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The Effects of Different Storage and Fumigation Lengths on Hatchability and Hatching Weight in Japanese Quails (*Coturnix coturnix japonica*)

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Abstract: This study was carried out to investigate the effects of storage and fumigation lengths on hatchability traits and hatching weight in Japanese quail eggs. A total of 315 eggs collected from 24 weeks old quail flock were used in the study. Eggs were allocated into three different groups for storage period (5, 10 and 15 days) and fumigation length (0 control, 20 and 40 min. It was determined that storage length has statistically significant effects on hatchability ($p<0.01$) and liveability ($p<0.05$) and hatchability and liveability were decreasing in longer storage periods.

Key words: Japanese quail, storage length, fumigation length, hatchability, liveability, embryonic death

INTRODUCTION

Productivity in poultry breeder houses and hatcheries is related with the production of hatching egg, hatchability and liveability of hatching chicks. On this context, hatchability traits are being affected from the age, health status, feeding and management procedures of breeder flock, transportation of hatching eggs, disinfection procedures, storage conditions and length, hatchery and machine conditions (Vali, 2007; Kamarloiy and Yansari, 2008).

In poultry production, it is reported that storage length >7 days has negative effects on hatchability traits and it is also reported that storage of quail eggs after the 1st 4 days would be resulted in 2% decrease in hatching capacity in optimum storage conditons.

It is revealed that longer storage lengts are resulted in decrease in fertility, liveability (Sachdev *et al*., 1985; Fasenko and Robinson, 1999), hatchability and hatching chick weight (Sachdev *et al*., 1988) while the weight loss in eggs during the storage period has increasing trend.

Seker (2004) reported that longer storage periods lead to a decrease in hatchability and increased early and middle age embryonic death rates and hatching eggs should not storage >9 days. Camci reported that there is a significant decrease in liveability in quail eggs storaged >7 days.

Kara in which quail eggs were storaged for 4, 7 and 10 days revealed that fertility was not affected from the storage length but storage length has statistically significant effects on hatchability, liveability, early and late age embryonic deaths. Oral Toplu determined the liveability rates in quail eggs as 96.67, 95.42, 91.67 and 88.14% for 3, 5, 7 and 10 days storage periods, respectively and reported that liveability was decreasing in longer storage periods ($p<0.05$). They also reported that there was a statistically non-significant increase in embryonic deaths due to the increasing length of storage period and the storage length has no significant effects on hatchability and hatching chick weight. Petek *et al*. (2003) and Petek and Dikmen (2004) reported that storage length has no significant effects on hatchability, liveability, early and middle age embryonic deaths and hatching chick weight in Japanese quail eggs.

Disinfection procedure in which formaldehyde gas generally used as fumigation for hatching eggs has also significant effects on the success of hatching process. It is recommended that to kill the 95-99% of total microoranisms on the surface of egg shell 42 mL formalin (40%) and 21 g $KMnO_4$ (for three times) should be applied for 20 min for 1 m^3 (Hayretdag and Kolankaya, 2008). It is reported that longer fumigation lengths cause a decrease in liveability in formaldehyde fumigation procedure (Furuta and Watanabe, 1978) and also lead to an increase in early age embryonic deaths.

Fertility rate, liveability, hatchability, early age embryonic death ratio and late age embryonic death ratios were found as 90.3, 91.7, 91.4, 91.1%; 68.6, 78.0, 74.6,

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71.7%; 61.8, 70.7, 68.1, 65.1%; 20.0, 12.7, 15.7, 17.9% and 11.3, 9.3, 9.7, 11.2% for 0, 15, 30, 45 min formaldehyde fumigation before hatching procedure for Japanese quail eggs, respectively and it was determined that fumigation length has significant effects on liveability, hatchability and early age embryonic deaths. Yildirim *et al*. (2003) reported that early age embryonic deaths but late age embryonic deaths were affected by fumigation length. Elibol in a study on hatching hen eggs were determined that liveability and hatchability were both decreasing due to increasing storage length ($p<0.05$). They also stated that fumigation length lead to increase early and late age death ratios ($p<0.05$) but has no statistically significant effect on middle age embryonic deaths.

This study was carried out to investigate the effects of storage and fumigation lengths on weight loss in eggs during the storage period, fertility, hatchability traits, early, middle and late age embryonic deaths and hatching chick weight in Japanese quail eggs.

MATERIALS AND METHODS

This study was conducted out in the Poultry Research Unit of Faculty of Veterinary Medicine, University of Adnan Menderes. A total of 315 hatching quail eggs from Japanese quail breeders at 24 weeks old and 213 chicks from those eggs were consisted of the material of this study. Daily collected quail eggs were stored in a storage room for 5, 10 and 15 days at 16-18°C and 55-60% Relative Humidity (RH) and stored eggs were rotated 45° regularly twice a day. An ANOVA test was performed to show that average egg weights in each storage group were equal for allocated eggs (F: 0.86; non-significant). Fumigation procedure (42 mL formalin and 21 g $KMnO_4$ (3 times) for 1 m^3) was applied to the stored eggs for 0 (control), 20 and 40 min at the end of the storage period in a room at 25°C.

The eggs grouped for storage and fumigation experiments were all placed in a cabinet incubator (Cimuka) at the same time and were transferred to the hatching trays at the 15th day of the incubation. The incubator was set to 37.7°C, 60% RH for the 1st 15 days and 37.5°C, 70% RH for the last period. Both eggs and hatched chicks were weighted with a scale (sensitive to 0.01 g) individually. All unhatched eggs were broken on a flat layer for determining fertility and stages of the embryonic growth. After this inspection eggs were determined as unfertil while embryonic deaths were classified as early age (between 0-5 days of the incubation), middle age (6-14 days of the incubation) and late age (15-17 days of incubation) embryonic deaths. The number of fertile eggs to the number of total eggs was denoted as fertility rate, the number of hatched chicks to the number of total eggs was denoted as hatchability, the number of hatched chicks to the number of fertile eggs was denoted as liveability, the number of early, middle and late age embryonic deaths to the number of fertile eggs were denoted as early, middle and late age embryonic death rates, respectively after multipliying with 100.

Chi-square (χ^2) test was performed to analyse the egg weight loss, fertility rate, hatchability, liveability and embryonic death parameters in SPSS Version 11.5. A General Lineer Model (GLM) was used to reveal the effects of storage and fumigation lengths on hatched chick weight and multiple comparisons were performed with Duncan (1995) test. Following statistical model was used to determine the hatched chick weight:

$$Y_{ijk} = \mu + a_i + b_j + e_{ijk}$$

Y_{ijk} = The weight of hatched chick
μ = General mean of population
a_i = Effect of egg storage length (i: 5, 10 and 15 days)
b_j = Effect of fumigation length (j: 0, 20 and 40 min)
e_{ijk} = Error

It was assumed that there is no significant interaction between investigated parameters and the sum of partial effects of a factor was equal to zero.

RESULTS AND DISCUSSION

Average egg weights in different storage groups at before and after the storage and average egg weight losses during the storage were shown in Table 1.

Egg weight losses were determined as 0.34, 0.85 and 1.45% for 5, 10 and 15 days storage periods, respectively. It was revealed that storage length has no statistically significant effect on egg weight loss. However, there was no statistically significance, it was determined that an increase in storage length lead to an increase in egg weight loss as parallel to the findings of Petek and Dikmen (2004). It can be said that weight loss was related to the water loss via vaporization in long run egg storage.

Table 1: Average egg weights in different storage groups at before and after the storage and average egg weight losses during the storage

Storage length (days)	n	Before storage (g) $\bar{X}\pm S_{\bar{x}}$	After storage (g) $\bar{X}\pm S_{\bar{x}}$	Weight loss (%)
5	101	11.89±0.10	11.85±0.10	0.34
10	94	11.82±0.14	11.72±0.14	0.85
15	120	11.69±0.11	11.52±0.11	1.45
				χ^2: 0.604†
Total	315	11.79±0.07	11.69±0.07	0.85

†Non significant

Table 2: Number of total and fertile eggs, embryonic deaths and hatched chicks by storage and fumigation length groups

Storage length (days)	Fumigation length (min)	No. of total eggs	No. of fertile eggs	No. of EAED	No. of MAED	No. of LAED	No. of hatched chicks
5	0	33	31	0	1	4	26
	20	34	32	1	1	2	28
	40	34	28	1	2	0	25
	Total	101	91	2	4	6	79
10	0	31	30	1	1	5	23
	20	32	26	1	2	3	20
	40	31	24	0	2	1	21
	Total	94	80	2	5	9	64
15	0	40	34	5	2	4	23
	20	40	33	0	2	2	29
	40	40	33	3	9	3	18
	Total	120	100	8	13	9	70
Total	0	104	95	6	4	13	72
	20	106	91	2	5	7	77
	40	105	85	4	13	4	64
	Total	315	271	12	22	24	213

EAED: Early Age Embryonic Death, MAED: Middle Age Embryonic Death and LAED: Late Age Embryonic Death

Table 3: The effects of storage and fumigation length on hatchability

Effects of length	Fertility (%)	Hatchability (%)	EAED (%)	MAED (%)	LAED (%)	Liveability (%)
Storage length (days)						
5	90.10	78.22^{a}	2.200	4.400	6.590	86.81^{a}
10	85.11	68.09^{ab}	2.500	6.250	11.250	80.00^{ab}
15	83.33	58.33^{b}	8.000	13.000	9.000	70.00^{b}
χ^2	2.184†	9.917**	4.787†	5.260†	1.212†	8.139*
Fumigation length (min)						
0	91.35	69.23	6.320	4.210^{b}	13.680	75.79
20	85.85	72.64	2.200	5.490^{b}	7.690	84.62
40	80.95	60.95	4.710	15.290^{a}	4.710	75.29
χ^2	4.701†	3.476†	1.885†	8.653*	4.710†	2.956†
Total	86.12	67.91	4.320	8.110	8.820	78.75

EAED: Early Age Embryonic Death. MAED: Middle Age Embryonic Death, LAED: Late Age Embryonic Death: †Non significant, *: p<0.05, **: p<0.01; $^{a, b}$: Means within a column with different superscript are different (p<0.05)

The number of total and fertile eggs, embryonic deaths and hatched chicks and hatching results by storage and fumigation length groups were shown as Table 2 and 3.

In this study, the highest fertility, hatchability and liveability rates (90.10, 78.22 and 86.81%, respectively) were determined in 5 days storage group. Fertility and hatchability had decreased in Japanese quail eggs as parallel to increase in storage length. In other words, there was a negative correlation between storage length and hatchability and liveability. In many similar studies it was stated that storage length has negative effects on fertility (Fasenko and Robinson, 1999) hatchability. In the present study, the statistically non-significant effect of storage length on fertility was similar to the findings reported by Sachdev *et al.* (1985).

Embryonic deaths show an increasing trend with parallel to increasing storage lengths. The differences between storage length groups for hatchability (p<0.01) and liveability (p<0.05) were found as statistically significant while there was no significance between embryonic deaths. The decrease in liveability due to increase in storage length was similar to many other studies. Petek and Dikmen (2004) reported similar findings on embryonic deaths related to storage length.

Additionally, there were also many studies having statistically significance report that embryonic deaths would be increase with parallel to an increase in storage length. It can be thought that longer storage lengths have negative effects on embryonic growth. Because, weak albumin quality due to the production of ammonia from embryo may be the main reason for decreasing embryonic growth as parallel to longer storage lengths.

Fertility rate in 0, 20 and 40 min fumigation groups were found as 91.35, 85.85 and 80.95%, respectively. Hatchability and liveability were the highest in 20 min fumigation group but the lowest in 40 min fumigation group but there was no statistically significance between fumigation length groups for hatchability and liveability. These results were similar to other studies performed at different times by Furuta and Watanabe (1978), Yildirim *et al.* (2003) and Hayretdag and Kolankaya (2008). Fumigation length has statistically significant (p<0.05) effect on middle age embryonic death but there was no significant effect on early and late age embryonic deaths. Increasing the fumigation length 20-40 min was resulted in an increase in early and middle age embryonic deaths. Similarly, Turkoglu and Elibol reported that early age embryonic deaths were negatively affected from longer

Table 4: Minimum least square means of hatching chick weights by storage and fumigation length groups

Factors	n	Chick weight $\bar{X} \pm S_{\bar{X}}$	Partially effects
Expected mean (μ)	213	8.72±0.06	-
Storage length (days)			
5	79	8.78±0.09	0.001
10	64	8.78±0.10	0.070
15	70	8.60±0.10	-0.071
Fumigation length (min)			
0	72	8.73±0.09	-0.180
20	77	8.70±0.09	-0.113
40	64	8.72±0.10	0.293

Storage length (D); Fumigation length (min) (F); -: Non significant

fumigation periods. It can be thought that higher early age embryonic deaths in control (not fumigated) group may be explained with intensive microorganism penetration to inside of these eggs. Higher early and middle age embryonic death numbers in 40 min fumigation group than 20 min fumigation group can be explained by longer formaldehyde exposure in 40 min fumigation group and sensitivity of the embryos in this stage of embryonic growth.

Minimum least square means of hatched chick weights by storage and fumigation length groups and the partial effects of factors related to hatched chick weight were shown in Table 4. Hatched chick weights were found higher in 5 and 10 days egg storage groups (8.78 g) than 15 days storage group (8.60 g).

Hatched chick weights in 0, 20 and 40 min fumigation groups were found as 8.73, 8.70 and 8.72 g but these averages were accepted as similar with each other. Results show that storage and fumigation length have no statistically significant effects on hatched chick weight. The result of which hatched chick weight was decreasing due to increasing storage length was consistent with the findings reported by Bowling and Howarth (1981) and Hager and Beane (1983).

This can be explained by the decrease in hatched chick weight may be caused from the water loss from the eggs via vaporization due to longer storage lengths and the other reason may be additional dehydration because of extended hatching process. At the same time, the statistically non-significant effect of storage length on hatched chick weight was consistent with Petek *et al.* (2003), Petek and Dikmen (2004) while Garip *et al.* (2005) reported that there were statistically significant differencies between 9 days storage group and 0, 1, 2, 4, 5, 6 and 7 days storage groups for hatched chick weight in Japanese quail eggs. This may be arised from the variation of the age in the material of these studies and different storage lengths and conditions.

CONCLUSION

Results of the study show that except for the rate of middle age embryonic death, there were no significant differences between fumigation length and hatchability traits. Finally, the effects of storage and fumigation length on hatching weight were found non-significant.

RECOMMENDATION

Consequently, it can be recommended that optimum storage length should be 5 days because of decreasing trend of hatchability after that time and to reach maximum hatchability and liveability and to decrease the number of embryonic deaths because of formaldehyde toxication, average fumigation length should be applied for 20 min in Japanese quail eggs.

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