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Effects of Egg Storage Material and Storage Period on Hatchability in Japanese Quail

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ABSTRACT : The present study aimed to determine the effects of different storage materials and storage period on some hatchability traits of Japanese quail (Coturnix coturnix japonica) eggs. A total of 32 male and 102 female quail (twelve weeks of ages) were housed in multiple-bird cages. Eggs laid were divided into three groups with respect to the period of storage (I = 1st, 2nd and 3rd days, II = 6th, 7th and 8th days, III = 12th, 13th and 14th days) prior to incubation. A total of 816 eggs was stored in 3 different storage environments during each storage period (B = no use of any storage material, P = use of perlite, H = use of hay) and kept in environmental conditions, where the temperature was 21°C and relative humidity was 75%, prior to incubation. Statistical analyses were performed after the exclusion of values pertaining to non-fertile eggs (190 eggs) from the data set. The fertility rate of the eggs in the experiment was 76.7%. In the present study, the influence of storage material and different storage periods on egg weight loss were found to be statistically significant ($p<0.01$). Upon the comparison of hatchability of fertile eggs values, the influence of storage material was determined to be significant ($p<0.05$), and the influence of storage period was demonstrated to be significant ($p<0.01$). The storage materials used were determined not to have any influence on early and late embryonic death rates. Perlite was concluded to be safe for use in the storage of hatching eggs. The extension of the storage period (more than 8 days) resulted in decreased hatchability values of fertile eggs in each group. (**Key Words :** Laying Quail, Storage Period, Perlite, Hatchability)

INTRODUCTION

The number of hatching chicks constitutes one of the most significant criteria which influences the profitability of quail breeding. Quail holdings generally meet their breeder animal requirements themselves. For this reason, in quail breeding, in order to maintain high hatchability, optimal conditions are required to be met both prior to and following incubation.

During storage, hatchability is influenced by the length of the storage period, temperature, humidity and gaseous environment. In addition Petek (2006) stated that feeding time had significant influence on hatchability in Pharaoh quail. Shafey and Al-Mohsen (2002) reported that hatchability is also affected by various light colors and intensity in meat type breeder eggs. In fertile eggs, embryonic development starts before the egg leaves the uterus and following exit from the oviduct, the zygote is expelled from the body in the form of a structure composed of approximately 256 cells.

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Following oviposition, the division of the zygote ceases, and the zygote enters into a resting period (physiological zero point). This period is reported to last for approximately 14 days (Saylam, 1999). In order to prevent any adverse effect on embryonic development and hatchability within this period, ideal storage conditions should be provided. Egg storage is related to the pH of the albumen due to loss of carbon dioxide (Dawes, 1975). Albumen pH at the start of the incubation process can be influenced in different ways. Generally, albumen quality is improved by presence of carbon dioxide. Storage temperature influences the loss of carbon dioxide and, therefore the increase of pH. Storage of eggs in CO_2 increased the number of early dead embryos in eggs held for 7 days but increased embryo survival in eggs held for 14 days (Walsh et al., 1995).

A great number of scientific researches have been conducted to determine the influence of different storage lengths on hatchability and fertility in quail. Woodard and Morzenti (1975) reported that length of storage for eggs from the pheasant and quail was critical, with significant declines in fertility in eggs stored beyond 14 days. Furthermore, negative correlation has been determined between storage length and hatchability in many studies

(Salyam, 1999; Fasenko et al., 2001; Narahari et al., 2002).

Aydogan (1998), even under optimal storage conditions, reported that quail eggs lose their hatching quality at a rate of 2% per day, starting from the fourth day of storage onwards. North and Bell (1990) reported hatchability to be reduced by 4% per day, and the hatching period to extend 30 minutes following storage for more than four days. According to Pedroso et al. (2006), hatchability was higher in quail eggs stored until 72 h. Seker et al. (2004) have suggested eggs should not be stored more than nine days in order to attain high rates of hatchability in Japanese quail.

Additional factors that affect hatchability include the temperature and humidity of the environment in which eggs are stored. The optimal storage temperature has been determined, based on the physiological zero point at which the embryonic development of quail ceases. Interaction between storage temperature and storage period occurs either below or above the physiological zero point at which embryonic development is minimal (Brake et al., 1997). The physiological zero point has been reported as 25-27°C by Meijerhof (1992) and 19-28°C by Decuypere et al. (2001). The temperature and relative humidity required for the storage of quail eggs has been reported as 16-18°C and 75-80%, respectively, for storage periods up to seven days, and 10-15°C and 75%, respectively, for storage periods of more than seven days (Kocak and Ozkan, 2000). Bloom et al. (1998) determined that storage at 12°C for 14 days increased the number of apoptotic cells (programmed to death) in the embryo.

The scientific literature includes many studies in which the influence of environmental factors on optimum hatchability in quail breeding has been investigated. However, studies are limited on the elimination of adverse effects that may arise due to the extension of the storage period of eggs and on the use of storage material for the prevention of the deterioration of egg quality.

Perlite, which has been used increasingly in different sectors in the last decade, is a pearl-like shiny volcanic material composed of amorphous, light grey colored, small, round glass particles (Chestermen, 1975). Perlite contains 2-6% trapped water. When heated sufficiently, it may expand to 10-20 times its original volume (Harben and Bates, 1990). The use of perlite as a feed additive for pigs and broiler chickens has yielded positive results (Talebali and Farzinpour, 2006). However to date, no study has been encountered on the use of perlite as a storage material for eggs.

The present study was aimed to determine the influence of different storage lengths and materials on the hatchability of quail eggs.

MATERIALS AND METHODS

The study was conducted in the Quail Breeding Unit of Ataturk University, Faculty of Veterinary Medicine. A total of 32 male and 102 female quail (twelve-weeks-old) were housed in multiple-bird cages. Eggs laid were divided into three groups with respect to the period of storage (I = 1st, 2nd and 3rd days, II = 6th, 7th and 8th days, III = 12th, 13th and 14th days) prior to incubation. A total of 816 eggs were stored in 3 different environments during each storage period (B = no storage material, P = perlite as a storage material, H = hay as a storage material) prior to incubation.

Male and female breeder quail were provided with feed containing 17% protein and 2,750 kcal ME/kg energy *ad libitum*. During the laying period, the animals were exposed to 16 hours of light per day.

In each period, prior to being stored, the eggs were weighed at the same time (09.00 am) with a precision of 0.01 g, and were kept in three different storage environments under 21°C, 75% relative humidity conditions. In order to eliminate the influence of temperature and relative humidity on storage materials and storage periods, the eggs were stored under fixed environmental conditions.

In groups P and H, hatching eggs were enclosed with storage material and placed into plastic boxes in such a way that they were not visible from above or below. Prior to being incubated and according to their storage period, the eggs were weighed at the end of the storage period to determine any weight loss resulting from storage. During the development (15 days) and hatching phases of incubation the eggs were exposed to a temperature and relative humidity of 37.7°C/55-60%, and 37.5°C/75-80%, respectively. During incubation, eggs were automatically turned 45 degrees eight times per day. The ventilation and heat of the incubator were adjusted automatically. At the end of the incubation period, eggs that did not hatch were broken for the determination of early and late embryonic death rates.

Statistical analyses were performed by using the General Linear Model (GLM) procedure and differences between groups were evaluated by Duncan's multiple comparison test (SPSS for Windows Release 10.0, SPSS Inc. 1996); after the exclusion of values pertaining to non-fertile eggs from the data set. The linear model to test the effects of treatment groups on egg weight loss during storage and hatchability parameters was as follows:

$$Y_{ijk} = \mu + ST_i + G_j + (ST \times G)_{ij} + e_{ijk}$$

Y_{ijk} = response variable, μ = population mean, ST_i = storage time, G_j = treatment group (storage material), e_{ijk} = experimental error.

RESULTS, DISCUSSION AND CONCLUSION

The mean values for fresh egg weights (g) and egg

Table 1. Effect of three storage material and period on mean weights (g) and weight losses during storage (%) of Japanese quail eggs

Treatments			Response variables		
Experimental groups[1]	Storage periods[2]	Total eggs	Fresh egg weight (g) Mean±SEM	At the end of the storage period egg weight (g) Mean±SEM	Egg weight loss during storage (%) Mean±SEM
B	I	78	12.60±0.118	12.41±0.117	1.44±0.145
	II	80	12.91±0.116	12.64±0.116	1.99±0.143
	III	40	12.83±0.164	12.50±0.164	2.56±0.202
	Total	198	12.78±0.077	12.52±0.078	1.99^{A}±0.095
P	I	61	12.64±0.133	12.52±0.133	0.82±0.163
	II	72	12.78±0.122	12.62±0.122	1.21±0.150
	III	70	12.83±0.124	12.49±0.124	2.73±0.153
	Total	203	12.75±0.073	12.55±0.073	1.58^{B}±0.090
H	I	88	12.58±0.111	12.48±0.110	0.77±0.136
	II	86	12.94±0.112	12.76±0.112	1.47±0.138
	III	51	12.75±0.145	12.40±0.145	2.77±0.179
	Total	225	12.76±0.071	12.54±0.071	1.67^{B}±0.088
Statistical significance (p<)[3]					
G			NS	NS	**
ST			NS	*	**
G×ST			NS	NS	*

[A,B] Means in the same column having different superscripts are significantly different ** p<0.01, * p<0.05. NS = Non significant, SEM = standard error of means.

[1] B = Environment in which no storage material was used, P = Environment in which perlite was used H = Environment in which hay was used.

[2] I = 1st, 2nd and 3rd days were stored prior to incubation, II = 6th, 7th and 8th days were stored prior to incubation, III = 12th, 13th and 14th days were stored prior to incubation.

[3] Statistical significance; G = Group effect, ST = Storage time effect, G×ST = Group×storage time interaction effect.

weight losses (%) for different storage materials and periods are shown in Table 1. The influences of different storage materials (B, P and H) and different storage lengths (I, II, III) on egg weight loss during storage were statistically significant (p<0.01). With respect to egg weight loss during storage, the interaction between the groups and storage lengths were significant (p<0.05). Throughout the trial (periods I, II and III), egg weight loss during storage in groups B, P and H were 1.99%, 1.58% and 1.67%, respectively. The mean values related to some hatchability results depending on storage material and period groups are given in Table 2. Comparison of hatchability rates of fertile eggs, showed the influence of storage material and storage length were significant (p<0.05). Mean hatchability of fertile eggs values in groups B, P and H for storage periods I, II and III were 42.2%, 53.9% and 46.2% respectively. Mean early embryonic death rates in groups B, P and H in all three storage periods were 25.10%, 21.90% and 27.30%, respectively. The use of different storage materials did not have any effect on early embryonic death rates (p>0.05). On the contrary, storage length had a significant effect on early death rates (p<0.01), and the interaction between groups and storage periods was significant (p<0.05). The influence of storage length on late embryonic death was significant (p<0.05).

For the extended storage of hatching eggs (more than seven days), environmental temperature and humidity are recommended to be adjusted to 10-12°C and 75%, respectively (Mayes and Takeballi, 1984). The storage length of hatching eggs varies with different management systems, and may be either 7 days (Altan et al., 2002) or 14 days in the case of pedigree production (Altan et al., 1995). However, ideal storage conditions may not be met in all compartments of a holding. In such a case, various precautions may be required to be taken starting from the environment in which the eggs are kept to the placement of eggs into the incubator. For this purpose, the temperature and (21°C) and humidity (75%) to which quail eggs were exposed to in the present study were fixed throughout storage, and perlite, reported to have isolation and adsorption properties by Alkan et al. (2005), and hay were used as storage materials.

In the present study, the extension of the storage period was demonstrated to result in increased egg weight loss in hatching eggs which complies with the report of Saylam (1999). Perlite, used as an egg storage material for the first time in this study, was determined to minimize egg weight loss. In comparison to the two remaining groups, egg weight loss occurred at the highest level in the group in which no storage material was used (Figure 1).

Storage length and the weight of hatching eggs have been reported to display a linear correlation (Fasenko et al., 1992). Starting from oviposition and until hatching, eggs loose a certain amount of weight during storage and

Table 2. Effect of three storage materials and period on hatchability results of Japanese quail eggs

Treatments			Response variables		
Experimental groups[1]	Storage periods[2]	Total eggs	Hatchability of fertile eggs (%) Mean±SEM	Early period embryonic death (%) Mean±SEM	Late period embryonic death (%) Mean±SEM
B	I	78	65.40±5.3	15.40±4.4	19.20±5.0
	II	80	48.70±5.2	20.00±4.4	31.30±4.9
	III	40	12.50±7.4	40.00±6.2	47.50±7.0
	Total	198	42.20^{B}±3.5	25.10±2.9	32.70±3.3
P	I	61	70.50±6.0	13.10±5.0	16.40±5.6
	II	72	62.50±5.5	13.90±4.6	22.20±5.2
	III	70	28.60±5.6	38.60±4.7	32.90±5.3
	Total	203	53.90^{A}±3.3	21.90±2.8	23.80±3.1
H	I	88	63.60±5.0	11.40±4.2	25.00±4.7
	II	86	59.30±5.0	11.60±4.2	29.10±4.7
	III	51	15.70±6.5	58.80±5.5	25.50±6.2
	Total	225	46.2^{B}±3.2	27.30±2.7	26.50±3.0
Statistical significance (p<)[3]					
G			*	NS	NS
ST			**	**	*
G×ST			NS	*	NS

[A,B] Means in the same column having different superscripts are significantly different ** p<0.01, * p<0.05. NS = Non significant, SEM = Standard error of means.

[1] B = Environment in which no storage material was used. P = Environment in which perlite was used. H = Environment in which hay was used.

[2] I = 1st, 2nd and 3rd days were stored prior to incubation, II = 6th, 7th and 8th days were stored prior to incubation, III = 12th, 13th and 14th days were stored prior to incubation.

[3] Statistical significance; G = Group effect, ST = Storage time effect, G×ST = Group×storage time interaction effect.

incubation, and this weight loss has a major influence on incubation processes and chick quality (Brake, 1989). The occurrence of egg weight loss has a negative effect on egg perivitellin (Britton, 1973) and reduces albumin quality (Hurnik et al., 1978). The pH value of albumin, which is approximately 7.6 during oviposition (Arad et al., 1989), may increase up to 9.0, depending on the length of the storage period (Stern, 1991). Case et al. (1989) have reported that the buffering function of albumin against bacteria may be at risk at pH values ranging between 7.5 and 8.5. This result is understood to exhibit a negative influence on hatchability. Based on its inorganic origin and low heat conductivity and due to its constituting no risk for bacterial growth, perlite has been concluded to be safe for use in the storage of hatching eggs.

In the present study, group P, which displayed the lowest egg weight loss in storage periods I and II, was also determined to have higher hatchability of fertile eggs than the remaining groups (Figure 2). The extension of the storage period resulted in decreased hatchability values of fertile eggs in each group. This finding complies with the scientific literature (Salyam, 1999; Fasenko et al., 2001; Narahari et al., 2002). In the present study, the decrease in hatchability of fertile eggs resulting from extended storage

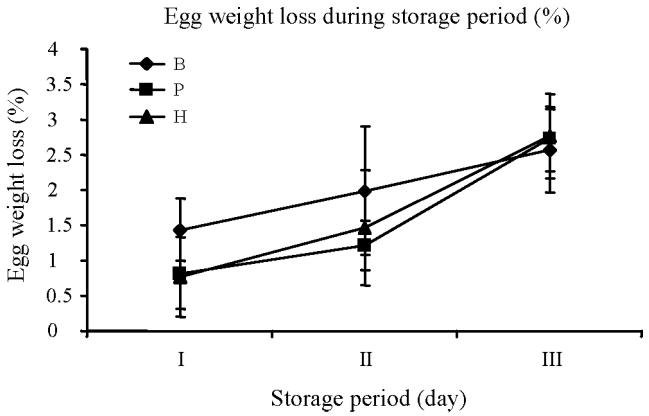

Figure 1. Alteration in egg weight loss during storage of groups with regard to periods.

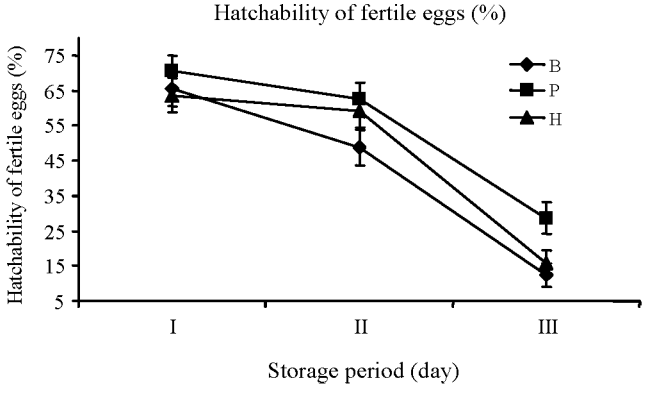

Figure 2. Alteration in hatchability of fertile eggs of groups with regard to periods.

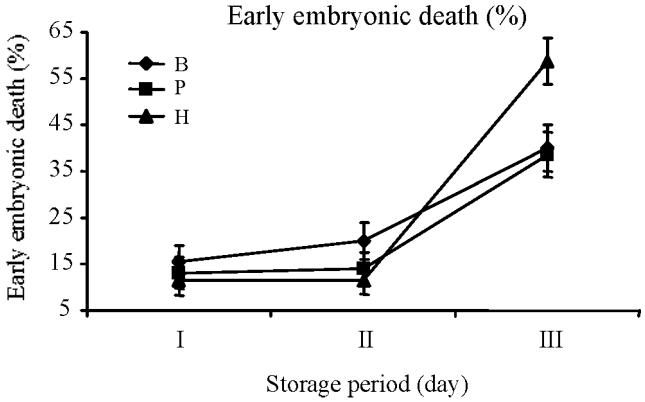

Figure 3. Alteration in rates of early embryonic death with regard to periods.

was most pronounced in the group in which no storage material was used, group B. In Groups P and H, due to the use of storage material, less variation was observed between storage periods (I, II and III) with respect to hatchability values of fertile eggs.

Storage material did not have any effect on rates of early and late embryonic death. As a result of extended storage period, death rates in both periods increased as the early and the late embryonic mortalities increased because of water loss and albumen degradation during storage. These results were consistent with previous reports (Uddin et al., 1994; Brake et al., 1997; Seker et al., 2005). The interaction between storage material and storage length was demonstrated to have significant influence on early embryonic death rates. During storage periods I and II, early embryonic death rates were lower in groups P and H, in comparison to group B (Figure 3).

Perlite is an inorganic material, having low heat conductivity and also in which microbial agents and bacterial fermentation cannot exist. Because of these characteristics, we planned to use perlite as an egg storage material in quail. To date no studies have examined perlite as a storage material in poultry eggs. The present study revealed that perlite did not influence the early or late embryonic death rate but had an increasing effect on hatchability of quail eggs, in three storage periods. Perlite is concluded to be safe for use in the storage of hatching quail eggs.

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