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PROOF

RESEARCH PAPER

The Effect of Placement Position and Weight of Japanese Quail (*Coturnix coturnix japonica*) Eggs on Hatching Results

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Abstract

This study was conducted to determine the effects of egg weight and positioning in incubation trays on hatching results in Japanese quail (*Coturnix coturnix japonica*). For this purpose, a total of 438 hatching eggs obtained from a 15-week-old quail flock were used. Eggs were classified into three groups according to weight: large (mean: 14 g), medium (mean: 11.95 g), and small (mean: 8 g). Large, medium, and small eggs were placed in incubation trays in three different positions: normal incubation position (blunt end up), at a 45° angle, and vertically. Incubation was carried out for 14 days at 37.5 °C and 60% relative humidity, with hourly turning, after which the eggs were transferred to the hatcher trays on day 15. On hatching day, chick quality was evaluated using the Pasgar score method, and hatchability, hatchability of fertile egg, and embryonic mortality rates were determined. The results of the study showed that egg position had a significant effect on hatchability, hatchability of fertile egg, and late embryonic mortality, while its effect on early and mid-stage embryonic mortality and chick quality was not significant. Egg weight had no significant effect on hatching results or chick quality. In addition, no interaction was determined between egg position and egg weight. In conclusion, it was determined that placing quail eggs vertically or at a 45° angle in incubation trays had more positive effects on hatching results compared to horizontal placement of eggs.

Introduction

In poultry farming, hatching success is considered one of the most critical stages of the production chain. The liveability, chick quality and uniformity of hatched chicks directly affect flock performance and economic efficiency. Therefore, a detailed analysis of the factors affecting hatching efficiency and hatchability is of great importance for both scientific and practical poultry farming (Wilson, 1991).

Incubation is a multifaceted biological process in poultry farming that determines not only production efficiency but also the physiological integrity of embryonic development. One of the most important parameters affecting incubation success in quail eggs is the egg placement angle at setter. Placement angle is considered a mechanical factor that directly affects gas exchange, embryonic positioning, albumen fluidity, yolk sac placement, and the speed at which the embryo moves towards the air sac (Elibol and Brake, 2006; Wilson, 1991; Decuypere and Michels, 1992).

It is known that an upright position contributes to the embryo taking the pipping position more quickly, while a horizontal position increases late-stage embryo losses (Elibol and Brake, 2006; Wilson, 1991; Decuypere and Michels, 1992). The biomechanical balance within the egg is highly delicate throughout embryonic development. Albumen density, yolk sac fluidity, and the relationship of the embryo to its shell membranes are shaped by how the egg is positioned. Therefore, the egg placement angle is not merely a mechanical placement preference, but a physiological regulatory

element that directly determines the embryo's chances of survival. During incubation, the embryo constantly changes position, but this change is directly consistent with the egg's initial position. In incorrectly placement eggs, complications such as the embryo's inability to assume the hatching position, suffocation during hatching, mechanical compression, and membrane rupture can occur. (Decuypere and Michels, 1992)

For the embryo to continue its normal development, it needs to orient itself towards the air space and assume the appropriate position before hatching. If the egg placement position is incorrect, the embryo's hatching position can be disrupted, which can lead to an increase in late-stage embryo mortality. The literature reports that incorrect placement practices reduce hatching force and increase embryonic losses (Romanoff, 1960; Wilson, 1991).

The main factors affecting incubation success include egg weight, eggshell structure, storage time and conditions, incubation temperature and humidity, and the way the eggs are placed in the incubation trays. In particular, the egg placement position directly affects the embryo's position relative to the air space, determining the embryonic development process and hatching mechanism (Romanoff, 1960).

This research aimed to determine the effects of quail egg placement position at setter trays and egg weight on incubation results.

Materials and Methods

In this study, 438 hatching eggs obtained from a flock of young quail (15 weeks old) were used. The eggs were divided into three groups: large (mean: 14 g), medium (mean: 11,95 g), and small (mean: 8 g). Large, medium, and small eggs were arranged in incubation trays in the normal incubation position (blunt end upwards), at a 45° angle and horizontally, and incubated for 14 days at 37,5°C and 60% humidity, turned hourly. On the 15^{th} day, the eggs were transferred to a hatcher tray. On the hatching day, chick quality, hatchability, hatchability of fertile eggs, and early, mid, and late embryonic mortality rates were determined using the Pasgar score method and the formulas given below, respectively.

Hatchability: (Total hatching chicks/Total hatching eggs) x100

Hatchability of fertile egg: (Total hatching chicks/Total hatching chicks of fertile eggs) x100

Early embryo mortality: (Total embryos that died between 0-4 days of incubation)/ (Total fertile eggs) x100

Mid-stage embryo mortality: (Total embryos that died between 5-15 days of incubation/ (Total fertile eggs) x 100

Late-stage embryo mortality: (Total embryos that died between 16-18 days of incubation/ (Total fertile eggs) x100

Chick quality: Determined using the Pasgar score chick quality assessment method (Boerjan, 2006).

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Statistical analysis

Analysis of variance (Two-way Anova) was used to evaluate the data. To determine which means differed, Tukey's multiple comparison test was applied at the 5% significance level. For the assessment of chick quality, which did not meet the assumptions of ANOVA, the Kruskal-Wallis test was used.

Results and Discussion

The evaluation of the data obtained in the study shows the results for hatchability, hatchability of fertile egg, and early, mid, and late embryo mortality rates in Table 1, the statistical analysis results for chick quality in Table 2, the variation of incubation results according to egg placement angles in Figure 1, and the variation of incubation results according to egg weight in Figure 2.

It was determined that egg weight had an insignificant effect on incubation results ($P>0.05$), but laying angle had a significant effect on incubation efficiency, hatching rate, and late embryo mortality ($P<0.05$), while its effect on other characteristics was insignificant ($P>0.05$). The interaction between egg laying angle and weight was found to be insignificant ($P>0.05$), and laying angle had no significant effect on chick quality ($P>0.05$). The study findings revealed that egg weight had no effect on incubation results or chick quality, but the placement angle did affect hatchability, hatchability of fertile egg and late embryo mortality. This effect manifested as lower hatchability, hatchability of fertile egg, and higher late embryonic mortality for horizontally placed eggs compared to those placed vertically or at a 45-degree angle. Vertically placed eggs or at a 45-degree angle had a similar effect. Vertical placed is preferred due to its ease of application. The specific placed angle at which incubation results begin to be negatively affected in quail eggs has not yet been determined, and this requires further research. In the group arranged vertically at a 45° angle, embryo mortality rates are lower compared to the horizontally arranged group. Hatchability and hatchability of fertile egg rate are high. Therefore, it has been scientifically proven that the standard practice in industry should be vertical arrangement (Decuypere and Michels, 1992).

This study strongly confirmed that the egg positioning angle is a determining factor in incubation results. Embryo positioning is of great physiological importance. An incorrectly positioned embryo cannot reach the air sac or assume the hatching position. Vertical placement aligns the embryo's center of gravity with the natural developmental trajectory, while horizontal placement causes the embryo to spread towards the egg surface due to centrifugal force. This spreading makes hatching movements more difficult (Decuypere and Michels, 1992). It is a known horizontal

Table 1. Incubation results

Placement angle	Average egg weight (g)	Hatchability	Early embryonic mortality (%)	Mid embryonic mortality (%)	Late embryonic mortality (%)	Hatchability of fertile egg
Upright	8	74,84±8,56	9,09±9,09	13,29±9,13	0,00±0,00	77,60±11,30
	11,95	67,74±5,64	16,08±0,29	8,97±1,86	7,21±3,61	67,74±5,64
	14	73,33±5,09	13,52±4,38	9,82±0,81	3,33±3,33	73,33±5,09
	Average	71,97±3,48[a]	12,90±3,09	10,69±2,78	3,52±1,76[a]	72,90±4,18[a]
45^0	8	68,30±6,76	13,29±9,13	8,62±5,27	6,06±6,06	72,03±5,86
	11,95	68,85±8,91	3,61±1,81	13,22±7,60	11,19±2,63	71,99±9,73
	14	73,53±6,36	10,64±3,50	4,76±2,38	11,06±6,20	73,53±6,36
	Average	70,23 ± 3,80[ab]	9,18 ±3,21	8,87 ± 3,01	9,44±2,75[b]	72,52±3,77[a]
Horizontal	8	30,00±11,08	16,96±5,03	19,09±6,49	34,00±11,10	30,00±11,08
	11,95	67,70±13,10	8,63±5,93	1,96±1,96	20,70±6,59	68,70±12,20
	14	56,86±7,58	9,59±1,86	5,66±3,21	26,80±3,27	57,95±7,56
	Average	51,52± 7,89[b]	11,72±2,66	8,91± 3,39	27,16±4,29[b]	52,21±7,89[b]

Table 2. Statistical analysis results of chick quality

Angle	N	Median	Ave Rank	Z
1	93	10,00	131,7	0,19
2	96	10,00	131,8	0,21
3	71	10,00	127,2	-0,44
Overall	260	-	130,5	-

1: upright, 2: 45º, 3: horizontal

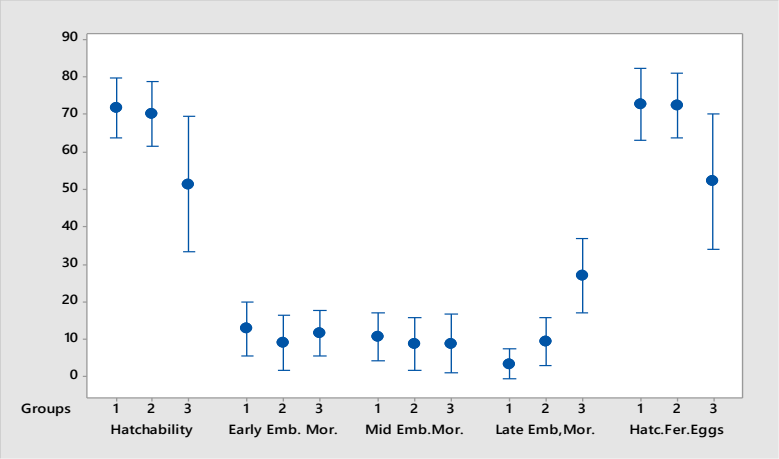

Figure 1. Variation in hatching results according to egg position angles

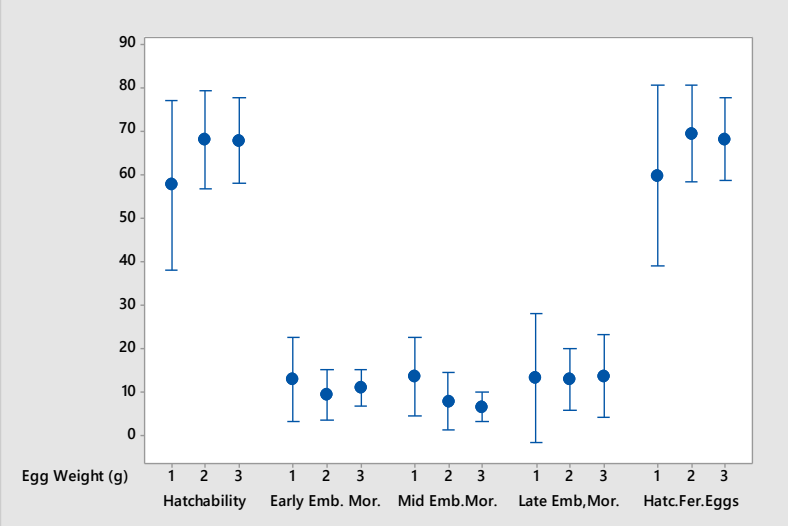

Figure 2. The variation of incubation results according to egg weight

position creates late developmental problems: The chick has much more difficulty performing body and neck rotation movements during the shell-breaking stage in a horizontal position (Decuypere and Michels, 1992).

Durmuş et al. (2015), in their research to determine the effects of egg placement positions (vertical, horizontal, and pointed upward) on incubation characteristics such as hatchability, hatchability of fertile egg, malformation rate, malposition rate, weight loss rate, chick quality, and early, mid, and late embryo mortality rates in chicken eggs, reported that there were significant differences between the groups in terms of egg weight loss rate, late embryo mortality rate, malposition rate, hatchability, and hatching efficiency, while there were no differences in terms of malformation rate, chick quality, and early and mid-stage embryo mortality rates. They also reported that when hatching eggs were placed with the pointed upwards, late embryo mortality due to positional errors increased, and a positional error occurred where the head was seen at the pointed end of the egg.

The upright position has been identified as the most advantageous placement method in terms of both physiological and mechanical aspects during the incubation process. The average hatching rate is over 91%. The rate at which the embryo moves towards the air sac, the success in assuming the hatching position, and late-stage viability are significantly higher than in other groups. The high early embryo mortality rate in horizontally placed eggs can be explained by the degree of stretching of the embryonic membranes. This position causes the embryo to be subjected to an uneven weight distribution during development. In horizontal arrangement, hatching power is dramatically reduced. Late-stage mortality is particularly high, and the chick is seen to have difficulty positioning itself towards the shell (Tona et al., 2005; Decuypere and Michels, 1992).

In their research, Karaman and Bulut (2018) divided hatching eggs obtained from a flock of Japanese quail (*Coturnix coturnix japonica*) into 5 different weight groups: ≤10 g, 11 g, 12 g, 13 g, and ≥14 g and above. They determined the hatching rate as 64.71%, 51.60%, 57.14%, 58.12%, and 50.82%, respectively; and the incubation efficiency as 58.93%, 44.64%, 51.65%, 48.57%, and 40.00%, respectively.

Conclusion

In this study, it was revealed that the egg positioning angle is a critical parameter that directly determines incubation results. It was concluded that, in quails, eggs must be placed in a vertical position with the blunt end facing upward in order to achieve successful hatchability. Although egg weight was found to have no significant effect on incubation results, it is a well-established fact that there is a linear relationship between egg weight and chick weight.

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