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Effects of Divergent Selection and Egg Status in Artificial Incubator on Reproductive Trait in Japanese Quail

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Abstract: This study was undertaken to determine the effects of divergent selection and different positions of Japanese quail eggs in artificial incubation on hatchability, egg weight loss, chick weight. 300 Japanese quail (100 birds in each line) were used for egg collection. These lines have been selected for high (HW) and low (LW) body weight for 9 generations and compared with control line(C). Average of 822 eggs (274 eggs in each line) was 14.19, 12.02 and 10.2 in HW, C and LW, respectively, all at 13 weeks of age. Based on eggs positions during incubation were divided into two experimental groups (137 eggs in each group in each line: vertical position with small end up, vertical position with small end down with turning). The eggs incubated in vertical and small end down had the higher hatchability (59.2%), while those incubated in vertical position with small end up presented the lower hatchability (8.5%). Egg position influenced water loss during incubation. The groups with better hatchability presented lower egg weight loss and better hatch weight. The eggs in HW had the lower hatchability and higher egg weight loss and better hatch weight.

Key words: Divergent selection · Egg position · Reproductive traits · Japanese quail

INTRODUCTION

Fertility rate and hatchability are influenced by many factors including male/female ratio, genetic, age of parents, nutrition, storage conditions and period of eggs, quality and weight of eggs and incubation conditions that have argued by many researchers [1, 2, 3]. Some researchers reported that body weight and egg weight are correlated [4] and by selection the body weight could be increasing [2, 5]. Incubation procedures are important for maintenance and improvement of quail egg production. Yoshizaki et al. have reported that many factors can interfere with the success of incubation or the quality of hatched chicks, such as egg position and turning during artificial incubation [6]. Wilson *et al*. showed he avian embryo progresses through a series of positions throughout incubation and ends in a normal position for hatching [7]. Egg position during storage and incubation can interfere with embryo position, affecting hatchability and chick quality. Egg position changes, the exposed surface area, changing the loss of water from the egg, affecting hatchability indirectly [7, 8]. Information about the effects of egg position during incubation for Japanese quail eggs is lacking. Thus the objective of this research was to verify the effects of divergent selection and different positions during artificial incubation of Japanese quail eggs on hatchability, egg weight loss, chick weight.

MATERIALS AND METHODS

Birds: 300 Japanese quail (100 birds in each line) were used for egg collection. They were housed in experimental battery cages in the animal research station in university of Tehran, Iran. Two females and one male were lodged in each cage. Water and balanced feed were supplied ad libitum. They were also exposed to 16 hours/day of light.

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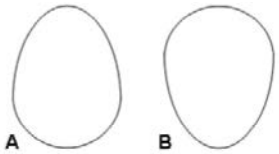

Fig. 1: TWO experimental egg positions

Quail breeders were used for egg collections, which were performed daily. A total number of 822 (274 eggs in each line) was 14.19, 12.02 and 10.2 in HW, C and LW, respectively, all at 13 weeks of age. Based on eggs positions during incubation were divided into two experimental groups (137 eggs in each group in each line: vertical position with small end up, vertical position with small end down, with turning (Fig. 1). Eggs were incubated in vertical position with the small end up (position A); in vertical position with small end down with turning (position B). The incubation temperature for the first 14 days of incubation was 37.7°C, after which it was reduced to 37.5°C for the rest of the incubation period. The relative humidity of 60 to 65% for the first 14 days of incubation and 70 % for the rest period were maintained properly. Automatic turning devices were used to turn the eggs 12 times in 24 hours up to the 14^{th} day of incubation. Air circulation and the temperature were controlled automatically as well.

Measurement: All eggs were identified individually and weighed on their collection day. They were also weighed during incubation period on days 1 and 14 of incubation. All quail chicks were weighed after hatching. Hatching parameters were calculated using the following formulas:

Hatchability of fertile eggs (%) = (Numbers of chicks/ Total numbers of fertile eggs) x 100

Statistical Analyses: To determine the effects of divergent selection and egg status in artificial incubator on hatchability of fertile eggs and analysis of variance (ANOVA) were performed by using non transform data. If significant differences ($P<0.05$) were found by ANOVA, means of fertility rate, hatchability, egg weight loss, chick weight data were separated using Duncan's Multiple Range Test.

RESULT

Hatchability: The statistical analysis results of effects of line and egg position on hatchability results and differences between line and between egg positions were presented in Table 1.

The influence of egg position on hatchability of fertile eggs and egg weight loss and chick weight was found significant ($P<0.05$, $P<0.01$). The effect of line on hatchability of fertile eggs and egg weight loss and chick weight was significant ($P<0.05$, $P<0.01$). The effect of interaction between egg position and line was found significant ($P<0.01$) for hatchability of fertile eggs and egg weight loss and chick weight. According to Table 1 two groups of eggs incubated in vertical position presented a very different hatch rate. Thus, the eggs incubated in vertical small end down had a seven times higher hatchability compared to the ones incubated with the small end up.

Egg Weight Loss: Table 1 shows the egg weight loss during incubation of Japanese quail eggs at different positions. The eggs incubated at vertical position with small end up presented the higher level of egg weight loss during incubation.

Chick Weight: Table 1 shows the relation between chick weight at hatch and initial egg weight of Japanese quail eggs incubated at different positions.

DISCUSSION

Yoshizaki and Saito found that quail eggs incubated at 39°C in vertical position with small end down and turned every two hours had a 85% hatchability, the eggs placed with their equatorial side down with turning had 63%, while the group of eggs placed with their equatorial side down without turning had only 24% [6]. Compared to our results, it was observed that Japanese quail eggs presented a higher hatch rate for vertical position with small end down (59.2). The hatch rate differences between these results were probably due to the use of different incubation temperatures. The avian embryo progresses through a series of positions throughout incubation and ends in a normal position for hatching. There are variations of the normal position that are considered not to be detrimental to successful hatching. However, there are many positions which are associated with difficulty in hatching or are found in increased incidence in cases of poor hatchability. According to Wilson et al., a major cause of detrimental malposition, especially in broiler eggs, is setting eggs with the small end up; it can also explain the poor hatchability (8.5%) found in Japanese quail eggs incubated in this position [7]. It was observed in this work that the different egg positions have influenced the rate of egg weight loss. Among the groups of static position, the eggs incubated in vertical small end

Table 1: Effect of egg position in artificial incubator and line on hatching results of Japanese quail eggs

Egg position groups	Line	Hatchability ± SD (%)	Egg weight loss ± SD (%)	Chick/egg weight ± SD (%)
Vertical small end down	HW	54.4^{z}±0.9	8.4^{x}±1.5	76.4^{x}±0.7
	C	64.8^{x}±1.1	8.1^{x}±1.6	74.8^{x}±1.1
	LW	58.2^{y}±0.8	7.9^{y}±1.9	70.5^{y}±0.9
P		**	*	*
Total		59.2^{A}±0.9	8.2^{B}±1.7	73.9^{A}±0.9
Vertical small end up	HW	7.7^{z}±2.3	12.8^{x}±2.9	70.2^{x}±1.4
	C	9.1^{x}±1.2	10.4^{y}±1.7	69.9^{x}±1.4
	LW	8.7^{y}±1.6	10.1^{y}±2.1	67.2^{y}±2.3
P		**	**	*
Total		8.5^{B}±1.7	11.1^{A}±2.2	70.2^{B}±1.7
Total	HW	31.1^{c}±1.6	10.6^{a}±2.2	73.3^{a}±1.1
	C	36.9^{a}±1.1	9.2^{b}±1.6	72.3^{a}±1.2
	LW	33.4^{b}±1.2	9.0^{b}±2.0	68.8^{b}±1.6
Total		33.8±1.3	9.6±1.9	72.0±1.3
Egg position effect		**	**	*
Line effect		**	**	*
Egg position x Line effect		**	**	**

-: Not significant (P>0.05), *: P<0.05, **: P <0.01; x, y, z: Values within columns with no common superscript differ significantly (P<0.05) (compares between egg position groups within line); a, b: Values within columns with no common superscript differ significantly (P<0.05) (compares between line); A, B, C: Values within columns with no common superscript differ significantly (P<0.05) (compares between egg position groups).

up showed the higher weight loss. The egg weight loss is an important parameter for incubation. It has been used to estimate vital gas exchange [9, 10] and has been correlated with the rate of embryonic metabolism and development [11, 12]. However, too low or too high water loss influences embryo development and, consequently, egg hatchability [13, 14]. Tiwari and Maeda studied the effect of egg position on weight loss during pre-incubation storage and verified that egg weight loss did not differ between the normal (small end down) and opposite (small end up) position groups [8]. Vali *et al*. found that hatching weight of Japanese quail chicks was about 72% of the initial egg weight [15]. We found that the vertical position with small end down position with turning produced the heaviest chicks (73.9). However, the weight of chicks at hatch can also be affected by other factors, including species, breed, egg nutrient levels, egg environment and weight loss during incubation period, weight of shell and other residues at hatch, shell quality and incubator conditions [16, 17, 18].

An important parameter evaluated in the present study was the line. Among different line, all parameter was found significantly different. In the present study, hatching rate of fertile eggs in line was found 33.4% (LW), 36.9% (C) and 33.4% (HW). The same estimates were reported for hatchability percentages in Japanese quail by Marks who estimated it as 44.5 and 50.8% for selected and control lines [19]. Among the line, the eggs in HW showed the higher weight loss. We found that the HW produced the heaviest chicks (73.3). This result was in agreement with the reports of Wilson [16].

CONCLUSION

In conclusion, this study found that different egg positions can highly interfere with artificial incubation of Japanese quail eggs. Optimum hatchability of fertile eggs was observed in eggs in control line and HW had the higher egg weight loss and chick weight.

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