International Journal of Poultry Science 3 (4): 259-265, 2004

Effects of Parental Age and Hatching Egg Weight of Japanese Quails on Hatchability and Chick Weight

I. Seker*, S. Kul and M. Bayraktar
Department of Zootechnia, Faculty of Veterinary Medicine, Firat University, 23119 Elazig, Turkey
E-mail: iseker@firat.edu.tr

Abstract: This investigation was carried out to determine the effects of the parental age and the hatching egg weight of the Japanese quails on the one-day old chick weight and fertility, hatchability of incubated eggs, hatchability of fertile eggs, the embryo mortalities in early middle and late periods and also some hatchability characteristics. The egg material of this investigation consisted of 2031 eggs obtained from the Japanese quails at the age of 10 weeks (1st parental age group) and at the age of 20 weeks (2nd parental age group). The eggs were grouped according to their weight as follows; 9.50-10.50, 10.51-11.50 and 11.51-12.50 g. Even if the differences related to the chick weight among the age groups were not statistically significant, the differences that were statistically significant ($P<0.05$) were found among the egg weight groups. The parental age had the statistically significant effect on the fertility ($P<0.01$) and hatchability of fertile eggs ($P<0.05$). In addition, the effect of the parental age on the hatchability of incubated eggs and the embryo mortalities was not found statistically significant ($P>0.05$). Even if the significant differences in the different levels ($P<0.05$, $P<0.001$) statistically were observed from the point of the generally analyzed hatching characteristics among the egg weight groups, any difference related to the early period embryo mortality was not determined as statistically significant. Results obtained from this study indicated that the parental age of Japanese quails of 10 and 20 weeks has not a significant effect on the one-day old chick weight. However, it had a significant effect on only the fertility and hatchability of fertile eggs. The effect of the egg weight had a very significant level on the chick weight so it was observed that the chick weight increased in parallel of increasing the egg weight. In addition, the egg weight had a significant effect on every aspect except the early stage embryo mortality as one of the hatching characteristics.

Key words: Parental age, egg weight, chick weight, hatchability, quail

Introduction

One of the important factors such as the sex ratio, parental age, period and conditions of egg storage, breeding system and the parental live weight that will have the effect on fertility, hatchability of fertile eggs and hatchability of incubated eggs is the age of male and female fertilities (Narahari *et al*., 1988).

A gradual increase was noted regarding to fertility and hatchability of incubated eggs of the Japanese quails up to the age of 12-14 weeks. However, the effect of older ages and bigger size of eggs should also be considered. The gradual decrease occurred in the age period of 15-19 weeks regarding to the fertility and hatchability of incubated eggs has indicated an immediate increase after 19th weeks (Insco *et al*., 1971). Since, the eggs of first few weeks obtained from the breeding hens were small; the chicks born from these eggs became small as well. The older ages consisting of the flock have led an increase in eggs and a reduction in eggshell and accordingly a decrease in hatchability of incubated eggs. Therefore, the eggs obtained from very young and very old flocks are not considered as appropriate for the hatching activities (Sahan and Ipek 2000).

In some researches, it was reported that the one-day old chick weight has increased due to an observable increase of parental age of in Japanese quails. (Tserveni-Gousi, 1986; Yannakapoulus and Tservesi-Gousi, 1987; Reis *et al*., 1997).

Yildirim and Yetisir (1998) researched to determine the effects of the parental age on the chick weight regarding to the Japanese quails; so they determined that the parental age of both groups consisting of 22 and 65 weeks age had no significant effect on chick weight. The researches reported that the fertility (Woodard and Alplanalp, 1967; Insco *et al*., 1971; Kling and Soares 1982; Narahari *et al*., 1988) and hatchability of incubated eggs reduced depending on the older parental age in flock (Narahari *et al*., 1988; Elibol *et al*., 2002).

Erensayin (2002) reported that the hatchability of fertile eggs in age groups of 10 and 20 weeks of Japanese quails realized respectively 74.72 and 69.44% in addition, the hatchability of fertile eggs was also observed higher in young group compared with the older group.

The researches reported that the embryo mortality increased in eggs of older laying hens compare to younger ones (Novo *et al*., 1997). Similarly, Sahan and Ipek (2000) reported that the parental age had affected the embryo mortality in early middle and late periods

and this rate was excessive in hens with 66 weeks age. In their research carried out with the hens with age of 37 and 66 weeks age. Additionally, they determined that the hatchability of fertile eggs of the eggs and hatchability of incubated eggs obtained from the young flocks were at the highest level.

In the study by Elibol *et al*. (2002) carried out with broilers, it was noted that the embryo mortality in early period for the eggs obtained from the hens with the age of 31 and 52 weeks was respectively 6.1 and 6.9%, also the embryo mortality in the late period was 3.8 and 6.6%. The differences between the groups regarding to the embryo mortality rates in the late period were found statistically significant (P<0.05).

Hatchability, chick weight, and the growth performance of the chick have close relation with the weight of the egg. Besides, it is known that the chick releasing from generally small and excessively big eggs indicates a low rate, using smaller eggs than the general leads to possibility of a hereditary situation for the next generations (Uluocak *et al*., 1995).

A high level relation between the egg weight and the one-day old chick weight was found in various studies (Kselen and Pannia, 1976; Kucukyilmaz *et al*., 2001).

Yildirim and Yetisir (1998) researched the effects of the egg weight of Japanese quails on the chick weight so they determined the weight groups of egg as 11.0-11.9g, 12.0-12.9g and 13.0-13.9g. As the result of so-called research, the chick weights were determined as respectively 6.98g, 7.56g and 8.39g in egg weight groups and the differences between the groups were evaluated as significant statistically. A correlation coefficient of 0.67 (P<0.01) between the egg weight and the chick weight was calculated accordingly.

Since the hatching egg weight is involved within a specified weight limits with respect to the poultry, an optimum hatchability of fertile eggs is obtained accordingly (Tullet, 1987).

Sachdev *et al*. (1985) found a higher fertility and the hatchability of fertile eggs of Japanese quails in heavy egg group (10.1-11.00) than the light egg group (7.01-8.90g). Sarica and Soley (1995) observed the highest fertility and hatchability of incubated eggs of Japanese quails with the eggs in the weight of 11.6g and over also they found the highest hatchability of fertile eggs with lighter eggs in the weight of 10.6-11.5g. They determined the lowest level of fertility, hatching and hatchability of fertile eggs in eggs that were in the weight of 9.5g and lower. Furthermore, Proudfoot and Hulan (1981) reported that the weight of egg had no effect on fertility and hatchability of fertile eggs.

Kucukyilmaz *et al*. (2001) grouped the hatching eggs of Japanese quails as 9.00-9.99g (1. Group), 10.00-10.99, 11.00-11.99, 12.00-12.99 and >13g; and stored until 9th day so they determined the embryo mortality as respectively 38.7, 22.0, 21.0, 29.0 and 30.7%.

This research was carried out to determine the effects of parental age and the egg weight of Japanese quails on the one-day old chick weight and fertility, hatchability of incubated eggs, hatchability of fertile eggs and the embryo mortality in early- middle and late periods.

Materials and Methods

This research was carried out in Quail Breeding Unit within the body of Firat University, Faculty of Veterinary Medicine, Department of Zootechnia. The egg material of the research was consisted of total 2031 eggs obtained from the Japanese quails at the age of 10 weeks age (1st parental age group; 35 males, 105 females) and 20 weeks (2nd . parental age group; 75 males and 225 females). The Japanese quail were raised in floor pens and fed conventional starter and grower diets until they reached 6 wk of age. The quail were housed in cages (40x30 cm). Water and a standard layer diet (20% protein and 3.0% calcium) were given ad libitum. A lighting schedule of 16 h light/day was used. The eggs collected daily for seven days were weighed in the day of laying at an electronic scale with the sensitivity of 0.01g. The eggs were grouped according to their weight as follows; 9.50-10.50g, 10.51-11.50g and 11.51-12.50g.

The collected eggs were numbered due to the above mentioned parental group as of the first day and in the manner of 3 egg weight groups to be involved in each parental age group then they were stored under 15-18^{o}C with the relative humidity of 70-75% a in storage room for 7 days. The mean values of egg weight depending on the parental age and egg weight of the eggs used in research were given in Table 1.

During the storage period, the eggs were turned at least once in every three days. The eggs were under 37.7^{o}C in improvement stage (1-15 days) during the incubation period and then kept under 37.5^{o}C with the humidity of 75-80% at releasing stage. The eggs were turned around automatically for 4 times once 6 hours per day during the incubation period. The air conditioning, temperature, and the humidity were adjusted automatically.

At the end of the incubation period, the eggs having no chick release were cracked and they were subjected to the fertility control so due to obtained results, the fertility, hatchability of incubated eggs and the hatchability of fertile eggs were calculated as follows;

(%) Fertility = (number of fertilized eggs / total numbers eggs placed into incubator) x 100.

(%) Hatchability of incubated eggs = (number of released chicks / total number of egg placed into incubator) x 100.

(%) Hatchability of fertile eggs = (number of released chicks / number of fertilized eggs placed into incubator) x 100.

In addition, at the end of incubation, non hatching eggs

Table 1: Egg weight according to parental age and egg weight

Groups of parent age	Groups of egg weight	No. of eggs	Egg weight (g) (Mean±S.E.)
1	1	175	9.78±0.06
	2	288	11.00±0.02
	3	168	12.10±0.05
2	Total	631	10.95±0.04
	1	204	9.93±0.04
	2	554	11.04±0.01
	3	642	12.01±0.02
Total	Total	1400	11.32±0.04
	1	379	9.86±0.04
	2	842	11.03±0.01
	3	810	12.03±0.02
	Total	2031	11.21±0.02

Table 2: The one day old chick weight according to parental age and egg weight

Groups of parent age	Groups of egg weight	No. of chicks	Chick weight (g) (Mean ±S.E.)
1	1	68	7.32 ± 0.10^{A}
	2	172	7.82 ± 0.04^{B}
	3	166	8.57 ± 0.04^{C}
	P		***
	Total	406	8.04±0.04
2	1	108	7.39 ± 0.12^{A}
	2	319	7.98 ± 0.03^{B}
	3	384	8.46 ± 0.03^{C}
	P		***
	Total	811	8.13±0.03
Total	1	176	7.36 ± 0.08^{A}
	2	491	7.93 ± 0.02^{B}
	3	550	8.49 ± 0.02^{C}
Total		1217	8.10±0.02
P values			
Age of parent			-
Egg weight			***
Age of parent x egg weight			**

-: Not significant (P>0.05), *: P<0.05, **: P<0.01, ***: P<0.001. $^{A-C}$:Means (±Standard error of mean) with column followed by different superscripts are significantly different (P<0.05)

were separated and cracked for determination of the cause including infertile, eggs early embryonic (0-6 day) or middle (7-14 day) or late embryonic mortality (15-17 day) and percentage of each condition was calculated data within each group.

By using the data obtained from the research, the effect of parental age and the egg weight on the one-day old chick weight was determined by means of using General Linear Model procedure and ANOVA. For the characteristic considered as significant due to the variance analysis, Duncan's Multiple Range Test was also applied accordingly (Snedecor andCochran , 1980). The data were analyzed according to the following linear model: $Y_{ijk} = \mu + a_i + b_j + ab_{ij} + e_{ijk}$

Where;

Y_{ijk} represents the ijk^{th} observation on chick weight, μ is population mean, a_i is the fixed effect of the i^{th} parental age (i = 1, 2), b_j is the fixed effect of the j^{th} egg weight (j = 1, 2, 3), ab_{ij} is interaction effect between fixed factors and e_{ijk} is the error term (0, $\acute{o}^2_e$).

In comparison to the parental age groups, the Student-t test was used. Chi-square test was also used in comparison to the hatching characteristics having the proportional values among and inside the research groups (Snedecor *et al*., 1980). Statistical analyses were performed with the SPSS (SPSS, 1999).

Results

The mean values of the one-day old chick weight due to the parental age and egg weight groups were given in Table 2. In this study, it was determined that the parental age had no significant effect statistically on the chick weight. However, it was determined that the egg weight had a very significant effect statistically on the chick weight (P<0.001).

When the one-day old chick weight means were considered generally in respect of the egg weight groups, some significant differences statistically were found among all groups (P<0.05). Thus very significant differences statistically (P<0.001) were obtained in respect of the chick weight among the egg weight groups involved in each parental age group. It was determined that the chick weight had shown a significant increase due to increasing egg weight. The mean values related to some hatchability results depending on the parental age and egg weight groups were given in Table 3.

As it is noticed from Table 2, the effect of parental age on fertility and the hatchability of fertile eggs was found significant statistically, so this effect was determined as very significant for fertility (P<0.01) and also the hatchability of fertile eggs (P<0.05). Moreover, the parental age had a non significant effect statistically on the hatchability of incubated eggs and embryo mortality rates (P>0.05). The highest fertility among the parental age groups was determined as 78.97% in 1^{st} group and hatchability of fertile eggs as 93.33% in 2^{nd} group. Therefore, it was seen that the fertility decreased but the hatchability of fertile eggs increased due to increasing parental age.

In respect of a general review among the egg weight groups, some significant differences that are at varying levels statistically were found regarding to the analyzed hatchability characteristics. These differences occurred at the highest significant level (P<0.001) in egg

Table 3: Hatchability characteristics in parental age and egg weight groups

Groups of parent age	Groups of egg weight	Total No. of egg	No. of fertile eggs	No. of resealed chicks	Fertility (%)	Hatchability of incubated eggs (%)	Hatchability of fertile eggs (%)	Early period embryonic Mortality (%)	Middle period embryonic mortality (%)	Late period embryonic Mortaility (%)
1	1	175	131	100	74.86	57.14	76.34	5.59	7.13	10.94
	2	288	234	196	81.25	68.06	83.76	3.99	5.71	6.54
	3	168	133	110	79.17	65.48	82.71	3.27	5.52	8.51
	P				-	-	-	-	-	-
	Total	631	498	406	78.92	64.34	81.53	4.22	6.02	8.23
2	1	204	122	108	59.80	52.94	88.52	1.64	4.10	5.74
	2	554	335	319	60.47	57.57	95.22	2.09	1.79	0.90
	3	642	412	384	64.17	59.81	93.20	1.70	2.43	2.67
	P				-	-	-	-	-	-
	Total	1400	869	811	62.07	57.93	93.33	1.84	2.42	2.42
Total	1	379	234	176	61.74^{A}	46.44^{A}	75.21^{A}	5.84	7.98^{B}	10.97^{B}
	2	842	495	491	58.79^{A}	58.31^{A}	99.19^{C}	0.49	0.14^{A}	0.18^{A}
	3	810	638	550	78.77^{B}	67.90^{B}	86.21^{B}	3.71	4.65^{A}	5.42^{A}
	P				**	**	***	-	*	**
Totlal		2031	1367	1217	67.31	59.92	89.03	2.71	3.73	4.54
P					**	-	*	-	-	-

-: Not significant (P>0.05), *: P<0.05, **: P<0.01, ***: P<0.001. $^{A-C}$:Means within columns followed by different superscripts are significantly different (p<0.05)

hatchability of fertile eggs; again at the high significant level (P<0.01) in hatchability of incubated eggs, fertility and the embryo mortality in late period; and at the significant level (P<0.05) in embryo mortality in middle period. There was no significant (P>0.05) differences statistically in early embryonic mortality among the egg weight groups. In respect of the egg weight groups, the highest hatchability of fertile eggs was found in group 2, the fertility and hatchability of incubated eggs in group 3 and the embryo mortality in group 1.

Even if statistically significant factors in general were found in respect of reviewed hatchability characteristics among the egg weight groups, there was no significant difference regarding to all hatchability characteristics among the egg weight groups at each age group.

Discussion

The effect of parental age on the one-day old chick weight was not found significant statistically in this research that was carried out to research the effects of parental age and the egg weight on the chick weight and some hatchability characteristics in Japanese quails. This result is consistent with the result reported by Yildirim and Yetisir (1998) that the parental age had no significant effect on the chick weight in Japanese quails at 22 and 65 weeks age however some differences were determined regarding to the claims reported by many researchers (Tserveni-Gousi, 1986; Yannakapoulus and Tservesi-Gousi, 1987; Reis *et al*., 1997) that the parental age had a significant and positive effect on the weight of chick release. The probable reasons of the present differences may be explained that the quails involved in parental age groups could fulfill or ensure the equal conditions for nutrition requirements of the embryo to be developed in the eggs as previously stated by some researchers (Yildirim and Yetisir, 1998). On the other hand the effect of the parental age on hatchability results was found very significant statistically for fertility (P<0.01), significant for hatchability of fertile eggs (P<0.05) and non-significant for hatchability of incubated eggs and the embryo mortality rates.

In this investigation, the fertility was determined as 78.92% in younger group and 62.07% in older group. These values were found similar with the ones

pointed out by Erensayin (2002) regarding to the fertility for the Japanese quails at 20 and 10 weeks age. In addition, the fertility of the group consisting of the age of 10 weeks was found lower than the value of 87% obtained by Dixon *et al*. (1992) regarding to the quails at age of 11-13 weeks age. The fertility of the group at age of 20 weeks was also found lower than the value of 71-81.4% obtained by Kumar *et al*. (1990).

The fertility decreased significantly depending on increasing parental age in this research. This result has become consistent with the results of investigation of some researches (Woodard and Alplanalp, 1967; Insco *et al*., 1971; Kling and Soares, 1982; Narahari *et al*., 1988).

Hatchability of incubated eggs was determined as 64.34% in group 1 and 57.93% in group 2. The differences between the age groups were not significant statistically. However, it was also seen that hatchability of incubated eggs decreased due to older ages. In this research, hatchability of incubated eggs values for the age group of 10 weeks were found similar to the values of 40-66% determined by Dixon *et al*. (1992) for the quails in age of 11-13 weeks and lower than the value of 70.34% reported out by Erensayin (2002).The hatchability of incubated eggs obtained in this research regarding to the group of 20 weeks was found close to the value of 51.1- 67.7% determined by Kumar *et al*. (1990) fiends for the quails of 20-24 weeks and the value of 56.81% reported by Erensayin (2002) for the group of 20 weeks in Japanese quails.

The result of this research that points out that hatchability of incubated eggs has decreased due to the older ages was found as consistent with many literature indications (Narahari *et al*., 1988; Elibol *et al*., 2002).

In this study the parental age on the hatchability of fertile eggs was found significant statistically ($P<0.05$) and obtained the values of 81.53% in group 1 and 93.33% in group 2. A significant level of increase was noted in hatchability of fertile eggs due to increasing age. The obtained values of hatchability of fertile eggs were determined higher than the values of hatchability of fertile eggs reported by Erensayin (2002) for the Japanese quails. In addition, a difference was noted from the indication of the mentioned researcher that the hatchability of fertile eggs was higher in younger group compared with the old group. It is possible to say that naturally the hatchability of fertile eggs has realized at a high level since the rates of embryo mortality occurred at low level in this research.

In this study, any difference was not considered significant statistically among the age groups regarding to the embryo mortality rates in early-middle, late periods. The obtained embryo mortality rates for the quails at 10 and 20 weeks age are respectively 4.22% and 1.84% in early period, 6.02 and 2.42% in middle period and 8.23 and 2.42% in late period. A decrease tendency was determined in embryo mortality rates depending on older ages. These results have showed some differences compared with the findings of some researchers (Novo *et al*., 1997; Sahan and Ipek 2000; Elibol *et al*., 2002). The present differences may occur due to the difference between the age group, egg weights of the quails used in this research and the ones used by the other researchers, difference that may be seen in sex ratio at the moment of housing and feeding in addition to the various storage and conditions of the eggs.

In this research, it was found that the egg weight had a very significant effect statistically on the chick weight ($P<0.001$). The chick weight means found respectively 7.36g, 7.93g and 8.49g in egg weight groups. The differences regarding to the chick weight were found significant statistically in all weight groups. It was also observed that an increase occurred in the chick weight due to increasing in egg weight. These results became the similar with the results regarding to the determination of the relation between the egg weight and the chick weight reported by Yannakapoulus and Tservesi-Gousi (1987); Foo (1995); Farooq *et al*. (2001). Uddin *et al*. (1994) grouped the eggs obtained from Japanese quails in weight groups of 8.59g, 9.52g and 10.56g. They reported that the egg weight indicated a positive correlation on the chick weight and the eggs in the middle weight (9.10-10.0g) could also ensure a successful incubation.

In this study, the fertility was obtained respectively as 61.74, 58.79 and 78.77% in egg weight groups and the significant differences statistically ($P<0.01$) were found between the groups. The fertility was found as the highest level in group 3 and the lowest level in group 2. As similar, Sarica and Soley (1995) obtained the highest fertility in the eggs in the weight of 11.6g and over in the research carried out with the Japanese quails. Again as the similar with the results of said research, the hatchability was reported as similar and approximately 81% in group 1 and 2 of quail eggs classified in groups of 11.00-11.99g, 12.00-12.99g, 13.00-13.99g and 14.00-15.00g. Lower values of hatchability of fertile eggs that were significant statistically were obtained in other groups (76.1 and 75% respectively for group 3 and 4). It was also found a low fertility for the group 3 (76.7%) and a high embryo mortality rate for the group 4 (Szczerbinska and Zubrecki, 1999). On the other hand, the result of this research was different from the results of the researchers (Proudfoot and Hulan, 1981) reported that the egg weight had no significant effect on the fertility.

In this research, hatchability of incubated eggs was found 46.44, 58.31 and 67.90% respectively in egg weight groups so the differences that were very significant statistically ($P<0.01$) were also obtained between the groups. Hatchability of incubated eggs was

seen as the highest in group 3 and the lowest in group 1. The hatchability of incubated eggs increased due to increase in egg weight.

The results of this research were determined as compatible with the results indicating that hatchability of incubated eggs in hens was higher in heavy eggs than the light eggs as reported by Prabkaran *et al*. (1984) and Sergeeva (1984). Again the result indicating that the hatchability of incubated eggs in Japanese quails was better in heavy group than the light group as previously mentioned by Altan *et al*. (1995) has supported the result of this research. Furthermore, the results obtained for the hatchability of incubated eggs in this research, were different from the result indicating that the differences between the groups in respect of the hatchability of incubated eggs in Japanese quails were not significant as reported by Saylam (1999).

In this study, very significant differences statistically ($P<0.001$) were obtained between the egg weight groups regarding to the hatching of fertile eggs. In egg weight groups, the hatchability of fertile eggs was found as 75.21, 99.19 and 86.21% respectively. The highest hatchability of fertile eggs was found (10.51-11.50g) in middle weight group. These results were found similar to the results indicating that the hatchability of fertile eggs was low in heavy egg group in Japanese quails as reported by Sachdev *et al*. (1985); Sarica and Soley (1995); Saylam (1999). Again the result indicating that the hatchability of fertile eggs was lower in heavy groups of quail eggs at a significant level statistically as determined by Szczerbinska and Zubrecki (1999) has also supported the result of this research. In addition, the significant difference obtained between the egg weight groups in respect of the hatchability of fertile eggs was different from the results of Proudfoot and Hulan (1981).

In this research, regarding to the embryo mortality rates, some differences that are significant ($P<0.05$) and very significant ($P<0.01$) respectively in middle and late periods in egg weight groups were obtained and any difference was not mentioned for the embryo mortality rate in early period. The embryo mortality rates in early, middle and late periods found 8.84, 7.98 and 10.97%; 0.49, 0.14 and 0.18%; 3.71, 4.65 and 5.42% in the group 1, 2 and 3, respectively. The highest rates of embryo mortality were seen in group 1 and the lowest rates in group 2 for all periods. These results have showed difference since these values were lower than the ones determined by Kucukyilmaz *et al*. (2001) and the highest mortality rate was observed in the lightest weight group and the lowest mortality rate was found in middle weight group.

Finally, even if the parental age of Japanese quails in age of 10 and 20 weeks had no significant effect on the one-day old chick weight, it had a significant effect on only the fertility and the hatchability of fertile eggs among the hatchability characteristics. It was obviously understood that a very good performance was seen in quails in the age of 10 weeks in respect of the fertility and the: hatchability of incubated eggs but also a better performance was noticed in quails in the age of 10 weeks regarding to the hatchability of fertile eggs. Again, it was noticed that the weight of egg had a significant effect on the chick weight so the chick weight has increased due to increasing in egg weight. In other words, the heaviest chicks were obtained from the eggs in weight of 11.51-12.50g. In addition, the effect of the egg weight realized at a significant level for all hatchability characteristics except the embryo mortality rate in early period. The group 3 was determined as the best suitable egg weight group in respect of the fertility and hatchability of incubated eggs and the group 2 in respect of the embryo mortality rates and hatchability of fertile eggs. It has been decided to point out that to prefer particularly middle and heavy eggs, if possible to select the eggs of the Japanese quails to be put into incubator, would be more beneficial.

References

Altan, O., I. Oguz and P. Settar, 1995. Effect of egg weight and specific gravity on hatchability and chick weight in japanese quail. Turkish J. Agri. and Forestry, 19: 4: 219-222.

Dixon, R.J., G.G. Arzey and P.J. Nickholls, 1992. Production, hatchability and fertility of eggs from breeding japanese quail (Coturnix coturnix japonica) fed diets containing furazolidone. Br. Poult. Sci., 33: 835-845.

Elibol, O., S.D. Peak and J. Brake, 2002. Effect of flock age, length of egg storage, and frequency of turning during storage on hatchability of broiler hatching eggs. Poult. Sci., 81: 945-950.

Erensayin, C., 2002. Influence of parental age on fertility, embryonic mortality and hatchability in japanese quail (Coturnix coturnix japonica). J. Central Anim. Res. Inst., 12: 1:47-50.

Farooq, M., K. Aneela, F.R. Durrani, A.K. Muqarrab, N. Chand and A. Khurshid, 2001. Egg and shell weight, hatching and production performance of Japanese broiler quails. Sarhad J. Agri., 17: 289-293.

Foo, J.K., 1995. The relationship quail (Coturnix coturnix japonica) hatching egg weight and day-old chick weight. Proceedings of the 17th Malaysian of Animal Production, Malaysia, Penang, 128-129.

Insco, W.M., D.W. Mac Laura, J.J. Jr. Begin and T.H. Johnson, 1971. The relationship on egg weight to hatchability of coturnix eggs. Poult. Sci., 50: 297-298.

Kling, K. and J.H. Soares, 1982 Vitamin E deficiency in japanese quail. Poult. Abst., 8: 2:55.

Kselen, L.V.I. and L.V.I. Pannia, 1976. The correlation of egg weight with hatching weight and 56 days weight of broiler fowls. Anim. Breed. Abst., 44: 2:888.

Kucukyilmaz, K., E. Baser, C. Erensayin, H.Orhan and E. Arat, 2001. Effect of egg weight on the hatchability, fattening performance and egg yield traits of Japanese quail. J. Central Anim. Res. Ins., 11: 6-12.

Kumar, K.M.A., K.S.P. Kumar, B.S. Ramappa and V. Manjunath, 1990. Influence of parental age on fertility, hatchability, body weight and survivability of japanese quail (Coturnix coturnix japonica). Poult. Adv., 23: 43-47.

Narahari, D., K.A. Mujeer, A. Thangavel, N. Ramamurthy, S. Viswanathan, B. Mohan, B. Burunganandan and V. Sundararasu, 1988. V. traits influencing the hatching performance of japanese quail eggs. Br. Poult. Sci., 29: 1:101-112.

Novo, R.P., L.T. Gama and M.C. Soares, 1997. Effects of oviposition time, hen age and extra dietary calcium on egg characteristics and hatchability. J. Appl. Poult. Res., 6: 335-343.

Prabkaran, R., D. Narahari, N. Ramamurthy, A.V. Parivallal and K.A. Musser, 1984. Influence of egg size and shell color on hatchability. Poult. Abst., 10: 1644.

Proudfoot, F.G. and H.W. Hulan, 1981. Influence of hatching egg size on the subsequent performance of broiler chickens. Poult. Sci., 60: 2167-2170.

Reis, L.H., L.T. Gama and M. Chaveiro Soares, 1997. Effects of short conditions and broiler breeder age on hatchability, hatching time, and chick weights. Poult. Sci., 76: 1459-1466.

Sachdev, A.K., S.D. Ahuja, P.C. Thomas and S.K. Agrawal, 1985. Effect of egg weight and duration storage on the weight loss, fertility and hatchability traits in Japanese quail. Ind. J. Poult. Sci., 20: 19-22.

Sahan, U. and A. Ipek, 2000. Effects of breeder age and incubation humidity on hatching characteristics of broiler breeder eggs. J. Poult. Res., 2: 2:11-14.

Sarica, M. and F. Soley, 1995. The effect of hatching egg weight on the hatchability, growing and egg production traits of japanese quail (Coturnix coturnix japonica). J. Agri. Faculty of O.M.U., 10: 19-30.

Saylam, S.K., 1999. The effects of egg weight and storage time on egg weight loss and hatchability traits in japanese quail. Turkish J. Vet. and Anim. Sci., 23: 367-372.

Sergeeva, A., 1984. The incubation of eggs of different weight classes. Poult. Abst., 10: 542.

Snedecor, G.W. and W.G. Cochran, 1980. Statistical method. Seventh edition. The Iowa State University Press. Ames, Iowa, U.S.A.

SPSS, 1999. Release 9.0. Standard version. Copyright SPSS Inc.

Szczerbinska, D. and A. Zubrecki, 1999. The quail egg weight and their storage period vs. hatching success and rearing performance. Adv. in Agri. Sci., 6: 91-100.

Tserveni-Gousi, A.S., 1986. Relationship between parental age, egg weight and hatching weight of Japanese quail. Br. Poult. Sci., 28: 749-752.

Tullet, S. G., 1987. Factors that determine size of day old chick. technical note. T87 Scottish Agricultural Colleges.

Uddin, M.S., D.C. Paul and Q.M.E. Huque, 1994. Effect of egg weight and pre-incubation holding periods on hatchability of japanese quail eggs in different seasons. Asian-Aust. J. Anim. Sci., 7: 499-503.

Uluocak, A.N., F. Okan, E. Efe and H. Nacar, 1995. Exterior and interior quality characteristics of eggs and their variation according to age in Japanese quail. Turkish J. Vet. and Anim. Sci., 19: 181-187.

Woodard, A.E. and H. Alplanalp, 1967. The effect of mating ratio and age on fertility and hatchability in Japanese quail. Poult. Sci., 46: 383-388.

Yannakapoulus, A.L. and A.S. Tservesi-Gousi, 1987. Relationship of parents age and hatching egg weight and shell quality to day old chick weight as influenced by oviposition time. Poult. Sci., 66: 829-833.

Yildirim, I. and R. Yetisir, 1998. Effects of hatching egg weight and parental age on the hatching weight and 6^{th} week live weight in Japanese quail (Coturnix coturnix japonica). Turkish J. Vet. and Anim. Sci., 22: 315-319.