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Research Article

Effect of lysine on growth performance and activity of lipase and amylase in domestic quail, *Coturnix japonica* diets

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Abstract: This work aimed to study the effect of dietary amino acid lysine supplementation on growth performance and activity of the digestive enzymes in the intestine in quail diets. A total of 180 one-day-old Japanese quail were divided into four groups, each with 45 chicks and 3 replications. The experiment was performed for 42 days. Group one was control, and those 2, 3 and 4 were fed a basic diet with amino acid lysine added at concentrations of 0.5, 0.9 and 1.03%, respectively. The results showed a significant improvement in the growth performance in terms of body weight and feed conversion ratio in quail birds. A significant activity of the intestinal digestive enzymes of amylase and lipase was also observed in the treated birds. We concluded that dietary lysine supplementation at a rate of 0.9 to 1.03% enhances the growth performance and as the activity of digestive enzymes of amylase and lipase in raising quail birds.

Keywords: Lysine, Quails, Weight, Amylase, Lipase.

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Introduction

Poultry is one of the important sources of animal protein. Due to the unique characteristics of quail (*Coturnix japonica*) meat, the demand for this protein source has increased recently because of its high nutritional value (Embury 2000; Nahashon et al. 2004). Amino acids such as lysine play an important role in the metabolism of birds when consumed, which promotes improved product performance and bird health (Wu et al. 2014; Liao et al. 2015). In poultry, adding corn and soybean with the amino acid lysine is a common practice, and therefore there is a significant effect when on the growth performance and carcass quality of birds (Zhai et al. 2016). When Lysine is added at high levels to the bird's diet, the secretion of insulin is stimulated, and the absorption of lysine increases and therefore, protein is created in the body tissues (Sturkie 1986; Murray et al. 1998). Mehri et al. (2010) conducted a trial for broilers from 2 to 4 weeks and they estimated the requirements for digestible lysine using different levels.

Increased breast meat is usually due to the higher nutritional density of amino acids resulting in more lean muscle tissue rather than collagen (Corzo et al. 2010). Zhai et al. (2012) showed that the consumption of lysine in high proportions above the need for nutritional requirements led to an increase in the growth of breast muscle. The use of lysine at high levels in bird diets, exceeding the recommended limit, causes the deposition of fat in the abdomen, breast and thigh muscles, an increase in the rate of body weights, and the efficiency of food conversion of breast meat (El-Wahab et al. 2015; Zhai et al. 2016). Also, recent studies in birds have indicated that supplemental lysine can stimulate their immune system (Faluyi et al. 2015; Saleh et al. 2018). Hence,

Table 1. The used feed ingredients.

Ingredients (%)	Diet from 1 to 42 day
Yellow corn	53.50
Soybean meal 44%	37.20
Corn gluten meal	5.65
Plant oil	0.60
Dicalcium phosphate	0.90
calcium carbonate	1.27
Vitamins and minerals	0.3
Salt	0.36
Methionine	0.102
Lysine	0.118
The total (Kg)	100%

Table 2. Chemical analysis of the components of the diet.

Parameter (%)	Diet from 0 to 42 day
Crude protein	24.01
ME. cal/Kg feed	2905
C/P ratio	142.16
Ca	0.80
Phosphor (available).	0.30
Lys.	1.30
Methio.	0.50
Cyst.	0.40

*NRC 1994

the current study aimed to investigate the lysine requirements to achieve maximum performance, such as increased body weight and feed content ratio and lipase and amylase activity in the feed of domesticated quail in Iraq.

Material and Methods

A total of 180 one-day-old quail birds were used in the study. They were divided into 4 groups randomly, each group containing 3 replicates i.e. 15 chicks / replicate. The lysine was added at 3 levels, 0.5, 0.9 and 1.03%, and designed a control group without lysine addition. The duration of the experiment was 6 weeks; feed and water were provided *ad libitum*. Body weight was measured weekly, and feed intake was measured daily. The ration was prepared according to the basic diet during the experiment to provide all other nutrients except for lysine, according to NRC (1994).

Performance: Data were recorded weekly for all experimental birds. The weekly body weights of the birds were measured according to Al-Fayyad & Nagy (1989), and the feed consumed and conversion efficiency were calculated according to Al-Zubaidi (1986).

Enzyme measurements: According to Nitsan et al. (1991), the contents of the intestine parts (duodenum, jejunum and ileum) were collected from the dissected birds, weighed and stored in equal volumes in a sterile saline solution. Then they were transferred into the centrifuge separately, and their supernatant liquids were poured and used to determine the activities of amylase and lipase enzymes.

Data Analysis: According to Duncan (1955), all data were subjected to analysis of variance (ANOVA) by a completely random design (CRD) using SAS.

Results

The results of the effect of adding lysine on body weight, feed consumed, and efficiency of food conversion are shown in Tables 3, 4, and 5. No significant differences were found in weight between treatments. The results showed significant differences in weekly weights and food conversion ratio in the treated groups compared to the control

Table 3. Impact Lysine in bird diets on body weight (g).

Groups	Age (week)					
Lysine (%)	First	Second	Third	Fourth	Fifth	Sixth
0	24.30±0.27	54.87±0.78	90.58±2.09^{b}	123.02±2.37	160.88±2.93	200.07±3.64
0.5	24.27±0.26	55.77±0.79	95.68±2.2^{ab}	125.62±2.42	164.07±2.98	203.19±3.69
0.9	24.31±0.26	55.67±0.78	95.58±2.19^{ab}	120.42±2.31	160.47±2.91	201.58±3.66
1.03	24.27±0.25	57.50±0.80	98.81±2.26^{a}	123.87±2.37	167.33±3.03	207.71±3.77

*Row contain (a, b, c) with significantly different at $P \leq 0.05$.

Table 4. Effect of lysine in bird diets on feed intake (g).

Groups	Age (week)				
Lysine (%)	Second	Third	Fourth	Fifth	Sixth
0	65.72±3.43^{b}	85.40±1.40	94.41.12^{a}	116.07±1.91^{a}	157.64±1.50^{b}
0.5	69.77±3.64^{b}	88.01±1.44	92.41±1.09^{ab}	110.04±1.81^{b}	169.37±1.61^{a}
0.9	68.88±3.59^{b}	86.46±1.41	87.26±1.02^{b}	116.15±1.91^{a}	160.70±1.52^{ab}
1.03	82.21±4.28^{a}	84.63±1.38	88.57±1.03^{b}	117.80±1.93^{a}	157.63±1.49^{b}

*Row contain (a, b, c) with significantly different at $P \leq 0.05$.

Table 5. Effect of lysine in bird diets on conversion efficiency.

Groups	Age (week)				
Lysine (%)	Second	Third	Fourth	Fifth	Sixth
0	1.10±0.05 ^{b}	2.06±0.09	2.15±0.02	2.19±0.04	2.15±0.01
0.5	1.15±0.04^{ab}	2.03±0.04	2.16±0.04	2.15±0.02	2.18±0.01
0.9	1.14±0.03^{b}	1.99±0.02	2.14±0.02	2.19±0.01	2.18±0.02
1.03	1.31±0.07 ^{a}	1.99±0.02	2.09±0.01	2.14±0.01	2.18±0.04

*Row contain (a, b, c) with significantly different at $P \leq 0.05$.

Table 5. Effect of lysine in bird diets on activity of amylase and lipase enzyme (Unit/dl).

Lysine (%)	Amylase (U/dl)			Lipase(U/dl)		
	Duodenum	Jejunum	Ilium	Duodenum	Jejunum	Ilium
0	1.850^{b}	1.460^{c}	2.411^{b}	7.915	8.553^{bc}	9.162^{b}
0.5	2.515^{a}	2.485^{a}	2.237^{b}	9.389	9.503^{b}	8.921^{b}
0.9	2.657^{a}	1.620^{bc}	2.427^{b}	9.670	9.727^{b}	9.805^{ab}
1.03	2.670^{a}	2.020^{b}	2.887^{a}	8.980	11.577^{a}	10.654^{a}

*Row contain (a, b, c) with significantly different at $P \leq 0.05$.

group no differences were found between treatments (Tables 3 and 5). In the third week, the group with 1.03% lysine/kg showed a significant weight gain compared to the control one. Based on the results, in 0.9, 0.90 and 1.03% lysine/kg treatments, no significant improvements were observed in feed conversion efficiency from the second to sixth weeks.

The effect on the intestinal mucosa can be attributed to the increase in the height of the villi in the first week of the bird's life in the 0.50% lysine/kg group, which had a higher significant effect than other groups in the fourth week. In the fifth week, there was no significant increase in feed intake of the treated group of 0.50% compared to the control one, but both other groups (0.9 and 1.03%) and the control group had a lower feed conversion compared to the treated groups in the sixth week ($P \leq 0.05$).

The results indicated an effect on the activity of amylase and lipase enzymes in the small intestine. The activity of duodenal amylase was lower in the control group. The same was true in the jejunum area, although there were no significant effects found between the control group and 0.50% treatment. Activity in the ileum was found significant only in the 1.03% group. The results also indicated that

lipase activity was slightly affected by adding lysine. A significant difference was observed in 1.03% treatment in both the jejunum, ileum and control groups (Table 6).

Discussion

Our results showed a higher growth performance by administration of the amino acid lysine; however, Ross (2007) and Cengiz et al. (2008) showed that the excess amount of lysine reduces the body weight in birds. But, our results showed that the quail birds with a diet containing higher lysine had improved productive performance and growth (Ciftci & Ceylan 2004; Abbasi et al. 2014; Sigolo et al. 2017). These results agreed with Mehri et al. (2013) who indicated an increase in the nutritional levels of digestible lysine leads a significant weight gain and feed consumption rate in birds. 95% increase in body weight can cause by increasing digestion lysine levels (Mehri et al. 2010). The need for lysine was more in conversion efficiency than weight gain (Baker et al. 2002; Kidd et al. 2005).

In broilers, low levels of lysine supplementation reduce protein accumulation and increase fat accumulation (Moran & Bilgili 1990). The effect of lysine on the efficiency of feed conversion can be explained by the increased energy expended for building body structure. Low weight and conversion ratio on birds fed lysine revealed a low relationship between the administration of lysine and growth performance. The lower weight and higher feed conversion efficiency at lower lysine concentrations probably is caused by the reduced supply of amino acids. Hence, it is crucial to provide quail diets containing all the requirements, particularly essential amino acids, for protein synthesis (Sklan & Plavnik 2002).

The treatments' body weights and food conversion efficiency were attributed to the thickness of the circular muscle and mucous layers of the duodenum, which led to increased transporting of nutrients from the intestine into the bloodstream. In addition, the decreased height and width of the villi of the treated groups in contrast to the villous area can lead to better absorption due to containing a larger surface area.

The lysine contributes to the secretion of growth hormone, insulin-like growth factor-I (IGF-I) and the modulation of bone growth via differentiation of osteoporosis and collagen synthesis. Sakomura & Coon (2003) and Nonis & Gous (2008) showed a trend towards the increased activity of enzymes (amylase and lipase) in all parts of the small intestine with supplemental lysine intake, which improves the productive performance of birds by altering metabolism. The beneficial effect of the amino acid lysine on the re-absorption of many minerals with catalytic roles in the birds, dietary lysine supplementation of 0.9 up to 1.03% in quails has enhanced growth performance in the treated quail birds. As conclusion, our findings revealed that growth performance and amylase and lipase enzyme activity are improved by dietary lysine supplementation at a rate of 0.9 to 1.03% in quail. Furthermore, the current study indicated that lysine has the potential for digestive enzyme activities.

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