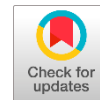


# How the diurnal hours affects maintenance behavior in Japanese quail concerning rearing modification systems



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**Abstract** This study was carried out to investigate the impact of times of day on the behavior of Japanese quail concerning managerial modifications systems. A total of 120 one-day-old quail chicks were used in this study. 60 chicks were housed in cage systems; distributed into 3 subgroups (20 birds on each), a normal cage group, a cage with cover as wire floor with plastic cover from the top and third cage group “Edinburg modification cage”, as a normal cage except that the front portion has dust bather filled with washed builder sand or fine sawdust. The other floor managerial modifications included 60 birds distributed into three subgroups. The first-floor group was considered “normal”, as 20 birds were housed using an 80×50 floor system with 5cm or 10cm dry, clean soft sawdust sprinkling with slaked lime, the second-floor group was named “A grill group”. The feed was offered to the quail in a plastic feeder covered with the grill to reduce feed wastage and the third-floor group offered feed to the quail in a longitudinal constructed feeder with six holes separated by wire. Data were analyzed using two-way ANOVA, where two factors affect the behavior of quails and from our study, we suggested that there were non-significant differences in the ingestive behavior of quail regarding the daylight effect. Most standing frequencies were conducted midday at most managerial modifications. Crouching time also increased in the early morning with the normal floor group and constructed feeder. We conclude that various times of the day and managerial modifications greatly alter maintenance behavior in most quail chicks. Abnormal behavior was comparatively higher in the morning.

**Keywords:** *Coturnix japonica*, diurnal times, maintenance behavior, managerial modification, managerial system

## Introduction

Japanese quail production has been increased among the poultry industry since its start as a commercial poultry

activity. Quail has excellent meat quality, high nutritional value, and pleasant flavor of its eggs, which has resulted in wide consumer acceptance. However, its production faces some challenges. The spotlight mounted directly to the net minimizes netter illumination by positioning the light source away from the netter’s body (Martins 2002). Circadian rhythms are the most critical factor that affects their behavior. (Troy et al 2012). The eye activity rhythm of Japanese quail controls circadian behavior, which directly affects rhythmicity. The light has an important impact on poultry behavior and physiology (Taniguchi et al 1993). Day length has a clear impact on patterns of behavioral expression in broiler chickens during the photo phase (Lewis and Morris 1998).

The Edinburgh modified cage of quail rearing is normal cage deck but at the front portion of the cage, there was a nest box as dust bather filled with fine wood shaving. In the free access version, birds had a free opportunity to the nest box and dust bath at all times (Appleby and Hughes 1995). The ingestive behavior was improved with floor managed quail in the early morning while quail reared at cages showed the highest level of feeding in the late afternoon. The crouching time was increased with mid-day at caged reared quail (Abdel-Hamid et al 2019).

Thus, our study was conducted to record the effects of different times of day in the broilers’ behaviors (Mohammed et al 2017, Bookers et al 2004) the behavior can aid in the interpretation of an animal’s feelings, both positive (such as playful, relaxed, and exploratory behaviors) and negative (including frustration, fear, or pain). This study was carried out in Japanese quail to investigate how the time of day influences quail behavior regarding rearing modification systems.

## Materials and Methods

This study was conducted with Japanese quail (*Coturnix coturnix japonica*) to investigate the impact of diurnal periods on the behavior of quail related to managerial modifications systems. The study was carried out at two housing systems at the experimental building belonging to the Faculty of Veterinary Medicine at Zagazig University in Egypt. The research protocol was approved by the Institutional Animal Care And Use Committee and Zagazig University (Approval N°. ZU-IACUC/2/F/2/2019).

*Birds and housing condition*

Two housing systems housed 120 one-day-old quail chicks. Half of the chicks were housed in cage systems; the other half was housed using a deep-litter floor. Cage systems were divided into three groups, each including 20 birds that were distributed into two laying cages. The measures of each cage were 60x50x25cm and noted as the normal cage group, named “cage with cover”, consisted of a wire floor replaced with fine sawdust and topped with a plastic cover to avoid head injuries. The third cage group was named the “Edinburg

modification cage”, which comprised a normal cage except that the front portion was included with dust bather filled with washed builder sand or fine sawdust to offer chicks the opportunity for dust bathing. The multi-decked cage group, the battery consists of 5 tires vertically cages as each tire was contained two laying cage with dimension (60×50×25×20 am) was given a wire mesh floor to prevent quail dropping accumulation.

According to Abdel-Hamid (2009), the other floor managerial modifications included 60 birds distributed into three groups. The first-floor group was considered “normal”, as 20 birds were housed using an 80×50 floor system with 5cm or 10cm dry, clean soft sawdust sprinkling with slaked lime. The second-floor group was named “A grill group”. Throughout the study, the feed was offered to the quail in a plastic feeder covered with the grill to reduce feed wastage. The third-floor group offered feed to the quail in a longitudinal constructed feeder with six holes separated by wire partitions. Figure 1 illustrates the shape of modified managerial systems and bird sitting behavior on it.



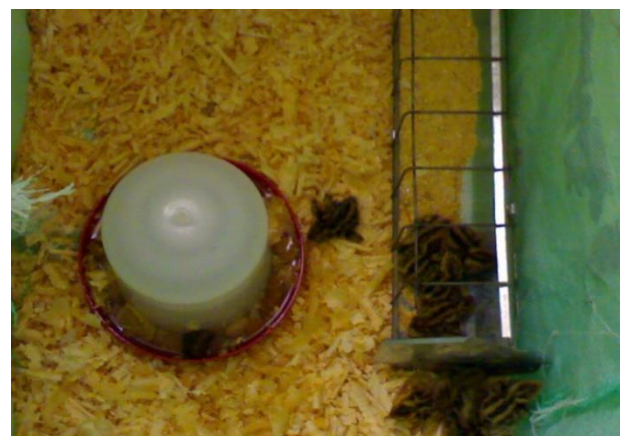
A



B



C



D

**Figure 1** Modified managerial systems and bird sitting behavior on it. A) Modified quail cage with a dust bath as normal cage deck but at the front part of the cage, there was a nest box that was designed as dust bather filled with sand or fine sawdust. B) Modified quail cage with cover cage decks was covered with white plastic table cloth at the top of the cage to avoid head injuries and mortality. C) Cringing behavior: Laying or sitting breast on the floor, locking about or with closed eyes. D) Constructed feeder at floor management which was divided into 6 longitudinal holes separated by wire partition each hole sufficient for one bird.

Food and water were available *ad-libitum*, with feed consisting of as yellow corn (56.10%), crude protein (24.9%), soybean meal (32.73%), crude fiber (3.45%), fishmeal (5.50%), metabolized energy (3909 MJ/kg), calcium & phosphorus (1.23%), and other feed additives (1.9%). The temperature was maintained at about 35°C during the first week of brooding and was then decreased by about 3–5°C weekly until the birds were full-feathered (3 to 4 weeks). Each bird was identified by the group using colored wing bands to differ between groups (Abdel-Hamid 2019). Natural light was offered during daytime hours, and continuous light was programmed with using a 200-watt lamp nightly. The birds were administered two intervals of vitamins A, D<sub>3</sub>, E, and supplemented with Ca, ph. Anti-coccidian drugs were also administered.

*Observation technique*

Behavioral observation was conducted using and recording a focal sample technique. The behavioral observation in both systems, floor, and cage, were recorded at 6-minute intervals during 12-hour observation periods per week to represent different times of day: (P1) Early morning: 7–11 hours period; (P2) Midday: 11–15 hours; and (P3) Late afternoon: 15–19 hours. The observed behavioral patterns were recorded as shown in Table 1.

*Statistical analysis*

All statistical analyses were performed using SPSS software, V.16 (SPSS Inc., Chicago, IL, USA). Data were analyzed using two-way ANOVA, where two factors affect the behavior of quails: first-factor is the modification system in quail rearing and second-factor are various day times, according to Duncan (1955).

**Table 1** Behavioral patterns (Dawkins 2004).

Behavior	Definition
1- Ingestive: a-Feeding b-Drinking	Head extended towards available feed resources while beak in or above the drinker appears to be manipulating or ingesting feed quails obtained water from drinking resource
2- Standing behavior	Quails were standing idle and not engaged in any activity.
3- Walking	Moves forward taking one or more steps.
4- Running	Moving rapidly not walking.
5-Crouching	Quails lying on the ground.
6-Comfort behavior: a-Feather preening b-Other comfort behavior: Wing flapping Body shaking Head shaking	Birds clean and care about their plumage with their beak using short and repeated action while standing or sitting. in which the bird stretches its full height and flaps its wings repeatedly. in which the bird shakes its body vigorously The head is tilted to one side and shaken vigorously in a circular fashion.
7-Abnormal behavior (Abdel-Hamid 2009): a-Wall pecking  b- Food wastage  c-Aggressive pecking	The ambivalent behavior (characterized by an aggressive action followed immediately by submissive posture) during feeding competition was observed in both the unstable and stable grouping of caged quail Quails waste the feed by scratching at the feeder with its legs by jumping in or out the feeder The ambivalent behavior (characterized by an aggressive action followed immediately by submissive posture)

**Results**

All cage rearing system modifications showed no significant differences in feeding times between different times of day, although most managerial modifications increased in the afternoon (Table 2). There were significant differences in walking activity, with increases in the late afternoon during dust bathing and in the early morning with the cage cover. Time of day affected ingestive and kinetic behavior of quail in all cage types.

The preening and other comfort behavior significantly increased in the early morning in both the normal cage and covered cage; these behaviors increased in the late afternoon in the cage with dust bathing (Table 3). Each group presented

a significant effect regarding comfort and behavioral disorders based on time of day.

Means of the ingestive and kinetic behavior of quail reared under different floor modifications to different times of day are shown in Table 4. It clearly shows there was no significant effect on feeding, drinking, or walking and running behavior. However, each group’s ingestive and kinetic behavior was significantly affected by the time of day.

The impact time of day had on comfort and behavioral disorders of quail reared under different floor modifications to different day times are presented in Table. 5. It shows that had no significant effect on comfort and behavioral disorder. Each group was significantly affected by the time of day regarding the birds’ comfort and behavioral disorders.

**Table 2** Ingestive and kinetic behavior of quail reared under different cage modifications at different daytimes periods.

Behavior traits	Normal cage group			Cover group			Dust bath group			P-value
	P1	P2	P3	P1	P2	P3	P1	P2	P3	
Feed frequency	8.66±2.66	6.66±2.40	12.00±3.05	10.00±2.30	12.66±2.90	7.33±2.90	8.33±1.66	7.00±0.57	15.33±7.68	N.S
Feed time	21.00±9.29	17.00±6.42	16.33±3.38	14.66±2.72	11.00±2.30	11.00±4.50	15.33±2.33	8.66±0.33	12.00±3.51	N.S
Drinking frequency	10.00±9.01	2.66±1.76	2.66±1.76	6.00±4.16	4.66±1.76	6.66±4.05	2.66±1.33	7.33±1.76	1.33±1.33	N.S
Stand frequency	12.66±5.20	17.33±4.80	12.00±4.00	11.00±3.21	5.33±1.76	21.33±1.33	16.00±0.00	20.33±5.78	16.66±9.68	N.S
Stand time	6.33±2.60	10.66±1.20	6.00±2.00	8.00±2.00	30.33±2.90	24.33±2.33	18.00±5.50	10.33±2.72	25.00±7.00	N.S
Walk frequency	10.66±4.05	5.33±2.90	9.33±4.66	16.66±0.66	20.00±5.29	27.33±6.35	14.00±3.05	11.00±1.52	10.66±2.40	*
Walk time	5.66±2.33	2.33±1.45	5.33±1.85	10.33±1.33	12.33±4.37	15.33±2.90	8.00±2.08	5.66±0.66	8.66±4.25	N.S
Run time	4.66±3.71	4.00±1.15	2.33±1.45	0.00±0.00	6.00±2.00	1.33±1.33	4.66±0.66	16.6±2.00	8.66±4.25	N.S

Period 1 (P1) Early morning: 7–11 hours; Period 2 (P2) Midday: 11–15 hours; Period 3 (P3) Late afternoon 15–19 hours  
 NS: Non-significant changes; \*Significant at 0.05 probability; \*\* Highly significant at 0.01 probability

**Table 3** Comfort and behavioral disorders of quail reared under different cage modifications at different times of the day.

Behavior traits	Normal floor group			Grill feeder group			Constructed feeder group			P-value
	P1	P2	P3	P1	P2	P3	P1	P2	P3	
Feed frequency	1.33±1.33	5.33±3.52	15.33±3.52	11.0±3.46	13.6±7.52	8.00±1.15	4.0±4.00	10.6±3.71	4.00±1.52	N.S
Feed time	0.66±0.66	7.33±6.35	22.66±8.87	7.33±0.66	6.66±2.90	6.66±2.40	2.00±2.00	12.00±8.02	3.33±0.88	N.S
Drinking frequency	0.00±0.00	4.66±3.71	5.33±2.90	5.00±1.15	0.66±2.08	0.66±0.66	1.33±1.33	3.66±1.20	5.00±2.5	N.S
Stand frequency	24.0±5.77	27.00±16.52	18.00±4.16	19.00±4.50	14.3±60.06	11.66±2.72	13.3±7.51	4.00±2.00	12.3±1.20	N.S
Stand time	28.6±3.28	17.00±7.00	16.3±5.48	14.6±0.66	14.6±3.52	260.0±9.50	15.3±7.68	13.0±7.50	14.0±4.72	N.S
Walk frequency	19.3±6.35	21.3±12.71	13.3±6.35	8.0±1.52	21.3±7.68	11.3±1054	24.6±2.90	16.6±10.47	5.3±2.02	N.S
Walk time	10.0±3.21	18.0±13.31	8.00±4.00	16.0±3.05	16.6±7.51	3.66±1.33	23.6±11.25	9.6±7.75	6.00±1.52	N.S
Run time	0.66±0.66	11.00±7.63	2.66±1.76	0.33±0.33	0.33±0.33	0.66±0.66	0.66±0.66	0.00±0.00	4.00±2.00	N.S

Period 1 (P1) Early morning: 7–11 hours; Period 2 (P2) Midday: 11–15 hours; Period 3 (P3) Late afternoon 15–19 hours  
 NS: Non-significant changes; \*Significant at 0.05 probability; \*\* Highly significant at 0.01 probability

**Table 4** Ingestive and kinetic behavior of quail reared under different floor modifications at different times of the day.

Behavior traits	Normal cage group			Cover group			Dust bath group			P-value
	P1	P2	P3	P1	P2	P3	P1	P2	P3	
crouch frequency	3.33±2.84	12.66±4.80	10.66±5.81	10.00±5.03	9.66±4.09	3.66±3.66	17.66±5.36	29.66±0.88	9.33±8.83	N.S
crouch time	4.66±2.40	2.66±1.76	1.33±1.33	20.33±2.33	1.33±1.33	2.00±1.15	4.00±2.30	6.66±1.76	4.00±1.15	N.S
preening other comfort	1.33±1.33	0.00±0.00	0.00±0.00	7.33±0.66	0.66±0.66	1.33±1.0	5.33±2.18	10.00±3.05	11.33±9.40	N.S
wall pecks	2133±2.40	10.66±8.74	6.66±3.33	2.33±2.33	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	**
aggressive peck	18.66±1.20	10.66±7.05	10.66±5.36	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	**
try to food wastage	0.00±0.00	1.33±1.33	0.00±0.00	0.00±0.00	2.00±2.00	2.00±2.00	0.00±0.00	0.00±0.00	0.00±0.00	N.S
	0.00±0.00	0.66±1.15	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	N.S

**Table 5** Comfort and behavioral disorders of quail reared under different floor modifications at different times of the day.

Behavior traits	Normal floor group			Grill group			Constructed feeder group			P-value
	P1	P2	P3	P1	P2	P3	P1	P2	P3	
crouch frequency	8.00±2.00	15.00±6.42	9.00±7.54	15.3±7.68	19.66±9.17	4.00±1.15	6.00±0.00	2.66±1.76	17.33±8.74	N.S
crouch time	12.6±4.861	1.66±1.76	8.00±4.61	3.33±1.76	4.33±1.85	35.6±4.25	16.33±7.16	16.66±13.17	1.33±1.33	*
preening	3.33±2.40	1.33±1.33	0.00±0.00	1.33±1.33	2.33±1.85	0.00±0.00	8.00±4.60	3.66±3.17	10.6±5.60	N.S
other comfort	4.00±2.30	4.00±2.00	0.00±2.00	5.33±4.37	1.66±0.88	0.00±0.00	0.60±0.66	2.00±2.00	0.33±0.33	N.S
wall pecks	2.33±1.45	2.00±1.00	1.33±1.33	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.33±0.33	0.33±0.33	N.S
aggressive peck	2.00±2.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	N.S
try to food wastage	0.00±0.00	3.00±3.00	1.33±1.33	4.66±2.40	3.33±1.76	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	N.S

**Discussion**

Lighting is an important external factor in the behavioral patterns of birds, as the photoperiod greatly influences their actions. Furthermore, observing behavior aids in evaluating a bird's welfare. The results shown in Table 2 referred that there were non-significant differences in birds' ingestive behavior relating to daylight effects, with most standing frequencies carried out midday for most managerial modifications. (Vestergaard et al 1990, Lindberg and Nicol 1997) as they studied that dust baths make the attractiveness to feed in the feeder. Because poultry typically does not feed at night, the morning feeding peak allows them to refill their food storage organ (the crop), which becomes depleted overnight. Most standing frequency and crouching behavior occurred midday with most cage modifications and showed significant differences (Martins 2002 and Amado et al.2011) stated that the behavioral pattern of poultry was highest in the early morning and late afternoon. More ever,(Nelson et al.2002 and Newton2007) cited that the circadian hour greatly affected the birds' behavior globally. Dust bathing in poultry is a highly motivated behavior that will occur even in the absence of stimuli as "Sham" or "Vacuum" dust bathing. Some designs of modified cages for laying hens contain dust baths (Abdel-Hamid 2009). These results, shown in Table 3, reference a close relationship with dust bathing frequencies and dusk. According to Abdel-Hamid (2017) mentioned that the preening and feather-shaking frequencies were not affected by diurnal factors,

It was concluded that changes time of day and the lighting duration of quails was significantly correlated to various normal bird behaviors. Abnormal behavior was higher in the morning. Diurnal hours have a weak impact on the birds' behavior as quail reared at a battery system showed the highest level of ingestive behavior in the late afternoon16 (Lincoln et al 2016). Although, Abdel-Hamid et al (2019) showed that there were non-significant differences in standing

time between different times of day in both housing systems. The results are shown in Table 4 indicate that the highest feeding frequency and time occurred midday at most floor modification systems. Additionally, increases were evident in the late afternoon for floor rearing without any modifications. The most standing time was increased with grill rearing quail in the late afternoon, Activity movement increased with midday for most floor rearing. Crouching time (Table 5) was increased in the early morning at the normal floor and constructed feeder cages. There were insignificant differences in preening and other comfort behavior at most times of the day and floor managerial modifications.

The ingestive behavior was higher in the morning than other photoperiods; this may be due to decreased heat stress. Most behavioral patterns of birds were greatly affected by circadian rhythms (Mohammed 2017; Amado et al 2011; Wirminghus et al 2001; Kondo et al 2006). Diurnal hours had no significant effect on wall pecking behavior. These results are supported by the research of (Kundu et al 2003; Khurshid et al 2004). Feed wasting was increased during morning hours, possibly because of increased activity in birds at this time of day. The preening was not affected by different times of day at either housing system (Lincoln et al 2006). The crouching time increased at midday for battery-managed quail compared with floor-reared ones. As, well as (Abdel-Hamid et al 2019) stated that diurnal hours had a significant effect on quail behavior, welfare, and egg-laying rate, all of which are instrumental in daily egg production. We suggest future research should investigate the effects of light duration on sexual behavior, as well as egg quality.

**Conclusions**

We concluded that the ingestive behavior increased in cage-managed quail in the afternoon, while floor-reared quail showed the highest level of ingestive behavior at midday. The standing time increased midday with battery-managed quail.

Aggressive pecking and food wastage rose in the morning, possibly owing to increased activity in the birds at this time of day. Each group was significantly affected by the time of day concerning maintenance and behavioral disorders. Circadian factors affected bird behavior, while light had a significant effect on the birds' behavior, welfare, and egg-laying rate, which contribute to daily egg production. Therefore, the economical effect of photoperiods on quail exists.

We suggest supplying quail with artificial light and increasing exposure hours to increase laying rates, amplify reproductive performance, and improve welfare.

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### Conflict of Interest

The authors declare no conflict of interest.

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