eggs accelerates hatching times without affecting hatchability, liver or heart growth, or glycogen content. *Poult. Sci.*, 79: 1627-1631.
- Faluhelyi, N. and V. Csernus, 2007. The effects of environmental illumination on the *in vitro* melatonin secretion from the embryonic and adult chicken pineal gland. *Gen. Comp. Endocrinol.*, 152: 154-158.
- Farghly, M.F.A., 2012. Effect of light pulses during incubation on hatch performance in different eggs size of Japanese quail. Proceedings of the 3rd Mediterranean Poultry Summit of WPSA and 6th International Poultry Conference, March 26-29, 2012, Alexandria, Egypt.
- Farghly, M.F.A. and K.M. Mahrose, 2012. Effects of light during storage and incubation periods on pre and post hatch performance of Japanese quail. *Egypt. J. Poult. Sci.*, 32: 947-958.
- Ghatpande, A., S. Ghatpande and M.Z. Khan, 1994. Effect of different intensities of fluorescent light on the early development of chick embryos in ovo. *Cell. Mol. Biol. Res.*, 41: 613-621.
- Gold, P.S. and J. Kalb, 1976. Secondary heating of chicken eggs exposed to light during incubation. *Poult. Sci.*, 55: 34-39.
- Gunlu, A., K. Kirikci, O. Cetin and M. Garip, 2007. Effect of hen age on some egg quality characteristics of pheasants (*P. colchicus*). Proceedings of the Symposium Current Problems of Breeding, Health, Growth and Production of Poultry, February 14-17, 2007, Ceska Budejovice, Czech Republic, pp: 211-215.
- Jones, J.M., M.A. Maloney and J.C. Gilbreath, 1964. Size, shape and color pattern as criteria for identifying Coturnix eggs. *Poult. Sci.*, 43: 1292-1294.
- Khalil, H., 2009. Productive and physiological responses of Japanese quail embryos to light regime during incubation period. *Slovak J. Anim. Sci.*, 42: 79-86.
- Kicka, M.A., F.K.R. Stino and G.A.R. Kamar, 1982. Influence of fluorescent light during incubation on hatch time and embryonic development of the Chicken, Turkey and Duck eggs. *Archiv Fur Geflugelkunde*, 46: 49-52.
- Kirikci, K., A. Gunlu and M. Garip, 2005. Some quality characteristics of pheasant (*Phasianus colchicus*) eggs with different shell colors. *Turk. J. Vet. Anim. Sci.*, 29: 315-318.
- Kozuszek, R. and H. Kontecka, 2005. Biological value of pheasant's eggs in relation to the colour of eggshell and time of storage before hatching. Proceedings of the 17th International Poultry Symposium, Program and Abstracts, (IPSPA'05), Poznan-Kiekrz, Poland, pp: 83-84, (In Polish).
- Mahmoud, T.H. and T.H. Coleman, 1967. A comparison of the proportion of component parts of Bobwhite and Coturnix eggs. *Poult. Sci.*, 46: 1168-1171.
- Maurer, G., S.J. Portugal and P. Cassey, 2011. Review: An embryo's eye view of avian eggshell pigmentation. *J. Avian Biol.*, 42: 494-504.
- Narahari, D., K.A. Mujeer, A. Thangavel, N. Ramamurthy and S. Viswanathan *et al.*, 1988. Traits influencing the hatching performance of Japanese quail eggs. *Br. Poult. Sci.*, 29: 101-112.
- Narushin, V.G. and M.N. Romanov, 2002. Egg physical characteristics and hatchability. *World Poult. Sci. J.*, 58: 297-303.
- Rizk, R.E. and F.N.K. Soliman, 1992. The effect of eggshell color pigmentations on hatchability of Japanese quail. *Egypt. J. Poult. Sci.*, 12: 867-891.

- Rozenboim, I., I. Biran, Z. Uni, B. Robinson and O. Halevy, 1999. The effect of monochromatic light on broiler growth and development. *Poult. Sci.*, 78: 135-138.
- SAS., 1998. Users Guide to the Statistical Analysis System. 5th Edn., SAS Institute Inc., Cary, NC., USA.
- Senapati, P.K., K.D. Madal and A.K. Chatterjee, 1996. Relationship between egg weight, shape index, fertility and hatchability of Japanese quail eggs. *Environ. Ecol. Stat.*, 14: 574-577.
- Shafey, T.M., M.M. Ghannam, H.A. Al-Batshan and M.S. Al-Ayed, 2004. Effect of pigment intensity and region of eggshell on the spectral transmission of light that passes the eggshell of chickens. *Int. J. Poult. Sci.*, 3: 228-233.
- Shafey, T.M., H.A. Al-Batshan, M.M. Ghannam and M.S. Al-Ayed, 2005. Effect of intensity of eggshell pigment and illuminated incubation on hatchability of brown eggs. *Br. Poult. Sci.*, 46: 190-198.
- Soliman, F.N., A. El-Sebai and M. Abaza, 2000. Hatchability traits of different colored Japanese quail eggs in relation to egg quality and female blood constituents. *Egypt. Poult. Sci.*, 20: 417-443.
- Walter, J.H. and R.A. Voitle, 1973. Effects of photoperiod during incubation on embryonic and post-embryonic development of quail and chickens. *Br. Poult. Sci.*, 14: 533-540.
- Woodard, A.E., H. Abplanalp, W.O. Wilson and P. Vohra, 1973. Japanese Quail Husbandry in the Laboratory (*Coturnix coturnix japonica*). 2nd Edn., Department of Avian Sciences, University of California, USA., Pages: 22.
- Yakimenko, I., V. Besulin and A. Testik, 2002. The effects of low intensity red laser irradiation on hatching eggs in chicken and quail. *Int. J. Poult. Sci.*, 1: 6-8.
- Zeman, M. and E. Gwinner, 1993. Ontogeny of the rhythmic melatonin production in a precocial and an altricial bird, the Japanese quail and the European starling. *J. Comp. Physiol. A*, 172: 333-338.
- Zeman, M., E. Gwinner, I. Herichova, D. Lamosova and L. Kost'al, 1999. Perinatal development of circadian melatonin production in domestic chicks. *J. Pineal Res.*, 26: 28-34.
- Zeman, M., P. Pavlik, D. Lamosova, I. Herichova and E. Gwinner, 2004. Entrainment of rhythmic melatonin production by light and temperature in the chick embryo. *Avian Poult. Biol. Rev.*, 15: 197-204.