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Effects of different environmental enrichments on the behavioral patterns, growth performance, hematological, and hormonal changes in Japanese quail.

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ABSTRACT

The current study was carried out to estimate the effect of environmental enrichments (E.E.) on behavioral patterns, growth performance, and hematological and hormonal changes in Japanese quail. A total number of 216 healthy Japanese quails 1-month-old with an average body weight of 135.66 ±1.32 g was randomly assigned to three groups (72 birds each), and each group was divided into three replicates (24 birds each) with a sex ratio of 1 male to 3 females according to the environmental enrichment within the pen. The first group had no environmental enrichment (control group), the second group was subjected to visual enrichment by using mirrors 40 cm in length fixed into the pen in the wall behind the birds (mirror group), while the birds in the third group were subjected to auditory enrichment through using of classical music which comes from speaker hanged at one corner of the pen. Behavioral patterns and growth performance were recorded weekly. At the end of the study, 15 birds from each group were selected randomly and slaughtered to obtain blood samples; 6 ml of blood was collected from each bird for hematological analysis and cortisol determination. The obtained results revealed that environmental enrichments especially using music, improved the feeding and comfort behaviors of Japanese quail and reduced aggression followed by mirror group and control one. No significant effect of E.E. on growth performance (P<0.05). In conclusion, environmental enrichments of Japanese quail houses improved the behavioral patterns.

1. INTRODUCTION

Quail rearing is simple as its housing requirement is not complicated; they are fast growers and have a good feed conversion ratio (Randall and Bolla, 2008). Even though chicken is the most common source of eggs among poultry species, Japanese quail production is being developed as an alternative source in many countries because of its fast growth and maturation. Adding some environmental enrichment elements in quail house affect their growth and behavior and reduce stress (Laurence et al., 2014).

Environmental enrichment (E.E.) is defined as a change in an animal's environment that improves behavioral patterns and leads to an increase in biological performance (Newberry, 1995). Enriching the environment is a well-known method used for boosting the performance and welfare of the animal (Jones, 2002). Environmental enrichment has a positive impact on the brain, behavior, and cognition by influencing the endocrinologic, immunologic, metabolic processes, and neuroplastic parameters (Brenes et al., 2016; Buschert et al., 2016). Several studies have linked the poor environmental condition with abnormal behaviors and poor productivity in animals and poultry (Borell and Hurnik, 1990; Mendl et al., 1992; Hemsworth et al., 1994), hence, interventions that reduce harmful behaviors, such as environmental enrichment, have the potential to improve the performance (Jones, 2002).

Using novel object enrichment improved body weight, body weight gain, and feed conversion ratio in broiler and layer chickens (Chadwick and Hughes, 1980). Different types of environmental enrichment (foraging opportunities, structural complexity, sensory stimulation/novelty, and social companionship) have been used to check its effect on the behavior and production of Japanese quail (Miller and Mench, 2006). Music was used as an environmental enrichment tool in broiler chickens (Jacob et al., 2020). Using different types of music improved the growth performance and behavior of Japanese quail (Cabaral et al., 2017). The study of (Nazar and Marin, 2011) revealed that exposing quail to an enriched environment can improve their immunity and decrease the negative effect of stressors.

Environmental enrichment has different forms and has a great impact on birds, so the current study was conducted to evaluate the effects of different environmental enrichments, auditory enrichment through classical music, and visual enrichment by using a mirror on the behavioral patterns, growth performance, hematological parameters and serum cortisol concentration in Japanese quail.

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2. MATERIAL AND METHODS

The study procedures were carried out in accordance with the standards for the use and treatment of animals at the Faculty of Veterinary Medicine, Benha University, Egypt (approval number: BUFVTM 11-04-22) in September 2021.

2.1. Birds and management:

A total number of 216 healthy Japanese quail one-month-old with an average body weight of 135.66±1.32g were purchased from a private farm in Gharbia province, Egypt. Birds were housed in 3 symmetrical pens, each one was 3.75m in length, 3m in width, and 3m in height which had been previously prepared and disinfected, the floor was covered by a layer of wood shaving about 10cm. Pen temperature was 28.18±0.19 °C, with 52–67% relative humidity, and a photoperiod of 16 h light: 8 h darkness. Feeders and drinkers were provided before the arrival of the birds. The ingredients and the chemical composition of the experimental diets have been summarized in table (1).

2.2. Experimental design:

A total number of 216 healthy Japanese quail one-month-old with an average body weight of 135.66±1.32g were allocated randomly to 3 groups (72 birds each), and each group was divided into three replicates (24 birds each) with a sex ratio 1 male to 3 females according to the environmental enrichment within the pen. Each pen was divided by wooden barriers into 3 parts (one for each replicate); each part was 1.25m in length× 1m in width. The first group was control had no environmental enrichment, while the second group was subjected to visual enrichment by using mirrors of 40cm length × 1.25m width fixed into the pen in the wall behind birds 40 cm from the wood shaving layer. The birds in the third group were subjected to auditory enrichment through using of classical music, which comes from a speaker hung 2 m height at one corner of the room, for 8 hours daily from 9.00 am to 5.00 pm; the volume of the music was measured using a sound meter (UNI-T Mini Sound Meter, China) and fixed at the normal sound volume up to 60 decibels (Cabaral et al., 2017).

2.3. Behavioral observations:

Behavioral patterns of each group were recorded three days per week, two times per day at 9.00 - 10.00 am and 4.00 - 5.00 pm using scan observation (Taskin and Karadavut, 2017). The behaviors of one replicate from each group were recorded for 15 min in the morning and afternoon per day; by the end of the week, the behaviors of three replicates for each group were recorded. All observations were carried out by one observer who was present at all measurement points to familiarize the birds with the presence of humans to avoid the effect of the observer on birds' actions. The most observed behaviors were ingestive behavior (feeding and drinking), comfort behavior (feather preening, open wing, wing and leg stretch, head scratch with leg, wing stretch, body shaking, head shaking, wing flapping, head stretch, and leg stretch), activity (walk, run, jump and fly), resting behavior (idling, crouching, sitting and huddling), aggression (feather pecking) and other behavior (object pecking and litter pecking and scratch). The behavioral ethogram is shown in table (2) as described by (Dawkins, 2004).

2.4. Growth performance parameters:

Body weight and body weight gain:

In order to determine the effect of environmental enrichments on the growth performance of quail, ten marked birds from each replicate were weighed weekly using a digital balance, and the weekly live body weight gain was determined as the difference between the body weights of two consecutive weeks (Yalçin et al., 1998).

2.5. Blood sampling, hematological and hormonal analysis:

To check the effect of environmental enrichments on blood contents and hormones, at the end of the study (4 weeks), 1,5 birds from each group were selected randomly and slaughtered to obtain blood samples. 6 ml of blood was collected from each bird in two different tubes; the first blood sample was collected in a clean sterilized tube containing anticoagulant Ethylene-diamine-tetra-acetic acid. Red and white blood cells were counted using a hemocytometer using a light microscope, as described by Hawkeye and Dennett (1989). Packed cell volume (PCV) and differential leucocytic count were determined according to (Nadia, 2003). MCV, MCH, and MCHC were recorded according to (Mangrum, 1975). Hemoglobin concentration (g/dl) was determined using haemoglobinometers as described by Tietz (1982). The second blood sample was collected in a clean, sterilized labeled tube without anticoagulant and centrifuged at 3the 000 rpm for 10 min. The serum was separated and kept at − 20 °C until analysis by ELISA using (Cortisol II, cobasR, USA) kits as recommended by (Shusha *et al.*, 2021).

2.6. The statistical analysis:

The SPSS software version 22 was used to analyze the data. All data were analyzed using analysis of variance (ANOVA). Means and standard error means were used to present the data. $P \leq 0.05$ was used to declare the data to be different.

3. RESULTS

3.1. Behavioral patterns:

The effect of environmental enrichments on the behavioral patterns of Japanese quail is shown in table (3).

3.1.1. Ingestive behavior:

The frequency of feeding behavior was (7.54±0.70), (9.25±0.70), and (10.75±0.70) for the control, mirror, and music group, respectively. It was clear that environmental enrichments affected significantly (P=0.008) feeding behavior as the birds in the music and mirror groups showed higher feeding frequency than birds in the control group. The frequency of drinking behavior was (6.41±0.62), (7.08±0.62), and (7.12±0.62) for the control, mirror, and music group, respectively. Although the difference in drinking behavior was not significant, the frequency was higher in the enriched environmental groups than in the control group.

3.1.2. Comfort behaviors:

The frequency of the feather preening was (7.50±0.53), (9.12±0.53), and (13.29±0.53) for the control, mirror, and music group, respectively. The average head scratch with leg was (2.29±0.45), (4.04±0.45), and (4.12±0.45) for the control, mirror, and music group, respectively. The frequency of body shaking was (2.54 ± 0.46), (3.45±0.46), and (5.58±0.46) for the control, mirror, and music group, respectively. Wing and leg stretch frequency was (2.83±0.47), (3.66±0.47), and (6.00 ± 0.47) for the control, mirror, and music group, respectively. The frequency of open wing was (2.16±0.47), (2.83±0.47), and (5.95±0.47) for the control, mirror, and music group, respectively, and the average of wing flapping behavior was (0.33±0.28), (0.95±0.28), and (1.75±0.28) for control, mirror, and music group, respectively. The results revealed that environmental enrichments significantly affected feather preening (P <0.001), head scratch with leg (P=0.008), body shaking

(P<0.001), wing and leg stretch (P<0.001), open wing (P<0.001) and wing flapping (P=0.004) as the frequency of the previous behaviors showed the highest level in music group then the mirror group and the control group.

The frequency of dust bathing was (0.37±0.29), (1.58±0.29), and (0.79±0.29) for the control, mirror, and music group, respectively, the head stretch frequency was (1.33±0.40), (5.37±0.40), and (3.33±0.40) for control, mirror, and music group respectively, while the leg stretch frequency was (0.83±0.28), (2.29±0.28), and (1.66±0.28) for control, mirror, and music group, respectively. Some behaviors as dust bathing, head stretch, and leg stretch, were higher in the mirror group than music and control groups, respectively.

Head shaking and wing stretch did not significantly affect environmental enrichments, although the frequency of them was higher in enriched groups than in control ones.

3.1.3. Resting behavior:

The frequency of idling was (6.29±0.90), (9.87±0.90), and (12.45±0.90) for the control, mirror, and music group, respectively, the frequency of idling was higher in the music group than the mirror and control group, respectively (P<0.001), the crouching frequency was (3.37±0.80), (6.41±0.80), and (3.83±0.80) for control, mirror, and music group, respectively. The huddling frequency was (0.62±0.45), (2.12±0.45), and (0.45±0.45) for the control, mirror, and music group, respectively. The crouching frequency was higher in the mirror group than in the music and control group, respectively (P=0.02). The same result was obtained for huddling as the highest frequency was observed in the mirror group than the control group and music group (P=0.02). Sitting behavior was not affected significantly by environmental enrichments (P=0.09).

3.1.4. Activity:

Walk, run and jump behaviors were not significantly affected by environmental enrichments (P>0.05). The frequency of flying was (0.62±0.25), (0.16±0.25), and (1.62±0.25) for the control, mirror, and music group, respectively. There was a significant difference in flying frequency between groups for the music group and then the other two groups (P=0.001).

3.1.5. Aggression:

The frequency of aggression was (2.33±0.31), (1.33±0.31), and (0.66±0.31) for the control, mirror, and music group, respectively. Aggression was significantly (P=0.002) decreased in environmentally enriched groups than control one.

3.1.6. Other behavior:

The frequency of object pecking was (1.25±0.35), (4.70±0.35), and (1.58±0.35) for the control, mirror, and music group, respectively. Object pecking showed higher frequency in the mirror group than music and control group respectively (P<0.001).

Litter pecking and scratching did not affect significantly by environmental enrichment (P>0.05), while object pecking showed higher frequency in the mirror group than music and control groups, respectively.

3.2. Growth performance:

3.2.1. Body weight:

Results in table (4) showed the effect of environmental enrichments on the live body weight of quail. The average live body weight in the 4th week was (139.33±2.34), (133.00±2.34), and (136.00±2.34); in the 5th week was (186.66±3.00), (184.66±3.00), and (185.66±3.00), at the 6th week was (219.66±3.35), (218.00±3.35), and (221.00±3.35), at the 7th week was (235.66±4.04), (239.00±4.04), and (245.00±4.04), at the 8th week was (250.33±4.70), (256.00±4.70), and (260.33±4.70) for control, mirror, and music group, respectively. There was no significant effect of environmental enrichments on the live body weight of birds (P>0.05); however, the live body weight of music group birds was higher than the other two groups from the second week till the end of the study also the mirror group showed higher body weight than the control group during the last two weeks of the study.

3.2.2. Body weight gain:

The result in table (5) revealed the effect of environmental enrichments on the body weight gain of Japanese quail. The average body weight gains at the 4-5th week was (47.33±3.98), (53.00±3.98), and (49.66±3.98), at the 5-6th week was (33.00±3.78), (33.33±3.78), and (35.33±3.78), at the 6-7th week was (16.00±4.81), (21.00±4.81), and (24.00±4.81), at the 7-8th week was (14.66±4.91), (17.00±4.91), and (15.33±4.91) for control, mirror, and music group, respectively. The environmental enrichment had no significant effect on body weight gain of quail (P>0.05); however, the body weight gain of environmental enrichment groups was higher than the body weight gain of control group during the experimental period.

3.3. Hematological and hormonal analysis:

As in table (6), The hematological parameters and cortisol concentration did not affect significantly by environmental enrichments (P>0.05), except for the total leukocyte count which was higher in the music group than in the two other groups (P=0.008). Also, platelets count was higher in the control group than in the two enrichment groups (P=0.01), the average leukocyte count was (1.69±0.23), (1.54±0.23), and (2.58±0.23) ×109/ L, the average platelets count was (3994±300.26), (3555±300.26), and (3665±300.26) ×109/ L for control, mirror, and music group, respectively.

Table 1 Composition and nutrient content of the basal diets.

Ingredients (g/kg as fed)	
Yellow corn	575.0
Soybean meal (44%CP)	236.0
Corn gluten meal (60% CP)	74.0
*Vita. &Min. mix.	3.0
DL-methionine	1.0
L-lysine	2.0
Wheat bran	20.0
Limestone	64.0
Soybean oil	21.0
Salt	4.0
Total	1000
Calculated chemical composition%	
Metabolizable energy (kcal/kg)	2900.9
Crude protein	20.03
Crude fiber	3.48
Na	0.17
Ca	2.52
Available phosphorus	0.39
Lysine	1.03
Methionine	0.48

*Vitamin-tracemineral mixture: composition per 3 kg, Vit. A 12,000,000 I.U.;Vit. D3 2,000,000 I.U.; Vit.E 10,000 mg; Vit.K31000 mg; Vit.B11000 mg; Vit.B25000 mg; Vit.B61500 mg; Vit. B1210 mg; niacin30,000 mg; biotin 50 mg; folic acid 1000 mg; pantothenic acid10,000 mg; choline chloride 500,000 mg; zinc 50,000 mg; manganese 60,000 mg; iron 30,000 mg; copper 10,000 mg; iodine 1000 mg; selenium100 mg; cobalt 100 mg; calcium carbonate to 3 kg.

Table 2 The behavioral patterns description of Japanese quail.

Behavior		Description
Ingestive behavior	1-Feeding	Head extended towards available feed troughs
	2-Drinking	The beak of bird in or above the drinkers
Comfort behavior	1-Feather preening	Birds clean and care its feathers with the beak while standing or crouching
	2- Wing flapping	The bird stretches to its full height and flaps its wings repeatedly
	3- Body shaking	The bird shakes its body vigorously
	4- Head shaking	The head is tilted to one side and shaken vigorously in a circular fashion
	6- Head scratching	The head scratched by toes of legs
	7- Wing stretching	Extending one wing at the same side of the body
	8- Leg stretching	Extending both legs while the bird in lying position
	9- Wing and leg stretch	Extending one wing and leg at the same side of body
	10- Open wings	Both wings raise away from the body
	11- Dust bathing	The bird lying on the ground and vigorously rubbing the lower part of the body against the litter
Resting behavior	1-Sitting	The bird lying on one side with opened eyes
	2- Idling	Quails were standing and not engaged in any activity
	3- crouching	Bird lying on the ground with closed eyes
	4- Huddling	Birds gathered with each other's
Activity	1-walk	In which the bird moves by taking one or more steps forward
	2- Run	In which the bird run from one point to another
	3- Jump	Bird jumps up from the ground
	4- Fly	Bird flies for short distance
Aggression	Feather pecking	Birds chasing and/or pecks the feather of another birds
Other behavior	1- Object pecking	Birds pecking any object
	2- Litter pecking and scratch	Birds pecking and scratch the floor

Table 3 Effect of environmental enrichments on behavioral patterns of Japanese quail.

Least square means (±SE) with different superscript letters in the same row are significantly different at $P \leq 0.05$.

Frequency of the behaviors	Environmental enrichments			
	control group	Mirror group	Music group	*P* - value
Feeding	7.54±0.70^{b}	9.25±0.70^{ab}	10.75±0.70^{a}	0.008
Drinking	6.41±0.62^{a}	7.08±0.62^{a}	7.12±0.62^{a}	0.664
Litter scratch and pecking	1.50±0.42^{a}	2.75±0.42^{a}	2.12±0.42^{a}	0.128
Feather preening	7.50±0.53^{c}	9.12±0.53^{b}	13.29±0.53^{a}	< 0.001
Head scratch with leg	2.29±0.45^{b}	4.04±0.45^{a}	4.12±0.45^{a}	0.008
Body shaking	2.54±0.46^{b}	3.45±0.46^{b}	5.58±0.46^{a}	< 0.001
Wing and leg stretch	2.83±0.47^{b}	3.66±0.47^{b}	6.00±0.47^{a}	< 0.001
Open wing	2.16±0.47^{b}	2.83±0.47^{b}	5.95±0.47^{a}	< 0.001
Wing flapping	0.33±0.28^{b}	0.95±0.28^{ab}	1.75±0.28^{a}	0.004
Dust bathing	0.37±0.29^{b}	1.58±0.29^{a}	0.79±0.29^{ab}	0.018
Head stretch	1.33±0.40^{c}	5.37±0.40^{a}	3.33±0.40^{b}	< 0.001
Leg stretch	0.83±0.28^{b}	2.29±0.28^{a}	1.66±0.28^{a}	0.003
Head shaking	1.20±0.31^{a}	1.91±0.31^{a}	1.95±0.31^{a}	0.175
Wing stretch	0.83±0.27^{a}	1.12±0.27^{a}	1.70±0.27^{a}	0.073
Walk	11.62±1.37^{a}	12.29±1.37^{a}	11.25±1.37^{a}	0.863
Run	2.04±0.67^{a}	2.41±0.67^{a}	2.20±0.67^{a}	0.926
Jump	1.00±0.44^{a}	2.25±0.44^{a}	1.37±0.44^{a}	0.136
Fly	0.62±0.25^{b}	0.16±0.25^{b}	1.62±0.25^{a}	0.001
Idling	6.29±0.90^{c}	9.87±0.90^{b}	12.45±0.90^{a}	< 0.001
Crouching	3.37±0.80^{b}	6.41±0.80^{a}	3.83±0.80^{b}	0.020
Sitting	4.83±0.57^{a}	6.62±0.57^{a}	5.62±0.57^{a}	0.093
Huddling	0.62±0.45^{b}	2.12±0.45^{a}	0.45±0.45^{b}	0.022
Aggression	2.33±0.31^{a}	1.33±0.31^{b}	0.66±0.31^{b}	0.002
Object pecking	1.25±0.35^{b}	4.70±0.35^{a}	1.58±0.35^{b}	< 0.001

4. DISCUSSION

The current study revealed that E.E. improved most of the quail's behavioral patterns and reduced aggression. Environmental enrichment enhanced quail's welfare by decreasing stereotypic behaviors and improving rest (Laurence et al., 2014). Feeding behavior increased significantly in E.E. groups than in control one, especially in the music group, due to the auditory enrichment increased tolerance to stress improving feeding. Results were in line with the findings of Cabaral et al. (2017), who mentioned that classical music improved feeding habits in Japanese quail. Similarly, Campo et al. (2005) and Davila et al. (2011) reported that layers provided with reggae music reduce stress, thus improving feed intake.

Table 4 Effect of environmental enrichments on live body weight of Japanese quail.

Body weight (g)	Environmental enrichments			
	control	mirror	music	*P* - value
4th week (Initial body weight)	139.33±2.34^{a}	133.00±2.34^{a}	136.00±2.34^{a}	0.167
5th week	186.66±3.00^{a}	184.66±3.00^{a}	185.66±3.00^{a}	0.895
6th week	219.66±3.35^{a}	218.00±3.35^{a}	221.00±3.35^{a}	0.819
7th week	235.66±4.04^{a}	239.00±4.04^{a}	245.00±4.04^{a}	0.261
8th (Final body weight)	250.33±4.70^{a}	256.00±4.70^{a}	260.33±4.70^{a}	0.325

Least square means (±SE) with different superscript letters in the same row are significantly different at $P \leq 0.05$.

Regarding comfort behavior, Environmental enrichment significantly affected the comfort behavior of quails, which may be attributed to the attractive effect of music and mirror in Japanese quails. Using some objects for
E.E. purposes had an effect, potentially increasing the welfare of the quail (Taskin and Karadavut, 2017). Unlike Konkol et al. (2020), who stated that cage enrichment had no influence on the hens' comfort behaviors.

Environmental enrichment improved most of the resting behaviors as sitting, idling, and crouching. The same was observed by Laurence et al. (2014), who recorded that quail housed in enriched cages rested more than quail housed in non-enriched cages. In the current study, E.E. did not affect significantly in activity except flying which increased in the music group than the two other groups, maybe as the quail fly to reach the source of sound. This finding did not agree with Laurence et al. (2014) who recorded higher locomotor activity in E.E. quail than non – E.E. quail. Also, an increase in activity and/or mobility behaviors during the enrichment phase was also recorded in crimson-bellied conures (Van Hoek and King, 1997), blue-fronted parrots (Melo, et al., 2014), and white-eyed parakeets (Telles et al., 2015). These results support the idea of the importance of E.E. to increase activity since the activity is good for health and improves quality of life.

Table 5 Effect of environmental enrichments on body weight gain of Japanese quail.

Body weight gain (g)	Environmental enrichments			
	control	mirror	music	*P* - value
4-5th week	47.33±3.98^{a}	53.00±3.98^{a}	49.66±3.98^{a}	0.623
5-6th week	33.00±3.78^{a}	33.33±3.78^{a}	35.33±3.78^{a}	0.896
6-7th week	16.00±4.81^{a}	21.00±4.81^{a}	24.00±4.81^{a}	0.532
7-8th week	14.66±4.91^{a}	17.00±4.91^{a}	15.33±4.91^{a}	0.943

Table 6 Effect of environmental enrichments on hematological parameters and hormonal analysis of Japanese quail.

Item	Environmental enrichment			
	control	mirror	music	P - value
Red cell count (RBC) × 10^{12}/L	5.67±0.20^a	5.52±0.20^a	5.32±0.20^a	0.495
Hemoglobin (Hb) g/dl	16.48±0.58^a	16.08±0.58^a	15.45±0.58^a	0.466
Packed cell volume (PCV) %	47.64±1.70^a	47.45±1.70^a	44.66±1.70^a	0.398
Mean cell volume (MCV) fl	84.05±0.13^a	84.06±0.13^a	84.02±0.13^a	0.979
Mean cell Hemoglobin (MCH) pg	29.00±0.11^a	28.98±0.11^a	28.98±0.11^a	0.987
Mean cell hemoglobin conc.(MCHC) g/dl	34.60±0.00^a	34.60±0.00^a	34.60±0.00^a	0.999
Total leukocyte count × 10^9/L	1.69±0.23^b	1.54±0.23^b	2.58±0.23^a	0.008
Platelets count × 10^9/L	3994±300.26^a	3555±300.26^a	2665±300.26^b	0.013
Differential Leukocyte count (Relative %)				
Neutrophil				
Lymphocytes				
Monocytes	28.00±1.76^a	25.70±1.76^a	26.30±1.76^a	0.638
Eosinophils				
Basophils	65.40±2.00^a	67.90±2.00^a	67.00±2.00^a	0.675
	4.60±0.22^a	4.90±0.22^a	4.60±0.22^a	0.561
	1.30±0.17^a	1.20±0.17^a	1.50±0.17^a	0.474
	0.70±0.16^a	0.40±0.16^a	0.60±0.16^a	0.413
Cortisol ug/dl	0.04±0.01^a	0.029±0.01^a	0.05±0.01^a	0.205

In the current study E.E. reduced the aggression between quails, especially in music group, which may result from the relaxation effect of music on birds. In the same line with the current findings, E.E. applied on Beijing ducks, caused a reduction in undesired behaviors compared to ones, on which E.E. wasn't applied (Colton and Fraley, 2014). It was reported that E.E., reduced pecking behavior in laying hens (Daigle et al., 2014). Unlike the current study, using a different type of music did not affect feather pecking behavior among Japanese quails ($p>0.05$) (Cabaral et al., 2017). Also, Miller and Mench (2006) found no effect of different types of enrichment on the aggressive pecking of Japanese quail.

Our results revealed that E.E. affected the body weight of quail at the 6th week of age as quail enriched with music showed a higher body weight than other groups till the end of the study; environmentally enriched quails showed higher body weight than control quails even this difference in body weight was not significant. Environmental enrichment improved the body weight gains of quails, while the difference in body weight gain between enriched and non-enriched quails was not significant. These results may be attributed to the favorable effect of enrichment on the physical and physiological condition that improves feeding habits and feed intake. In agreement with the current study, quails which provided with classical music showed higher final body weight than quails that were not provided with music (Cabaral et al., 2017). Also, layers that were provided with classical had higher feed intake and body weight (Davila et al., 2011). In the same line with the current results, Korsos et al. (2019) recorded that the body weight of young meat chickens subjected to music was higher than the body weight of control chickens not subjected to music while this difference was not significant. Contrary to the current study, E.E. did not affect B.W.s of quail during the experiment (Laurence et al., 2014). There were no significant effects of environmental enrichment on the body weight of broilers (Altan et al., 2013).

Environmental enrichment showed no significant effect on all hematological parameters except for total leukocyte count as the highest count was observed in the music group. Cortisol concentration was not significantly affected by environmental enrichment, which may be attributed to the proper management offered to all groups, as no stress caused significant difference in cortisol concentration between groups. In quail, E.E. had a positive effect on the immune parameters of quail as submitting birds to E.E. can effectively improve the immune response and may alleviate the stress effect (Nazar and Marin, 2011). The same result was obtained by Korsos *et al.* (2019) who found that corticosterone concentration was lower in the control group than music provided group in young meat chickens. Like the current findings, E.E. had no significant effect on leucocyte components (basophils, eosinophils, heterophils, lymphocytes, monocytes) (Altanet al., 2013) of broilers.

5. CONCLUSION

Environmental enrichments of Japanese quail houses improved the behavioral patterns.

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