# Effect of Feeding Time on Laying and Reproductive Performance of Pharaoh Quail (*Coturnix coturnix Pharaoh*) Housed in Different Cage Systems

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**ABSTRACT :** A total of 120 male and 240 female quail (*Coturnix coturnix Pharaoh)* were used to determine the effect of feeding time on laying and reproductive performance of Pharaoh quail. They were fed *ad libitum* between 09:00 to 17:00 or full day, daily. Each female-male pair was housed in multiple-bird cages and colony cages. Initial and final body weight, quail-day egg production, feed consumption per egg and mortality were measured to determine laying performance of breeders. A total of 960 eggs were used to determine reproductive performance of quail in each treatment group. Eggs were incubated in a commercial setter and hatcher in standard conditions. Embryonic mortality, apparent fertility, hatchability of total and fertile eggs were calculated to determine the reproductive performance. Results indicated that feeding between 09:00 to 17:00 h reduced final body weight and egg production ($p<0.001$, $p<0.001$). Whereas, limited time of feeding improved hatchability of total ($p<0.001$) and fertile eggs ($p<0.001$) and reduced embryonic mortality ($p<0.001$) when compared with the effects of feeding full day. It was found that there were no significant differences for the egg production of quail housed in different cage systems. Quail caged in multiple-bird cages consumed less feed ($p<0.01$) compared to quail housed in colony cages. There were significant differences for the mortality ($p<0.05$), hatchability of total ($p<0.001$) and fertile eggs ($p<0.001$), and embryonic mortality ($p<0.001$) during the incubation due to main effect of cage systems. There were significant cage systems×feeding time interactions for hatchability of total and fertile eggs and embryonic mortality ($p<0.001$). As a conclusion; feeding from 09:00 to 17:00 reduced laying performance of quail and improved the reproductive traits compared to full day feeding of quail breeders. But, further investigations are needed to determine the optimum length of feeding time and egg production of breeders in quail fed limited time must be evaluated in comparison with its beneficial or detrimental effects.
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**Key Words :** Quail, Feeding Time, Cage System, Egg Production, Hatchability

## INTRODUCTION

Several feeding regimes and cage systems are applied to improve the performance of fertile egg production in poultry. Limited feeding or changing the time of feeding during the day are among the experimental alternatives used to improve eggshell quality of broiler breeder hens (Botwalla et al., 1983; Wilson and Keeling, 1991). Numerous studies have been performed to determine the effect of different feeding times on broiler breeder performance, with inconsistent results. Harms (1991) and Samara et al. (1996) reported a delay in the time of oviposition when broiler breeders were fed later in the day. A similar response was observed in cross-bred layers (Daniel and Balnave, 1981) and Japanese quail (Hassan et al., 2003). However, Brake (1985) reported no difference in oviposition times between morning and afternoon fed breeders. Lewis and Perry (1988) observed no difference in oviposition time between broiler breeders fed a single allocation of food in the morning or half of the daily food allocation twice a day. Furthermore, Wilson and Keeling (1991) reported a delay in oviposition time due to afternoon feeding in standard sized broiler breeders, but observed no such response in dwarf breeders. Cage system and bird density are an important factor affecting fertile egg production (Satterlee et al., 1985; Anderson and Adams, 1994). Although multiple-bird cages for 3-6 layers are now most common in table-egg production in hens, it is difficult to find clear experimental evidence to support an optimum group size and cage system for quail breeders. Over a wide range of conditions, it appears that large group sizes may be detrimental in respect of a number of behavioural factors including: injurious feather pecking and cannibalism, fearfulness, hysteria and mortality. There is a need for a clearer understanding of the effect of this on their egg production and hatching success. Whether feeding early or late during the day can be used as a means to improve the fertility, hatchability, and embryonic mortality in Pharaoh quail, especially under normal circumstances is unknown. Therefore, two feeding periods were studied to measure the impact of feeding time on laying and reproductive performance of Pharaoh quail (*Coturnix coturnix Pharaoh*) housed in different cage systems.

## MATERIALS AND METHODS

A total of 120 male and 240 female (5-wk-old) Pharaoh quail breeders (*Coturnix coturnix Pharaoh*) obtained from the colony maintained by the Faculty of Veterinary

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**Table 1.** Effect of cage systems and feeding time on body weight, egg production, FCR and mortality in quail breeder

| Main and interactive treatment effects | Initial body weight (g) | Final body weight (g) | Egg production (%) | Feed consumption /per egg (g) | Mortality (%) |
|---|---|---|---|---|---|
| Main effects | | | | | |
| Cage system | | | | | |
| Multiple-bird cage | 238.91±2.84 | 229.94±2.95 | 80.22±2.18 | 76.40±1.99 | 18.33±3.56 |
| Colony cage | 231.52±3.84 | 235.47±3.98 | 78.79±2.19 | 89.35±2.03 | 3.33±0.56 |
| Feeding time | | | | | |
| 09:00 to 17:00 | 229.95±3.48 | 217.29±3.39 | 71.19±2.22 | 74.20±2.04 | 6.66±1.11 |
| Full day | 240.78±3.57 | 248.13±3.61 | 87.82±2.22 | 91.50±2.36 | 15.00±2.90 |
| Interactive effects | | | | | |
| Multiple-bird cage×09:00-17:00 | 226.46±5.15 | 216.96±4.17 | 70.22±2.04 | 67.88±1.87 | 11.11±4.02 |
| Multiple-bird cage×full day | 237.04±5.69 | 242.93±4.01 | 90.21±1.87 | 84.92±1.85 | 25.55±3.99 |
| Colony×09:00-17:00 | 233.44±4.01 | 217.63±5.32 | 72.31±1.99 | 80.53±1.92 | 2.22±0.93 |
| Colony×full day | 244.39±4.04 | 252.32±5.90 | 85.43±2.25 | 98.18±1.96 | 4.44±1.95 |
| ANOVA | | | | | |
| Cage systems | NS | NS | NS | ** | *** |
| Feeding time | NS | *** | *** | ** | ** |
| Cage systems×feeding time | NS | NS | NS | NS | NS |
| SEM | 2.45 | 3.02 | 1.54 | 1.93 | 0.40 |

** p<0.01, *** p<0.001, NS: No significant.

Medicine, Uludag University, Bursa, Turkey were used. The quails were divided into two groups and placed into *multiple-bird cages* (20 cm wide×20 cm deep×21 cm high in front, and 17 cm high in the rear,) or *colony cages* (90 cm wide×45 cm deep×21 cm high in front, and 17 cm high in the rear) at the rate of one male per two females. The quails in each group were further divided into feeding time treatment and they were fed *ad libitum* between 09:00 to 17:00 or full day, daily. A total of 4 treatment groups with 30 male and 60 female quails in each group constituted this study (1 male and 2 females in each multiple-bird cage or 10 males and 20 females in each colony cage, and 10 males and 20 females constituted a replicate in each treatment group).

Quails in all treatments were reared in the same environmental conditions in a windowed house with mehanical ventilation. All quails were reared at 18-21°C throughout the experiment. Quail were subjected to a 16 L:8D cycle until the end of the study. They received a standard quail breeder ration (22% total protein, 3,100 kcal ME/kg and 3.4% calcium) and water *ad libitum* during the study. Water was provided via automatic nipple drinkers, and feed was provided via trough feeders. Production data in each group were collected between the age of 50% production and 42 wk of age. The age at 50% production was accepted as the beginning of laying period, as described previously (North and Bell, 1990). Individual body weights of quail were measured at the beginning and end of the experiment. Egg production and feed consumption were recorded on daily and biweekly basis. Mortality was recorded on a group basis as it occurred. Hatching eggs were stored at 18°C and 75% RH and were turned twice a day. 240 eggs from each treatment groups were incubated in a commercial setter and hatcher (Cimuka®) with 30 eggs in each of 8 replicates per group. The setter was operated at 37.5±0.5°C dry bulb and 29.0±0.5°C wet bulb temperatures. The hatcher was operated at 37.0±0.5°C dry bulb and 31.0±0.5°C wet bulb temperatures. Eggs in the setter were turned 15 times per day.

The egg production and feed intake of the quail in the groups were calculated on the basis of live birds in groups in each day (quail-day) as previously described (North and Bell, 1990). The number of eggs laid was recorded with two hour intervals for each replication for 10 d to determine the effect of feeding time and cage systems on oviposition time. Three days after removing the chicks from the hatcher all unhatched eggs were classified as infertile or fertile. Hatchability was calculated as the number of chicks hatched per fertile or total eggs. The fertility results were reported as apparent fertility on a clear egg basis. All traits were analysed with ANOVA test (Snedecor and Cochran, 1989) using SPSS® computer software 10.00 (SPSS Inc. Chicago, USA 1999). Results for the traits measured are expressed as mean values±SEM. Feeding time and cage system were the main effects.

## RESULTS

The effects of feeding time and cage systems on laying performance of quail breeder are presented in Table 1. The initial BW of quail between the treatment groups were not different at the beginning of the experiment. However, the final body weight of quail fed from 09:00 to 17:00 was significantly lower (p<0.001) than for quail feeding full day. There were significant differences for egg production

**Table 2.** Effect of cage systems and feeding time on oviposition time by two hourly intervals in Pharaoh quail (%)

| Variable | Oviposition time (h) | | | | |
|---|---|---|---|---|---|
| | 11:00 | 13:00 | 15:00 | 17:00 | 17:00-09:00 |
| Cage system | | | | | |
| Multiple-bird cage | 1.68 | 4.62 | 8.40 | 15.54 | 69.74 |
| Colony cage | 1.96 | 8.82 | 18.62 | 23.52 | 47.05 |
| Feeding time | | | | | |
| 09:00 to 17:00 | 1.28 | 6.41 | 11.53 | 17.30 | 63.46 |
| Full day | 2.17 | 5.43 | 11.41 | 18.47 | 62.50 |

**Table 3**. The effects of cage systems and feeding time on embryonic mortality, fertility, hatchability of total and fertile eggs in quail

| Main and interactive treatment effects | Apparent fertility (%) | Hatchability of | | Total embryonic mortality (%) |
|---|---|---|---|---|
| | | Total eggs (%) | Fertile eggs (%) | |
| Main effects | | | | |
| Cage system | | | | |
| Multiple-bird cage | 90.33±0.41 | 76.74±0.49 | 79.55±0.40 | 20.44±0.32 |
| Colony cage | 93.72±0.34 | 86.46±0.47 | 92.23±0.45 | 7.73±0.29 |
| Feeding time | | | | |
| 09:00 to 17:00 | 90.50±0.45 | 85.42±0.44 | 88.77±0.32 | 11.22±0.45 |
| Full day | 93.54±0.56 | 77.78±0.49 | 83.04±0.39 | 16.99±0.17 |
| Interactive effects | | | | |
| Multiple-bird cage×09:00-17:00 | 88.23±1.00 | 85.29±0.69 | 85.33±0.38 | 14.66±0.60 |
| Multiple-bird cage×full day | 92.42±0.93 | 68.18±0.59 | 73.77±0.45 | 26.21±0.58 |
| Colony cage×09:00-17:00 | 92.77±0.90 | 85.55±0.62 | 92.21±0.65 | 7.77±0.53 |
| Colony cage×full day | 94.66±0.85 | 87.37±0.65 | 92.30±0.49 | 7.69±0.59 |
| ANOVA | | | | |
| Cage system | NS | *** | * | *** |
| Feeding time | NS | *** | ** | *** |
| Cage system×feeding time | NS | *** | ** | *** |
| SEM | 0.25 | 0.40 | 0.27 | 0.25 |

* p<0.05, ** p<0.01, *** p<0.001, NS: No significant.

between the feeding time groups (p<0.001). It was found that there were no significant differences for egg production between the quail housed in different cage systems. In this study, quail caged in multiple-bird cages (p<0.01) or fed from 09:00 to 17:00 (p<0.01) consumed less feed compared to housed in colony cages or feeding full day. There were significant differences in mortality due to main effects of cage systems and feeding times (p<0.001, p<0.01). There were no significant cage systems×feeding time interactions for traits measured in the laying period. Length of time between ovipositions in quail fed from 09:00 to 17:00 and full day or housed multiple-bird cage and colony cage were not different (Table 2).

The effects of cage systems and feeding times on reproductive performance of quail breeders are presented in Table 3. It was found that there were no significant differences for the apparent fertility between the main and interactive groups. There were significant differences for the hatchability of total (p<0.001, p<0.001) and fertile eggs (p<0.05, p<0.01), and embryonic mortality (p<0.001, p<0.001) during incubation due to main effects. There were significant cage systems x feeding time interactions for hatchability of total (p<0.001) and fertile eggs (p<0.01) and embryonic mortality (p<0.001).

## DISCUSSION

In this study, body weights of quails assigned to all treatment groups were not significantly different at the beginning of experiment. Whereas, final BW of quail was significantly reduced due to limited time of feeding for quail fed from 09:00 to 17:00. Final BW of quail were not significantly affected due to cage systems. These results agree with previous observations in quail (Sabine et al., 1995). Results obtained in this study indicated that Pharaoh quail fed from 09:00 to 17:00 h decreased egg production as compared to quail fed full day. These results agree with observations in chickens according to Brake and Peebles (1986) and Harms (1991) who observed that changing the time of feeding of hens from morning to afternon resulted in a reduction in egg production. Similar results were reported by Balnave (1977) who found that afternoon feeding resulted in a higher rate of egg production and Hassan et al. (2003) who reported that 8 h restricted feeding regimen affected egg production. The longer time of feeding in full day feeding groups could result in better nutrition for egg production. No significant differences were observed in egg production due to cage systems. On the contrary to findings of Daniel and Balnave (1981),

Brake (1985), Wilson and Keeling (1991) and Harms (1991), length of time between ovipositions in quail in all groups was not different (Table 2). Quail in all groups in the present study showed that oviposition increased gradually during the day and peak oviposition was measured after 17:00 h as 69.74, and 47.05 or 63.46 and 62.50% in quail housed multiple-bird cage and colony cage or fed from 09:00 to 17:00 and full day, respectively. These results agree with Tanabe and Nakamura (1980) and Choil et al. (2004) who state that oviposition in Japanese quail mostly occurs in the last hours of daylight and laying hens showed a smaller peak at 10:00-12:00 and a larger peak at 17:00-19:00 during the day in relation to time of oviposition.

Significant differences in mortality were observed between main treatments with 33 deaths (18.33%) within multiple bird-cage systems and 6 deaths (3.33%) within colony cages or 12 deaths (6.66%) within 09:00 to 17:00 feeding and 27 deaths (15.00%) within full day feeding treatments. Different results were observed by Gowe et al. (1969) and Lee (1981) in laying hens and Sabine et al. (1995) in quail raised in retsricted feeding. The main causes of mortality are probably placing the birds in multiple-bird cages. Most of the dead birds (33 birds within 39 bird deaths) were in multiple-bird cages. Pecking and cannibalism are often a bigger problem in multiple-bird cages since birds are not able to escape and to hide from their more aggressive partners due to limited area. In this study quail housed in multiple-bird cages and fed from 09:00 to 17:00 consumed significantly less feed per egg compared to colony cages and feeding full-day. Limited area in multiple-bird cage may be responsible for less feed consumption and energy saving. A lower feed conversion value in quail feeding from 09:00 to 17:00 would suggest that limited feeding retards egg production, therefore, improves feed efficiency due to both lower egg production and lower time for feeding. This result agrees with the reports of Duncan and Hughes (1975) who noted that pattern of feed intake is influenced by the egg formation cycle.

There were no significant differences for apparent fertility between the main groups due to main effects of feeding times and cage systems. These result agree with observations of Bootwella et al. (1983) who found no effect of feeding time on fertility. Whereas, Brake (1988) found that feeding in afternoons resulted in higher fertility. Contrary to the findings of Farmer et al. (1983), hatchability of total and fertile eggs was significantly higher in quail fed from 09:00 to 17:00 h and housed in colony cages than those of full day feeding and housed in multiple-bird cages. These results agree with observations of Mc Daniel et al. (1979) and Brake (1988) who reported that afternoon feeding improves hatchability. In this study, significant differences in embryonic mortality were observed between main treatment groups. Therefore, differences in hatchability between the main groups appeared to result from differences in embryonic mortality and may be due to increased greater fertility. The significant feeding times x cage systems interaction revealed that depressive effects of full day feeding on hatchablity of total and fertle eggs and embryonic mortality was highest only in quail housed in multiple-bird cages.

Based on these data; cage systems used in this study affected feed consumption per produced egg and mortality of breeders and also reproductive traits of breeders. Feeding from 09:00 to 17:00 reduced laying performance of quail and it improved reproductive traits compared to full day feeding of quail breeders. Further investigations are needed to determine the optimum length of feeding time. Meanwhile, the egg production of breeders in quail fed limited time must be evaluated in comparison with its beneficial or detrimental effects.

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