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Effect of Dietary Lysine on the Meat Production and Behaviour of Broilers

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ABSTRACT

Hubbard broilers were studied to investigate the influence of lysine on meats production and behavior performance. Total 300 day old chicks were divided into six groups (50 broilers each) i.e. A, B, C, D, E and F, fed ration containing 0, 0.25, 0.50, 0.75, 1.00, 1.25 percent of synthetic lysine, respectively. Feed intake in broiler group A was higher (3572 g/b) ($P<0.05$). Live body weight was higher in group F (2.234 kg/b). Broiler carcass weight and dressing of group F (1.298 kg/bird and 60.83 kg/bird) was higher as compared to other groups. Feed conversion ratio (FCR) was better (1.538) in group D following by group A, B, C, E and F. Broiler breast, leg, neck, drum and head weights was higher in group D than other groups ($p<0.05$). Broiler heart was heavier in group D, while liver and gizzard were heavier in group B than other groups, whereas, spleen and crop were heavier in group A, and gall bladder was heavier in group C. Mortality ratio increased in group A ($p>0.05$). Group E broiler spent more time on feeding (8.31 min/h). Group F spent more time on drinking (4.76 min/h). Group A spent more time on standing/walking (13.38 min/h). Group A spent more time on lying/sleeping (37.37 min/h) than other groups. Hematological observations indicated that the average value for RBCs were enhanced (2.89 million/mm^3) in group D, WBC (24.78 1000/mm^3) in group C, PCV in group A (31.63 %) and serum cholesterol in group F (83.07 mg/100ml). Above findings suggest that 0.75% lysine in broiler ration is better for growth, as well as to achieve maximum net return of the farmers.

INTRODUCTION

The poultry farming has now become one of the most dynamic associated parts of agriculture throughout the world. Poultry culture in Pakistan is expanding rapidly and the rate of growth of commercial layer and broiler (meat producing) farms is phenomenal to meet the ever-increasing demand for protein through poultry meet and eggs (Sadiq, 2004; Hussain *et al*., 2015; Vistro *et al*., 2015). In the country, poultry industry has made considerable contribution to food production and plays a vital role in the national economy. Raising of poultry has virtually proven a profitable enterprise as it is the best source of cheap, palatable and nutritious food. The commercial poultry farming emerged through the combined efforts and foresight of the government and the private enterprises. Now commercial poultry production is concentrated around the large urban centers in the provinces of Sindh and Punjab and initially at Karachi, Lahore with the passage of time, it is now fairly well spread all over the country. In the province of Sindh, there are farms in Mirpurkhas, Sukkur, and Nawabshah, as well as in small cities (Alam and Khan, 2000).

Poultry sector is one of the most vibrant segments of agriculture sector of Pakistan. This sector generates employment (direct/indirect) and income for about 1.5 million people. Poultry meat contributes 19% of the total meat production, 5.8% in agriculture and 1.2% overall GDP in the country (GOP, 2014; Sohaib and Jamil, 2017). During the year of 2013-2014, the country produced 786 million day-old chicks, 588 million poultry birds which produced 987 thousand tons of meat and 14556 million eggs. The commercial poultry contributed 50.1 million layers, 40 million broilers and 722.4 million breeding stock, 10.2 million eggs, 10586 million and 875.24 thousand tons of meat. The domestic poultry contributed 82.08 million cocks, 10.7 million hens, 40 million chicken, 31.95 million eggs, 3947 million tonnes and meat 110.8

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thousand tonnes (Hussain *et al*., 2015).

Feeding strategy in poultry production has been given a new perception and dietary adjustments to broiler requirements are aimed at maximizing production performance without special concern for nutrient supply, especially protein and amino acids. A sound management of protein feeding in poultry necessitates nowadays a close adjustment of amino acid supply so as to obtain maximum output. Many factors can influence amino acid requirements of chicks at any given growing stage, i.e., dietary factors (e.g., protein level, energy level, and presence of protease inhibitors), environmental factors (e.g., disease, crowding, feeder space, and heat or cold stress), and genetic factors (e.g., sex and capacity for lean vs. fat growth) (Baker *et al*., 2002; Baker, 1997; Baker and Han, 1994). Thus, amino acid requirements cannot apply to all birds under all dietary, environmental and body composition conditions. Although amino acid requirements change due to the factors mentioned above, the ideal ratios remain similar and thus only an accurate requirement for Lys needs to be established. Lysine was chosen as the reference amino acid because it is used almost exclusively for protein accretion, it is a limiting amino acid in reduced-protein broiler diets and the analysis for Lys is uncomplicated (Baker, 1997). Thus, estimating an accurate Lys requirement is essential because it is the basis for setting requirements for all other indispensable amino acids. Certain steps need to be taken in order to accurately determine amino acid ratios to Lysine.

The lysine requirement for optimum carcass quality is probably higher than that for optimum growth rate. The response of breast meat yield to increased lysine levels suggests a potential benefit. Whether or not such a nutritional change is economically feasible is dependent on the relative value of breast meat and cost of amino acids. Considering the above hypothesis and significance of lysine as feed supplement in poultry ration, study was carried out to investigate the effect of lysine on meat production and behavior of broilers.

MATERIALS AND METHODS

In order to investigate the effect of different lysine levels on the growth and behavior of broilers, a total of 300 day-old Hubbard broilers were procured from Hyderabad, weighed and randomly divided into six groups i.e. A, B, C, D, E and F, each group containing fifty chicks. These broilers were reared in Poultry Experiment Station, Department of Poultry Husbandry Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University Tandojam. Group A broilers were kept as control, while in groups B, C, D, E and F were fed on ration supplemented with lysine at the rate of 0.25, 0.50, 0.75, 1.00 and 1.25 %, respectively.

The experimental chicks were kept for two weeks brooding period at temperature ranged between 90 to 95°F and 85 to 90°F during first and second week, respectively. Water and pre-starter feed were provided for 24 h. Initially, plate type plastic made feeders for feeding and drinkers (2-litre capacity) for watering were provided. Later the tube feeders were used for feeding the chicks. Chicks were weighed at the end of each week for six weeks by using kitchen-weighing balance. Live body weight of each group of each broiler were weighed and recorded. Broiler in different groups were kept in separate partitions and provided similar management.

Feeding and watering

The iso-nitrogenous and iso–caloric pellets of starter and finisher feed were provided to all groups of broilers during morning and evening time *ad libitum*. The unconsumed feed of all groups was collected separately and weighed at the morning time only. Furthermore, finisher feed pellet was offered to broilers of all groups from week 5 to 6 of their age. The fresh underground water was offered by using plastic bottles (5 liters capacity) daily in the morning, mid-day and evening time.

Behavior

Broiler ingestive behavior such as feeding, watering, standing/walking and lying/ sleeping were visually observed with the interval of 5 min and recorded. Ten broilers from each group were randomly selected and marked/painted with different colors on their feathers, head, neck and back of each broiler for identification and behavior recording. The behavior of each broiler (10 broilers from each group) was recorded on the prescribed proforma for 24 h twice over six weeks. Behavior of broiler was recorded by using the time sampling technique (Rind *et al*., 2004). All broilers of different groups were finally weighed, two broilers were randomly selected and slaughtered for hematology and edible and non-edible parts of the body and rest of the broiler were marketed after the completion of experimental period.

Hemocytometer and Natt and Herrick's solution was used for the counting of RBC and WBCs. To determine the packed cell volume (PCV), blood was filled with micro-hematocrit tube having ammonium heparin and centrifuged at 15,000/g for 3 min Autoanalyzer was used to determine cholesterol level (Vistro *et al*., 2019).

Data analysis

The collected data was tabulated and analyzed by using Minitab statistical package under General Linear

Model (GLM).

RESULTS

Feed intake

Feed intake was significantly (P<0.01) different in groups A, B, C, D, E and F fed on ration supplemented with various level of lysine with average feed intake of 3572, 3479, 3484, 3401, 3504 and 3538 g/broiler in 42 days. Broiler received feed with highest level of lysine (1.25%) consumed significantly lowest quantity of feed, while feed intake was highest in the control group (Table I). It was noted that feed intake of broiler was increased gradually with the progression of their age and during finishing period birds consumed more feed as compared to initial period.

Live body weight

The live body weight for six weeks was significantly different (P<0.01) and there was linear increasing trend in weight with advancement in age of broiler; whereas average live weight of broiler fed ration supplemented with lysine at various concentrations (A, B, C, D, E and F) was also significantly (P<0.005) different (1.717, 1.922, 2.088, 2.210, 2.222 and 2.234 kg/b, respectively). The broiler fed ration in group D produced economically better live body weight, while broiler in group F with 1.25% lysine. The live body weight was apparently higher but was uneconomical (Table II).

The carcass weight also followed the similar trend as observed for live body weight (Table III). Average carcass weight of broiler fed ration supplemented with lysine at different levels (A, B, C, D, E and F) was 1.034, 1.101, 1.238, 1.274, 1.288 and 1.298 kg/b, showing 60.22, 57.28, 59.29, 60.38, 60.71 and 60.83 % carcass over live body weight, respectively. The birds receiving feed with 1.25% lysine (group E) recorded highest carcass weight of 1.298 kg/b (60.83%) compared to group B (0.25% lysine) resulted lowest carcass recovery of 57.28 %.

Feed conversion ratio

Feed conversion ratio was better (1.538) in group D, where the broiler feed was supplemented with 0.75% lysine, followed by average feed conversion ratios of 1.576, 1.583, 1.668 and 1.815 resulted by the broiler fed ration supplemented with 1.00, 1.25, 0.50 and 0.25% (control) lysine, respectively. However, the FCR was relatively poor (2.080) in broiler fed control ration without lysine supplementation (Table III). The FCR was significantly affected by lysine levels (P = 0.003).

Weight of edible parts of broiler

Weight of edible parts of broiler fed on ration with various lysine concentrations (g/b) in (Table IV). Broiler breast, leg, neck, drum and head weights results shows that weights in group D were higher for all than other groups (p<0.05).

Weight of giblets

Weight of giblets of broiler fed on ration with various lysine concentrations (g/b) in (Table IV). Broiler heart was heavier in group D, while liver and gizzard weight was heavier in group B than other groups, whereas, spleen and crop weight was heavier in group A, and gall bladder weight was heavier in group C respectively.

Mortality

Total mortality in various groups of broiler during growing period was 4 (A); 2 (B); 2 (C); 2 (D), 2 (E) and 3 (F) broiler per group (Table VII), which accumulated to 8.00, 4.00, 4.00, 4.00, 4.00 and 6.00 percent, respectively. It was observed that the mortality was higher group A and F then other groups B, C, D and E, respectively (Table V).

Feeding behavior

The results on feeding behavior (Table VI) revealed that the broilers of group E, spent significantly (P=0.0478) greater time (8.31 min/h) for feeding, while broilers

Table I. Effect of various lysine concentrations on the feed intake of broiler (g/bird/week).

Week #	Control	Lysine supplemented diet (%)					Prob
	A	B (0.25%)	C(0.50%)	D(0.75%)	E(1.00%)	F(1.25%)	
W1	197	140	127	125	163	169	0.001
W2	328	330	324	323	332	361	
W3	480	446	467	485	479	505	
W4	683	684	686	592	669	697	
W5	835	831	833	837	825	821	
W6	1049	1048	1047	1039	1036	985	
Total (42 days)	3572 a	3479 b	3484 b	3401 c	3504 ab	3538a	

Table II. Effect of various lysine concentrations on the live body weight of broiler (kg/bird/week).

Week #	Control	Lysine supplemented diet (%)					Prob
	A	B(0.25%)	C(0.50%)	D(0.75%)	E(1.00%)	F(1.25%)	
W1	0.189	0.200	0.135	0.151	0.155	0.153	0.001
W2	0.422	0.489	0.400	0.502	0.510	0.515	
W3	0.809	0.893	0.812	0.933	6.945	0.910	
W4	1.104	1.245	1.300	1.381	1.400	1.410	
W5	1.435	1.601	1.763	1.791	1.800	1.803	
W6	1.717 d	1.922 c	2.088 b	2.210 a	2.222 a	2.234 a	
Total	1.717 d	1.922 c	2.088 b	2.210 a	2.222 a	2.234 a	

Table III. Effect of various lysine concentrations on the carcass weight, dressing and feed conversion ratio (FCR) of broiler.

Particulars	Control	Lysine supplemented diet (%)				
	A	B(0.25%)	C(0.50%)	D(0.75%)	E(1.00%)	F(1.25%)
Body weight (kg/b)	1.717	1.922	2.088	2.210	2.222	2.234
Carcass weight(kg/b)	1.034	1.101	1.238	1.274	1.288	1.298
Dressing (%)	60.22 b	57.28 d	59.29 c	60.38 b	60.71 a	60.83 a
FCR	2.080 d	1.815 c	1.668 b	1.538 a	1.576 ab	1.583 ab

Table IV. Effect of various lysine concentrations on the weight of edible parts and giblets of broiler.

Particulars	Control	Lysine supplemented diet (%)					Prob.
	A	B(0.25%)	C(0.50%)	D(0.75%)	E(1.00%)	F(1.25%)	
Edible parts							
Legs	45.00	49.66	53.00	59.33	56.00	52.66	0.001
Breast	425.33	450.33	480.33	519.66	487.00	485.00	0.001
Neck	51.33	54.00	61.66	70.00	65.00	54.00	0.003
Drum	423.00	447.33	460.66	487.66	467.66	448.33	0.001
Head	39.33	43.00	45.00	47.00	43.00	41.33	0.002
Giblets							
Heart	10.98	10.70	8.98	11.86	10.16	7.32	10.00
Liver	40.71	51.98	38.03	45.03	43.58	29.98	41.55
Gizzard	26.96	36.23	29.98	31.82	34.61	27.85	31.24
Spleen	2.63	2.22	2.03	2.25	2.40	1.44	2.16
Gall bladder	1.22	2.21	2.48	2.07	1.71	1.51	1.87
Crop	80.60	69.03	71.21	48.34	56.70	59.78	64.28

Table V. Effect of various lysine concentrations on the mortality of broiler.

Particulars	Control	Lysine supplemented diet (%)				
	A	B (0.25%)	C (0.50%)	D (0.75%)	E (1.00%)	F (1.25%)
Broiler died (#)	4	2	2	2	2	3
Percentage	8	4	4	4	4	6

Table VI. Effect of various lysine concentrations on the ingestive behaviour of broiler.

Behaviour activity (min/hr)	Control	Lysine supplemented diet (%)				
	A	B(0.25%)	C(0.50%)	D(0.75%)	E(1.00%)	F(1.25%)
Feeding	6.17	6.49	6.50	7.54	8.31	7.39
Drinking	3.10	3.16	3.18	3.59	3.51	4.76
Standing/Walking	13.38	13.12	12.86	12.50	12.51	12.56
Lying/Sleeping	37.35	37.63	36.49	35.17	35.47	35.29

Table VII. Effect of various lysine concentrations (%) on the haematological parameters.

Particulars	Control	Lysine supplemented diet (%)				
	A	B(0.25%)	C(0.50%)	D(0.75%)	E1.00%)	F(1.25%)
RBC (million/cu mm)	2.57	2.61	2.66	2.89	2.88	2.88
WBC (thousand/cu mm)	24.64	24.56	24.78	24.61	24.59	24.67
PCV (%)	31.63	30.84	30.01	29.90	30.06	30.11
Serum cholesterol (mg/100ml)	70.11	72.12	75.22	78.13	81.79	83.07

in group A, B, C, D and F spent 6.17, 6.49, 6.50, 7.54 and 7.39 min/h for feeding behavior during 42 days period.

Drinking behavior

Drinking behavior refers the activity of broilers for water intake. The results on drinking behavior (Table VI) indicated that the broilers of group F, fed ration with 1.25% lysine spent significantly (P=0.0256) more time (4.76 min/h) in drinking, while broilers in group A, B, C, D and E spent 2.61, 3.16, 3.18, 3.59 and 3.51 min/h for drinking behavior during 42 days period.

Standing/walking behavior

Standing and walking behavior refers the activity of movement or standing idle. The results in relation to standing/walking behavior (Table VI) showed that the broilers of group A (Control), spent significantly (P=0.0096) greater time (13.38 min/h) in standing idle or in movement, while broilers in group B, C, D, E and F spent 13.12, 13.06, 12.50, 12.51 and 12.56 min/h, respectively for standing and walking behavior.

Lying/sleeping behavior

The results regarding the lying/sleeping behavior (Table VI) indicated that the broilers of group A (control), spent significantly (P=0.0426) more time (37.35 min/h) in lying/sleeping, while broilers in group B, C, D, E and F spent 37.13, 36.49, 35.17, 35.47 and 35.29 min/h, respectively for lying and sleeping.

Blood hematology

The results of the hematological examination of broilers (Table VII) indicate that RBC and Serum cholesterol were affected significantly, while no significant effect on WBC and PCV were recorded.

The average values for RBC were 2.57, 2.61, 2.66, 2.89, 288 and 2.88 million/mm^3, while WBC were 24.64, 24.56, 24.78, 24.61, 24.59 and 24.67 000/mm^3 in groups A, B, C, D, E and F, where lysine was supplemented at con concentration of 0, 0.25, 0.50, 0.75, 1.00 and 1.25%, respectively. The average values for PCV in groups A, B, C, D, E and F were 31.63, 30.84, 30.01, 29.90, 30.06 and 30.11 % and serum cholesterol 70.11, 72.12, 75.22, 78.13, 81.79 and 83.07 mg/100ml, respectively.

The hematological values for birds in all the groups were within the normal range and hence no adverse effect of lysine even at higher level was found on blood hematology of broilers except RBC and serum cholesterol, which was increased significantly but all the values remained with the normal range.

Economics

The economic analysis of the broiler flock fed ration with varied levels of lysine was carried out and results showed that broiler in group D (0.75% lysine) generated maximum net profit of Rs.61.6/bird, while the higher lysine level of 1.00 and 1.25 showed adverse effect with some reduced net profit of Rs. 61.12 and Rs.59.46/bird respectively. However, the broilers fed ration with 0.50 and 0.25% lysine generated relatively lower net profit of

Rs.59.21 and 47.02/bird, respectively against Rs.29.51/ bird under control broiler.

DISCUSSION

Poultry farming may be set up for egg and meat production as well as breeding of grandparent and parent flocks. Research has indicated a number of amino acids and other elements which can be supplemented to poultry ration for obtaining quantitative and qualitative advantages for weight gains particularly in broiler. Lack of demonstration of research findings at mass level has impelled the poultry farmer to use only traditional and commercial feed available in the market. Moreover, these feed supplements can increase resistance of birds against various disease outbreaks, thus the present study was carried out to investigate the effect of lysine on meat production and behavior of broilers.

The findings showed that feed intake was considerably increased with development of broiler age and during finishing period birds consumed more feed as compared to initial period. Moreover, broiler fed ration supplemented with 0.75% lysine gained maximum live body weight, carcass, dressing percentage and FCR. These results are fully supported by the findings reported by (Zampiga *et al*., 2018), those studied on supplementation as 1.10 and 1.20% of lysine in broiler diets and concluded that additional lysine improved feed: gain and lysine interact to increase weight gain and breast fillet yields. Similarly, (Gorman *et al*., 1995) determined the optimum dietary lysine concentrations for growth and breast meat yield of broiler and reported that balanced lysine supplements improved weight gain but gave no further improvement in breast meat yield. Previous study reported significant more body weight at 33 day in broilers receiving lysine supplemented diet (Zampiga *et al*., 2018). However, dietary supplementation of arginine from 21-42 day (total arginine ratio = 1.17) has no any effect on body weight at processing (Fouad *et al*., 2013). (Xu *et al*., 2018) have observed a quadratic improvement in body weight at 21 and 42 day of age in response to the dietary supplementation of arginine (total ratio = 0.67). Balance and Brake (2002) investigated the effect of lysine on growing poultry and concluded that the effect was more evident with an excess of lysine and improved response of broilers to increasing dietary lysine was most clearly seen during heat stress.

Similarly, the breast weight in the present study was highest among the edible body parts followed by drum and almost all the body parts were heavier when broiler were fed 0.75% lysine supplemented ration. It was also noted that the mortality was higher in control group and with the supplementation of lysine of feed the mortality was checked to a considerable extent. However, no linear influence on digestive behaviors was noted but broiler fed higher lysine levels spent more time on feeding and drinking; while frequency of total forced mating behavior and aggression was higher in broiler fed ration supplemented with lysine as compared to control. The above findings are further in line with those of Rezaei *et al*. (2004) who tested the effects of dietary lysine levels on performance and carcass characteristics of Ross male broiler chickens and reported that increasing dietary lysine increased feed consumption in starter and weight gain, feed to gain ratio; also increased breast meat yield and percentage. He also reported that dietary treatments had no significant effect on mortality.

The findings of the present study was consolidate supported by Berri *et al*. (2008) who evaluated the responses to increased dietary lysine concentrations on Ross male broilers and reported that an increase in dietary Lys from 0.83 to 0.93% resulted in an increased growth rate (from 91.8 ± 1.6 to 95.5 ± 0.8 g/d, $P < 0.05$), improved feed conversion (from 1.783 ± 0.008 to 1.742 ± 0.009, $P < 0.05$), and increased breast meat yield (22.0 ± 0.1% to 22.7 ± 0.2%, $P < 0.01$). Performance and body composition traits were not significantly improved for concentrations of lysine higher than 0.93%. Similarly Dozier *et al*. (2008) supplemented lysine concentrations from 0.50 to 1.04% in increments of 0.09% and reported that lysine requirements of male broilers for body weight gain, feed conversion, breast meat weight, and breast meat yield were 0.86, 0.88, 0.90, and 0.90%, respectively, based on 95% of the responses. The comparative discussion on the findings of the present research and results reported from different parts of the world showed that lysine is obviously a beneficial element to supplement the broiler ration to the certain proportions.

CONCLUSION

Based on our experimental conditions, the lysine ratios currently adopted at least in countries where the animal protein sources are not allowed in feed formulation (i.e. European Union) appear to be inadequate to exploit the maximum productive potential of modern fast-growing broilers. The lysine supplementation at the rate of 0.75% tested herein had positive effects on meat production and behavior of broilers without showing any negative effect on meat quality attributes, foot pad condition and incidence of breast meat abnormalities.

Statement of conflicts of interest

No potential conflicts of interest were disclosed.

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