Original article

Effects of dietary Lysine and Methionine supplementation on broilers growth performance

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Abstract

This study was conducted to assess the effects of dietary Lysine (Lys) and Methionine (Met) on the performance of broiler chicks. Ninety-six Hybro strain broilers were allotted to four groups, each included four replicates (6 birds per replicate) in a completely randomized design. The treatment groups received the same basal diet supplemented with Lys and Met in 00: 0.0; 0.10: 0.20 and 0.0; 0.7: 0.60; and 0.5 respectively. Data were analyzed using SPSS software; Duncan's test was used to compare the means on a value of $P< 0.05$. Whereas feed conversion ratio (FCR) was the least in these two treatment groups ($P< 0.05$) showed that birds positively responded to dietary levels Lys and Met 0.1:0.6 tend to a significant increase in body weight gain ($P<0.05$). Results showed that increasing Lys and Met to diets of today's broiler can improve immune system functions, FCR, carcass efficiency. This reveals the possibility to produce healthier and economic poultry meat by supplementation Lys and Met to broiler diets increased gross marginal profit.

Keywords: Lysine, Methionine, performance, broiler chick.

Introduction

Dietary protein is the most expensive component of a broiler diet; broilers fed less dense amino acid diets could increase feed consumption, which in turn increased abdominal fat yield [1,2]. Formulating broiler diets based on digestible amino acids gives a better prediction of dietary protein quality and bird performance than total amino acids [3]. Dietary amino acid recommendations are limited on broilers grown to 3.4 kg or greater, primary breeding guides provide nutrient recommendations to maximum body weight (BW) of 3.0 kg [4]**.** Increasing the percentage of essential amino acids and the balance within the dietary crude protein can improve the proportion of productive energy recovered from methionine (Met) [5]. Studies have shown that birds require greater levels of dietary Met to achieve an optimum FCR and a maximum breast meat yield rather than a maximum BW gain [3,6]. Methionine (a sulfur amino acid) is the first limiting amino acid in a corn-soybean meal diet for broiler breeder hens [7].

The need for dietary Lysine (Lys) is greater for breast meat yield than for growth rate [8-10]. Studies have shown that feeding high amino acids (i.e., Lys, Met, cysteine, and threonine) density diets may improve

feed conversion ratio (FCR, feed intake /BW gain), increase BW gain and carcass yield (especially breast meat yield), and lower abdominal fat pad yield in modern commercial broilers [11,12]. Studies showed that Met and Lys are essential amino acids that are critical for tissue growth in chickens [13,14]. Lys and Met are the most limiting essential amino acids in cereal and legume crops, respectively [15-17]**.** The limited Lys and Met contents reduce the nutritional values of these crop plants to 50–75%, compared to those of a diet possessing balanced levels of essential amino acids. As such, the availability of dietary Met and Lys affects the composition of amino acids protein in the body [18,19]. Exhibited that broiler chickens given feed supplemented with 1.30% Lys and 1.10% Met achieved maximum growth [20]. Met and Lys have many important functions in the metabolism of monogastric animals and the consumption of these functional amino acids improves their health, survival, growth, development, and reproduction [21-24]. Supplemental Met and Lys provided no additional benefits [25]. The dietary levels of Met and Lys affect broiler growth, performance and carcass quality [26-28]. The addition of high levels of synthetic amino acids, such as Met and Lys, can stimulate insulin secretion [29], and this increases the uptake of amino acids and protein synthesis in multiple tissues [30]. BW, FCR, and carcass yield, as well as the yield of most cut-up parts, were improved by dietary Met supplementation at both low and high Lys levels [28].

This study was conducted to evaluate the effects of different dietary Met and Lys levels on the performance of the broiler chicks growth.

Materials and methods

Bird husbandry

Hybro one-day-old straight run chicks were obtained from a commercial hatchery after they were vaccinated for Marek's disease, Newcastle disease virus, and infectious bronchitis. The chicks were unsexed upon arrival (96 total) were used. The chicks were randomly distributed across 16 floor pens (6 chicks/pen), each measuring 0.55 meters' squire in area, in a solid-walled broiler house at the Faculty of Agricultural Studies, Sudan University of Sciences and Technology. Each pen was equipped with a commercial feeder, drinker, and its floor was covered with shovel litter. Birds had *ad libitum* access to feed and water. Starter-phase diets were provided from 0 to 27 d of age in the form of crumbles, whereas the experimental grower diets were provided from 28 to 42d of age. Ambient temperature set points and the lighting program were used. Light intensities at bird level (30 cm) were set and confirmed photometrical. Mortality was recorded daily.

Experimental rations

A basal diet was formulated to yield 22.4% CP and 3100kcal ME/kg being adequate. Lys was set at 1.20% and the Met at 0.48% [31]. Ration ingredients were sorghum, sesame cake, groundnut cake, and wheat bran Met and Lys without adding any concentrate (see table 1). (0.0, 0.7), (0.1, 0.6), (0.2, 0.5), (0.0, 0.0) respectively was added to the basal diet resulting in four formulae. Experimental diets were fed for 42 days.

Table 1. Composition of the experimental diets (% as-is).

Ingredients	00 Lys 00 Met	00 Lys 0.7 Met	0.1 Lys 0.6 Met	0.2 Lys 0.5 Met
Fetarita (Sorghum)	65.00	65.00	65.00	65.00
Ground nut cake	13.00	22.00	22.00	22.00
Sesame cake	15.00	10.00	10.00	10.00
Sodium Chloride	0.50	0.25	0.25	0.25
Concentrate	05.00	-	-	-
Oyster flour	1.50	0.80	0.80	0.80
Vitamin* & mineral	-	0.25	0.25	0.25
L-Lysine	-	0.70	0.60	0.50
DL-Methionine	-	-	0.10	.20
Total	100	100	100	100
Calculated analysis %				
Crude protein	22.5	22.7	22.3	22.8
Ether extract	3.30	2.90	3.80	3.00
Crude fiber	3.80	4.40	4.20	4.10
Ash	7.60	6.60	6.30	6.6
M- E, kcal/kg	3100	3100	3100	3100
Total Phosphorous	0.70	0.60	0.60	0.60
Calcium	1.50	0.90	0.90	0.90

*Guaranteed levels of vitamin and minerals supplements per kg product: vit. A : 300.000 UI ; vit. D_3 : 100.00 UI ; vit E. 4.00mg ; vit K : 98 mg ; vit. B2 : 1.320mg ; vit. B12 : 4.000mg ; pantothenate : 2.000mg ; niacine : 20.000mg ; folic acid : 100 mg ; choline : 50.000 mg ; Copper : 15.000 mg ; idoines : 250mg ; selenium : 50 mg ; manganese : 24.000mg ; zinc : 20.000 mg ; iron. : 10.000mg ; coccidies : 25.000mg ; antioxydants ; 125mg.

Performance data

Average body weight, weight gain and feed consumption (g) for each group were determined weekly throughout the experimental period. The health of the experimental stock and mortalities were closely observed.

Evaluation criteria

Bird BW and feed intake were determined on a pen basis at the beginning and end of the experimental phase. Mortality was monitored twice daily, and BW was recorded and used to adjust FCR. At 42 d of age, 2 broilers from each pen (24/treatment; 96 total) were randomly selected for processing. Birds fasted overnight with water allowed slaughtered terminally. Birds were weighed individually before slaughter by severing the right and left carotid and jugular vessels, trachea and esophagus. After

bleeding they were scaled in hot water, hand-plucked and washed. The head was removed close to the skull; feet and shanks were removed at the hock joint. Evisceration was accomplished by a posterior ventral cut to completely remove the visceral organs. Hot carcass and each with the intestine, liver, and gizzard were separately weighted. The carcass was chilled in a refrigerator at 4 ^{o}C for 24 hours before further preparation.

Carcass data

The cold carcass was prepared for analysis by removal of the skin and neck near the body and each was weighted separately. The carcass was then divided into right and left side by mid-sawing along the vertebral column each side was weighed. The left side divided into six commercial cuts, wing, thigh, drumstick, breast, rib back and tail-back, each cut was weighed separately [32].

Statistical analysis

A randomized complete block design was used to test for the effects of the different dietary Lys and Met regimens. Pen location was considered as the blocking factor, and the pen was considered as the experimental unit. A 2×2(2Lys and 2 Met dietary levels) factorial arrangement was used in this trial. A one-way ANOVA was used to determine the significance of responses to Lys and Met supplementation. All data were analyzed by the LSD procedure of SAS software. Fisher's least significant difference option of SAS was used to separate treatment means.

Results and discussion

Table 2 summarizes the growth, feed intake and feed conversion data. Birds performed well during both starter and grower periods. Up to 27 days of age, feed intake was affected by dietary treatment. BW on d42was improved by dietary Lys and Met supplementation. At 0.1 and 0.2% Lys levels, the 0.7, 0.6, or 0.5% Met level diets improved BW as compared to the 00% Met diet. Broilers fed the Lys (0.1%) and Met (0.6%) levels exhibited a higher BW than those fed any of the other dietary treatments. Because feed intake was affected, but BW was improved by Lys and Met supplementation.

The results showed that the feed conversion at 6 weeks was not significantly different among the treatments (P>0.05). Birds fed diets un-supplemented and (0.0and 0.7) showed significantly lower FCR than those fed supplemented diets. Better FCR for (0.1and 0.6) were caused by faster growth when diets were supplemented with Met and Lys. Some [33] suggested that the ideal levels of Met and Lys for higher growth rates may be more than those previously recommended [34] for growth and conversion performance FCR was decreased (improved feed conversion) by Lys and Met supplementation. At a 0.1% Lys level, FCR was lowered by using the 0.6, 0.2, or 0.7% Met levels rather than the 00% Met level. In

addition, FCR was similar in the second stage 28-42-day comparison to the 0.7% Met group. Among all groups, broilers fed the 0.1% Lys and 0.6% Met levels exhibited the lowest FCR. This was followed by 0.2% Lys and 0.5% Met groups. Supplementing Met and Lys in the diets increased the growth compared to the control. May this be due to Met and Lys being more digestible and quickly absorbed by the body such that birds fed diets showed higher body weight at the age of 7 weeks Met and Lys function form tissue protein. These results supported the findings of similarly: Feed formulated with the addition of 0.27% Met and 0.79% Lys resulted in the best growth performance [35]; giving 1.25% Lys to chickens until an age of 42 days and 1.06% Met in the finisher period can increase the growth and development of chicken breast meat [36].

Increasing dietary Lys content causes increase broiler carcass protein retention and a decrease in fat retention [37]. In contrast to this, there was a linear decrease in feed conversion ratio (FCR) with an increase in the supplementation of Lys and Met [38]. It has concluded that using only surplus levels of Met and Lys is enough to have the highest BW and BW gain [39]. It was reported that the dietary Lys requirement for growth performance in male chicks (1 to 18d) (1.18 to 1.22% total Lys of diet or 1.07 to 1.11% digestible Lys of diet) [5]. Recent studies have revealed that considerable use of Met and Lys in diets has yielded positive growth responses in the broiler. The body weight of the birds sampled for carcass analysis reflected the average weight gain of the respective treatment groups (Table 3).

Table 2. Analysis of variance and average (mean ± std. error) of performance values of broiler chicks fed different Lys and Met levels for 42 days.

Items in grams	F[♆]	00 Lys 00 Met	00 Lys 0.7 Met	0.1 Lys 0.6 Met	0.2 Lys 0.5 Met
1 to 27 d					
Initial weight	0.00	48.0±0.00	48.0±0.00	48.0±0.00	48.0±0.00
Final weight	34.98	485.4^{c}±43.5	683.4^{b}±45.1	805.4^{a}±54.3	700.00^{b}±36.0
Weight gain	34.98	410.40^{c}±43.3	608.4^{b}±45.1	730.4^{a}±54.3	625^{b}±36
feed intake	2.50	1020.75^{b}±147	1062.5^{ab}±232	1313.8^{a}±190	1202^{ab}±53.1
Feed conversion ratio	5.00	2.5^{c}±0.03	1.8^{a}±0.04	1.8^{a}±0.03	1.9^{b}±0.01
28 to 42 d					
Final weight	16.3	1279.2^{c}±53.4	1464.6^{b}±70.8	1646.7^{a}±119	1512.5^{b}±25
Weight gain	1.14	1231.2^{a}±29.9	1416.6^{a}±57.8	1598.7^{a}±66.9	1464.5^{b}±28.5
feed intake	0.050	1678^{b}±216.9	1672^{a}±169.6	1713.8^{a}±183	1696^{a}±79.2
Feed conversion ratio[1]	0.10	2.1^{a}±0.03	2.1^{a}±0.02	2.1^{a}±0.02	2.1^{a}±0.02

[♆]At (3, 12) d.f.

Means in the same row bearing different superscripts differ significantly ($p<0.05$).

FCR =FC / average weight gain (g).

Carcass yield as a percentage of slaughter weight was affectedly by dietary treatment. Hot and cold dressing meat yield responded to differences in dietary treatment. Carcasses from birds on diet (0.1, 0.6) significantly (P<0.05) slaughter weight, more than the diet with met and Lys supplied (0.2, 0.5), confirming the high sensitivity of the broilers to dietary levels of amino acids. These findings agree with a previous result that the Met requirements of birds grown at some constant temperatures (25 to 35°C) achieved optimum growth when fed Met: Lys of 0.31 [39]. Birds under cycling temperatures required ratios of 0.37, whereas maximum growth was obtained with Met: Lys of 0.39 for birds at 21°C. The results show that birds negatively respond to dietary levels of 0.10% Lys and 0.60% Met when amino acid supplemented to diet. Similarly, the levels of 0.20% Lys and 0.50% Met added to diet of ingredients. The present data set gives further evidence that diet formulation on amino acids will yield more consistent bird performance, moreover, amino acids might be considered as a necessary tool making possible the use of high portions of by-products without variability in performance or formulating with large safety margins.

Table 3. Analysis of variance and average (mean ± SE) slaughter and carcass values of broiler chicks fed different Lys and Met levels for 42 days

Items	F✞	00 Lys 00 Met	00 Lys 0.7 Met	0.1 Lys 0.6 Met	0.2 Lys 0.5 Met
Slaughter weight	16.3	1279.2a±53	1512.5b±25	1646.7a±119	1464.4b±71
Hot dressing%	1.1	69.7 [a]±0.80	69.9 [a]±0.20	69.3[a]±0.70	69.9 [a]±0.30
Cold dressing%	0.5	68. 8 [a]±0.6	68.9 [a]±0.20	68.9 [a]±0.70	69.2 [a]±0.20
Feed conversion %	0.10	2.25 [a]±0.2	2.0 [ab]±0.1	1.93 [b]±0. 2	1.95 [b]±0. 2
Mortality%	1.1	4.2	0.0	0.0	0.0

✞ At (3, 12) d.f. Means in the same row bearing different superscripts differ significantly (p<0.05).

The economic significance of the diet alterations evaluated in this study is considerable. Based on the performance data obtained, Table 4 calculates cost ratios using typical prices for the feedstuffs included (Sudanese market, mid 2004); feed cost per bird and feed cost per kg carcass weight were lowest without supplemented diet. Feed formulated with the addition of 0.27% Met and 0.79% Lys resulted in the best growth performance [35].

It has reported that essential amino acid balance and total amino acid levels should be considered to optimize growth and to maximize profits [40]. Note that mortality is only in the rations that did not add the Met and Lys in the experiment was 4.2%. Met participates in protein synthesis as an essential amino acid and is also as a glutathione precursor that helps to protect cells from oxidative stress, and is required for the synthesis of polyamines (spermine

and spermidine), which take part in nucleus and cell division processes. Besides, Met is the most important methyl group donor for methylation reaction of DNA and other molecules.

On the other hand, Lys is also essential amino acid that is necessary to produce proteins like antibodies, so adequate dietary levels of these amino acids are needed to support optimum performance of immune system. The increased of Met and Lys led to significant increase in blood lymphocytes and decrease in heterophyls and ratio of heterophyls to lymphocytes as a stress index (P<0.01) due to decreased the mortality [41,42].

Table 4. Major inputs and margin over major inputs (per head) of broiler chicks fed different Lys and Met levels for 42 days.

Items	00 Lys 00 Met	00 Lys 0.7 Met	0.1 Lys 0.6 Met	0.2 Lys 0.5 Met
Meat sales (SDG)*	1170.072	1186.128	1263.032	1188.605
Chick purchase (SDG)	185.000	185.000	185.000	185.000
Feed cost(SDG)**	195.6	198.8	220.1	210.7
Major cost of production	519.2	522.5	544.9	535.0
Margin over major inputs	700.0	700.0	700.0	700.0
Profitability (%)	58.42	57.42	60.50	58.86
Profitability ratio	1.00	1.30	1.50	1.40

Conclusions

The results obtained implicate that excess Lys and Met could improve performance. it is suggested that levels of Lys and Met in excess of NRC [34] recommendations may result in enhanced health and economic performance and processing yield especially regarding the above-mentioned traits in today's high performance broiler strains. Results reported here also support the hypothesis that it is possible to produce healthier and economic poultry meat by supplementation excess Lys and Met to broiler diets.

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