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Effects of betaine as feed additive on behavioral patterns and growth performance of Japanese quail.

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ABSTRACT

This study was conducted to investigate the effect of dietary betaine supplementation on behavioral patterns and growth performance of Japanese quail. A total number of 200 healthy unsexed quail chicks with an average body weight of 51.80±0.66 g 2 weeks' old were randomly assigned to 2 groups (100 birds each), and each group was subdivided into five replicates (20 birds each) according to the diet. The first group was fed on a basal diet without any supplementation (control group), while the second group was fed on a basal ration supplemented with betaine hydrochloride at a level of 1g/kg diet (betaine group). Behavioral patterns and growth performance (body weight, body weight gain, feed intake, and feed conversion ratio) were evaluated for three weeks. The obtained results revealed that betaine supplementation had no significant effect on behavioral patterns except for crouching behavior which showed higher frequency (P=0.023) in the betaine group; also, betaine supplementation had no significant effect on body weight, body weight gain, feed intake, and feed conversion ratio (P>0.05) of Japanese quail. It was concluded that dietary betaine supplementation insignificantly improved the final body weight, body weight gain, and feed conversion ratio of Japanese quail.

1. INTRODUCTION

Poultry has become the most consumed meat in the world recently (Rashid et al., 2020). Quails have been widely and intensively farmed owing to their small body size, rapid growth rates, and high egg production; besides, their meat has low fat and cholesterol content, so it's recommended for human consumption (Kaye et al., 2017). Recently, using of natural plant extracts in animal science has taken special attention. Betaine is a trimethyl derivative of the amino acid glycine, which is present naturally in plants such as sugar beet, wheat, and lucerne meal (Chendrimada et al., 2002). It has been widely used as a dietary feed additive in animal nutrition (El-Shinnawy, 2015).

Betaine has two important metabolic functions; it acts as a methyl group donor, which has a vital role in the metabolism of protein and energy, in addition to its proper osmotic properties, which aid in maintaining cellular osmolarity (Ratriyanto et al., 2009). Growing chicks fed a diet supplemented with 0.1% and 0.2% betaine could improve live body weight, body weight gain, feed conversion ratio, and mortality rates (Nofal *et al.*, 2015). Also, it can improve the growth, feed efficiency, and breast yield of broiler chickens (Rama Rao et al., 2011). Therefore, this study was conducted to evaluate the effect of a betaine-supplemented diet on behavioral patterns and growth performance of Japanese quail.

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 12-04-22) in September 2021.

2.1. Birds and management:

A total number of 200 unsexed healthy Japanese quail chicks two weeks old with an average body weight of 51.80±0.66 g was purchased from a private farm in Gharbia province, Egypt. Birds were housed in two symmetrical battery cages. Each one had five rows with two pens in each row; each pen's dimensions were 40cm length × 30cm width × 30cm height.

The experimental diets were formulated according to the NRC (1994). The experimental diet was formulated from yellow corn, soybean meal 46% CP, Corn gluten meal, soya oil, monocalcium phosphate, limestone, sodium chloride, sodium bicarbonate, L lysine, Dl methionine, and broiler concentrate. Deficient nutrients were supplemented using DL-methionine and mineral and vitamin premix. The energy was augmented by adding oil. The diet was mixed to contain 23% protein and 3000 Kcal, ME/kg, and fed all over the experiment. Feed and water were offered ad libitum. The temperature and relative humidity were recorded daily. The average environmental temperature was 27.22±1.81ºC, and the average relative humidity was 60-70%.

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2.2. Experimental design:

A total number of 200 healthy unsexed quail chicks with an average body weight of 51.80±0.66 g at two weeks were randomly assigned to 2 groups (100 birds each), and each group was subdivided into five replicates (20 birds each) according to the diet during the growing period. The first group was fed on a basal diet without any supplementation as control, while the second group was fed on a ration supplemented with betaine hydrochloride at a level of 1g/kg diet.

2.3. Behavioral observations:

Each group's behaviors were recorded three days weekly, two times per day in the morning (9.00 -10.00 am) and in the afternoon (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 five 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), resting behaviors (idling, crouching, and sitting), aggression (feather pecking) and other behavior (object pecking). The behavioral patterns were recorded as described by (Dawkins, 2004) and presented in table (1).

Table 1 The behavioral patterns of Japanese quail.

Observed behaviors		Description
Ingestive behavior	1-Feeding	Head extended towards the 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 their 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 the body
	10- Open wings	Both wings raise away from the body
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
Activity	walk	The bird moves by taking one or more steps forward
Aggression	Feather pecking	Birds chasing and/or pecks the feather of another birds
Other behavior	Object pecking	Birds pecking the wires of the cage

2.4. Growth performance parameters:

2.4.1. Body weight and body weight gain:

Five marked birds from each replicate were weighed weekly using a digital balance to examine the impact of various diets on quail growth performance. The weekly live body weight gain was determined as the difference in body weight between two successive weeks. (Yalçin et al., 1998).

2.4.2. Average feed intake:

Feeds were regularly supplied to chicks at 8:00 am, and the daily feed consumption was determined by subtracting the weight of feed supplied and the remaining part, then divided by the number of birds in each group (Amer et al., 2018).

2.4.3. Feed conversion ratio (FCR):

The feed conversion ratio was calculated weekly by dividing the weekly feed intake by the weekly body weight gain (Kamran et al., 2008).

FCR= Feed intake (g) per bird/ Body weight gain (g) per bird.

2.5. Statistical analysis:

The SPSS software version 22 was used to analyze the data. During the growing phase, behaviors and growth performance parameters were analyzed using independent t-test. 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 dietary betaine supplementation on the behavioral patterns of Japanese quail chicks during the growing period is presented in table (2).

Behaviors	Treatments		
	Control group	Betaine group	*P* - value
feeding	9.25±1.01[a]	11.54± 1.20[a]	0.152
drinking	4.54±0.74[a]	5.75±0.70[a]	0.242
Feather preening	8.41±0.99[a]	8.87±1.07[a]	0.755
Open wing	2.37±0.33[a]	2.50±0.35[a]	0.801
Wing and leg stretch	2.20±0.32[a]	2.50±0.30[a]	0.517
Head scratch with leg	1.20±0.23[a]	1.00±0.28[a]	0.577
Wing stretch	0.04±0.04[a]	0.08±0.05[a]	0.561
Body shaking	0.20±0.14[a]	0.04±0.04[a]	0.286
Head shaking	0.00±0.00[a]	0.04±0.04[a]	0.328
Wing flapping	0.04±0.04[a]	0.04±0.04[a]	1.000
Head stretch	00±00[a]	00±00[a]	0
Leg stretch	0.33±0.17[a]	0.12±0.06[a]	0.282
walk	1.54±0.41[a]	1.25±0.38[a]	0.606
idling	2.66±0.36[a]	3.12±0.51[a]	0.472
crouching	3.95±0.62[b]	6.41±0.82[a]	0.023
sitting	0.70±0.29[a]	0.95±0.44[a]	0.645
aggression	0.62±0.50[a]	0.58±0.33[a]	0.945
Object pecking	0.08±0.08[a]	0.12±0.12[a]	0.783

Table 2 Effect of dietary betaine supplementation on behavioral patterns of Japanese quail chicks during the growing period.

The frequency of feeding behavior was 9.25±1.01 and 11.54± 1.20, while the frequency of drinking was 4.54±0.74 and 5.75±0.70 for control and betaine groups, respectively. The obtained results revealed that betaine supplementation in diet did not significantly affect ($P > 0.05$) the ingestive behaviors (feeding and drinking).

The frequency of feather preening was 8.41±0.99 and 8.87±1.07 while body shaking was 0.20±0.14 and 0.04±0.04 besides open wing was 2.37±0.33 and 2.50±0.35 for control and betaine group, respectively. The frequency of wing and leg stretch was 2.20±0.32 and 2.50±0.30 while head scratch with leg was 1.20±0.23 and 1.00±0.28 also, wing stretch was 0.04±0.04 and 0.08±0.05 for control and betaine group, respectively. The frequency of head shaking was 0.00±0.00 and 0.04±0.04 while wing flapping was 0.04±0.04 and

0.04±0.04 also, leg stretch was 0.33±0.17 and 0.12±0.06 for control and betaine group, respectively. The comfort behaviors were not affected by betaine supplementation (*P*> 0.05).

The frequency of walk behavior was 1.54±0.41 and 1.25±0.38 for the control and betaine groups, respectively. The frequency of idling behavior was 2.66±0.36 and 3.12±0.51 while crouching behavior was 3.95±0.62 and 6.41±0.82 besides sitting was 0.70±0.29 and 0.95±0.44 for control and betaine group, respectively. The activity (walk) and resting behaviors (idling and sitting) had no significant differences (*P*> 0.05) between the groups, while crouching behavior showed significantly higher frequency (*P*= 0.023) in the betaine group.

The frequency of aggression behavior was 0.62±0.50 and 0.58±0.33 while object pecking was 0.08±0.08 and 0.12±0.12 for the control and betaine group, respectively. No significant differences (*P*> 0.05) between the groups were found in aggression (feather pecking) and other behavior (object pecking).

3.2. Growth Performance during the growing period:

3.2.1 Live body weight:

As shown in table (3), the initial body weight of quail chicks was 52.25±1.10 and 50.75±1.03 for the control and betaine groups, respectively. In contrast, the body weight in 3rd week for the control and betaine groups was 94.50±2.17 and 95.75±1.67, respectively. The body weight in 4th week for the control and betaine groups was 151.75±2.50 and 149.00±2.57, respectively. Also, the body weight in the 5th week was 192.50±3.19 and 196.25±2.59 for control and betaine groups, respectively. Although Japanese quail chicks fed 0 and 1g/kg betaine-supplemented diet showed no significant differences (*P*> 0.05) in body weight during the growing period, the final body weight was higher in quails fed betaine-supplemented diet than the control group.

3.2.2. Body weight gain:

The effect of dietary betaine supplementation on the body weight gain of Japanese quail chicks is shown in table (4). The body weight gain in the 2nd-3rd week for the control and betaine group was 42.25±1.10 and 45.00±2.08 and in the 3rd-4th week was 57.25±2.75 and 53.25±1.10 while at 4th-5th week was 40.75±5.29 and 47.25±1.88, respectively. There were no significant differences (*P*> 0.05) in body weight gain on a weekly basis between the betaine-supplemented diet and the control groups during the growing period. The final body weight gain during growth was insignificantly higher in the betaine group than in the control group.

3.2.3. Feed intake:

Data presented in table (5) showed that the feed intake in 3rd week for the control and betaine group was 16.67±0.57 and 15.74±0.57 while in 4th week was 26.22±0.57 and 25.42±0.57 and in 5th week was 26.78±0.57 and 26.55±0.57, respectively. The data cleared that supplementation of betaine in diet had no significant differences (*P*> 0.05) from the control group in feed intake during the growing period.

3.2.4. Feed conversion ratio:

The effect of dietary betaine supplementation on the feed conversion ratio of Japanese quail chicks is given in table (6). Data showed that the FCR at 3rd week was 0.39±0.57 and 0.34±0.57 while FCR in the 4th week was 0.45±0.57 and 0.47±0.57 and FCR in the 5th week was 0.65±0.57 and 0.56±0.57 for control and betaine group, respectively. The Feed conversion ratio was not affected by betaine supplementation in the diet during the growing period of Japanese quail chicks (*P*> 0.05).

Table 3 Effect of dietary betaine supplementation on body weight of Japanese quail chicks during the growing period.

Body weight (g)	Treatments		
	Control	Betaine	*P* - value
Initial body weight	52.25±1.10[a]	50.75±1.03[a]	0.325
3rd week	94.50±2.17[a]	95.75±1.67[a]	0.650
4th week	151.75±2.50[a]	149.00±2.57[a]	0.446
5th week	192.50±3.19[a]	196.25±2.59[a]	0.366

Table 4 Effect of dietary betaine supplementation on body weight gain of Japanese quail chicks during the growing period.

Body weight gain (g)	Treatments		
	Control	Betaine	*P* - value
2-3rd week	42.25±1.10[a]	45.00±2.08[a]	0.301
3-4thweek	57.25±2.75[a]	53.25±1.10[a]	0.249
4-5thweek	40.75±5.29[a]	47.25±1.88[a]	0.316

Table 5 Effect of dietary betaine supplementation on feed intake of Japanese quail chicks during the growing period.

Feed intake (g)/chick	Treatments		
	Control	Betaine	*P* - value
3rd week	16.67±0.57[a]	15.74±0.57[a]	0.318
4th week	26.22±0.57[a]	25.42±0.57[a]	0.383
5th week	26.78±0.57[a]	26.55±0.57[a]	0.792

Table 6 Effect of dietary betaine-supplementation on feed conversion ratio (FCR) of Japanese quail chicks during the growing period.

feed conversion ratio (FCR)	Treatments		
	Control	Betaine	*P* - value
3rd week	0.39±0.57[a]	0.34±0.57[a]	0.954
4th week	0.45±0.57[a]	0.47±0.57[a]	0.982
5th week	0.65±0.57[a]	0.56±0.57[a]	0.918

Least square means (±SE) with different superscripts letters in the same row are significantly different at p≤0.05.

4. DISCUSSION

Dietary betaine supplementation had no significant effect on behaviors of Japanese quail during growth, including feeding, drinking, object pecking, head-scratching with leg, head shaking, body shaking, wing and leg stretch, open wing, wing stretch, leg stretch, feather preening, wing flapping, walk, idling, sitting and aggression while crouching behavior showed significantly higher frequency in betaine group. The results were in accordance with Mostashari-Mohases *et al.* (2017), who revealed that there was no effect of betaine supplementation on the feeding of broiler chickens. This finding disagreed with Egbuniwe *et al.* (2019), who reported that betaine supplementation at a level of 2g/kg diet enhanced feeding and water intake in Japanese quail. The current results revealed non-significant differences in growth performance (body weight, body weight gain, feed intake, and feed conversion ratio) of Japanese quail as affected by betaine supplementation, although the betaine group showed insignificantly higher final body weight and body weight gain with lower FCR than the control group. These findings may be attributed that the efficiency of any feed additive supplementation may be affected by several factors such as species and type of poultry, nutrient content of the diet, and environmental condition (Alhassani and Alshukri, 2016). In the present study, dietary betaine supplementation did not significantly affect live body weight during the growing period but insignificantly improved final body weight. The current result agreed with Egbuniwe *et al.* (2019), who observed that 2 g betaine/kg diet had no significant difference in body

weight of growing Japanese quail. Santos *et al.* (2019) recorded those levels of 0.1, 0.3 and 0.5 % dietary betaine did not have any effects on broiler body weight. Also, broiler breeders supplemented by 1, 2, and 3 g betaine/kg of diet had no significant effect on body weight (Rokade *et al.*, 2020). Furthermore, Ölmez (2021) concluded that 0.8% betaine supplementation to quail diets improved body weight. El-Shinnawy (2015) mentioned increasing in the live body weight of broilers due to the supplementation of dietary betaine at 1.0, 1.5, 2.0, and 2.5 g/kg.

Although there were no significant differences between the control and the dietary-treated group for body weight gain during the growing period, the final body weight gain was insignificantly higher in the betain group. These results in the same line with the finding of Ratriyanto *et al.* (2021) which suggested that a diet supplemented with 0.12% betaine had no significant effect on average body weight gain in Japanese quail. Also, Rasul *et al.* (2019) indicated that 0.7g/kg supplemented betaine in a quail's diet could improve body weight gain. Besides, Ölmez (2021) found that Japanese quail body weight gain could be achieved by adding 0.8% betaine to their diet. Also, Chand *et al.* (2017) and Shakeri *et al.* (2018) noticed that adding betaine to a broiler diet at a level of 1.0 and 2 g/kg could improve weight gain. Moreover, 0.5 g/kg betaine supplement diet could improve weight gain in broilers (Zhan et al., 2006**).** In contrast to the present study, Ahmad and Ismail (2017) reported that 0.1, 0.2, and 0.3 g betaine /kg diet did not affect the final body weight gain of broilers.

Dietary supplementation had no significant differences in feed intake during the quail growing period. Similar to the present results, Ratriyanto *et al.* (2021) reported that a diet supplemented with 0.12% betaine did not significantly affect quail feed intake. Likewise, Sakomura *et al.* (2013) demonstrated that dietary supplementation of betaine 0.05% and 0.075% did not significantly affect feed intake in broiler chicken. Similarly, Uzunoğlu and Yalçin (2019) reported that a diet supplemented with 0.12% betaine did not affect the feed intake of broilers. These results disagreed with the findings of Ratriyanto and Prastowo (2019), which concluded that quails fed a diet with 0.12% betaine significantly increased feed intake. At the same time, Haldar *et al.* (2015) observed that feed intake in broilers improved parallel with the betaine concentration. Also, Egbuniwe *et al.* (2019) observed that quails at the age of 5-8 weeks old fed on 2 g betaine/kg consumed more feeds than the control group. Additionally, Ölmez (2021) indicated that quails feed consumption increased by adding 0.8% betaine to their diet. Moreover, Ratriyanto *et al.* (2017) found that a higher feed intake was observed in quails fed a diet with 0.06 % and 0.12 % betaine.

Non-significant differences were found in the feed conversion ratio between all treated groups during the growing period except for the final FCR, which insignificantly improved in the betaine group. The current results are in concur with Hassan *et al.* (2005), who noticed that no significant differences were found in broilers at 5-8 weeks of age fed a diet with 0.0, 0.072, and 0.144% betaine. In addition, Fu *et al.* (2016) found that betaine had no impact on FCR of broiler chicken. Also, Ratriyanto *et al.* (2021) said that quails fed a diet with 0.12% betaine had no significant differences FCR. Moreover, Rasul *et al.* (2019) found that 0.7g/kg supplemented betaine in a quail's diet showed a better feed conversion ratio. Also, Attia *et al.* (2009) recorded that betaine at 0.5 and 1 g/kg diet improved FCR in slow-growing broilers. Similarly, Ratriyanto and Prastowo (2019) recorded that 0.12% betaine in diet enhanced quail FCR. Besides, Chand *et al.* (2017) and Shakeri *et al.* (2018) suggested that broilers fed a diet with betaine at a level of 2 g/kg improved FCR. On the other hand, Hassan *et al.* (2005) stated that broilers during the first four weeks of age fed a diet with 0.0, 0.072, and 0.144% betaine improved FCR.

5. CONCLUSION

From these results, the dietary betaine supplementation at a level of 1g/kg diet insignificantly improved the final body weight, body weight gain, and feed conversion ratio of Japanese quail.

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