Egypt. J. Vet. Sci., pp. 1-6

Egyptian Journal of Veterinary Sciences

https://ejvs.journals.ekb.eg/

Effects of Dietary Variations in Methionine and Lysine Levels on The growth Performance and Carcass Characteristics of BLRI-improved Hilly Chicken

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Abstract

THIS study aimed to assess how different lysine and methionine supplementation levels affect growth and carcass characteristics in BLRI-improved hilly chickens. A total of 432-day-old chicks were randomly assigned to nine treatment groups, each with four replicates of 12 chicks. The birds were provided with an iso-energetic, iso-nitrogenous basal diet formulated from corn and soybean meal to meet their nutritional needs. A 3x3 factorial design was used, with three levels of lysine (NRC standard, 10% below, and 10% above) and three levels of methionine (NRC standard, 10% below, and 10% above), applied across starter (0–2 weeks), grower (3–5 weeks), and finisher (6–8 weeks) phases. Feed was provided ad libitum, and weekly measurements of body weight, weight gain, and feed intake were used to calculate feed conversion ratio (FCR). At eight weeks, eight birds per treatment were sacrificed for carcass analysis. Data were processed using SAS (2009), and differences were determined via DMRT. Results indicated that the NRC (1994) dietary standards for lysine (1.05%) and methionine (0.48%) achieved optimal growth during the grower and finisher phases, with significant increases in body weight and weight gain ($p<0.05$), while no significant effects were observed in the starter phase ($p>0.05$). Additionally, lysine and methionine supplementation had no significant impact on carcass traits. These findings suggest that for BLRI-improved hilly chickens, the NRC (1994) standards for lysine and methionine are sufficient for optimal growth, with no added benefits from deviations in either nutrient level.

Keywords: Methionine, Lysine, Growth performance, Chicken, Carcass.

Introduction

Poultry feed often adequate essential amino acids, making supplementation necessary in commercial diets. Methionine and lysine, depending on feed composition, are among the most limiting amino acids in poultry nutrition, playing vital roles in monogastric metabolism, including growth, health, and reproduction [1,2]. Supplementing amino acids provides multiple advantages, such as reducing feed costs, promoting weight gain, improving meat yield, reducing carcass fat, and ensuring consistent nutrient intake. This approach also aids in resource conservation and minimizes waste by enhancing protein synthesis efficiency [3]. In poultry production, methionine and lysine are commonly added to corn-soybean diets. Increased levels of synthetic amino acids, such as methionine and lysine, can stimulate insulin secretion, which in turn facilitates amino acid uptake and protein synthesis across tissues. Diets rich in these amino acids often lead to greater breast meat production through enhanced lean muscle development. Furthermore, higher-than-required methionine intake has been associated with increased breast muscle growth by influencing specific metabolic pathways [4].

The hilly chicken holds great significance as a native breed in Bangladesh, particularly in the hilly regions, where they are raised for local consumption. The meat of the hilly chicken is highly prized by consumers due to its distinctive taste and delicacy, especially among rural populations [5]. Despite this, there is a lack of comprehensive documentation on the growth patterns of hilly chickens. Consequently, the Bangladesh Livestock Research Institute has launched an initiative to enhance the growth performance of hilly chickens, achieving an increase

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(Received 17 November 2024, accepted 15 January 2025)
DOI: 10.21608/EJVS.2025.337092.2498
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from 350-400 g to 700-800 g at 8 weeks of age over the past few years through selective breeding and improvement efforts. Methionine and lysine are regarded as the first and second limiting amino acids in poultry diets, respectively. The term "limiting amino acid" refers to the essential amino acid that is found in the diet in the smallest amount and are essential for the development, growth, health, and reproduction of chickens. The precise methionine and lysine requirements for these birds are still unknown. Determining and optimizing the dietary lysine and methionine levels for BLRI-improved hilly chicken is essential for improving its performance [6]. Therefore, this study was undertaken to evaluate the effects of different levels of methionine and lysine on the growth performance and carcass characteristics of BLRI-improved hilly chickens.

Methionine and lysine are essential amino acids in poultry diets, acting as the first and second limiting nutrients, respectively, and are key for promoting optimal health, growth, development, and reproductive performance in native chickens. The term "limiting amino acid" denotes the essential amino acid found in the lowest concentration in the feed. Therefore, determining and optimizing the levels of dietary lysine and methionine is essential for enhancing the performance of BLRI-improved hilly chickens. However, precise requirements for these amino acids in this breed remain undefined. This study aimed to evaluate the effects of varying dietary levels of lysine and methionine on growth performance and carcass characteristics in these improved hilly chickens.

Material and Methods

Experimental birds and management

The experiment was conducted in the BLRI poultry research farm during 2020-21. A total of 432-day-old BLRI-improved hilly chicks were evenly allocated into nine dietary treatment groups, with four replicates per treatment and twelve birds per pen. Each treatment in all three phases included a baseline and adjusted levels of lysine (Lys) and methionine (Met) at 0% and 10% deviation from NRC [7] recommendations. The experiment utilized a fully randomized 3x3 factorial design. Diets, formulated to be iso-energetic and iso-nitrogenous with a corn-soybean meal base, were provided ad libitum throughout the starter (0–2 weeks), grower (3–5 weeks), and finisher (6–8 weeks) phases. Nutrient levels in the basal diets for Lys were set at 1.05%, 1.0%, and 0.95%, and for Met at 0.48%, 0.44%, and 0.40% for the starter, grower, and finisher periods, respectively.

Growth performance

Body weight and feed intake were measured weekly, with feed intake calculated by subtracting the amount of feed refused from the amount offered. For each treatment replicate, daily feed intake, average daily gain (ADG), and feed conversion ratio (FCR) were determined for the starter, grower, and finisher phases, as well as for the overall study period (0–8 weeks).

Carcass measurements

At eight weeks of age, eight birds from each treatment group were randomly selected and matched by weight from each replicate for carcass analysis. After a six-hour feed withdrawal, the birds were weighed, slaughtered using the cut-throat method, and allowed to bleed out fully. Carcass parts (such as wings, thighs, drumsticks, breasts, and shanks) and internal organs (including the liver, kidneys, pancreas, gizzard, spleen, heart, and lungs) were weighed individually using a digital scale. These measurements were then expressed as a percentage of the live weight prior to scalding and de-feathering.

Statistical analysis

Data on growth performance were examined during the starter, grower, and finisher phases. On day 56, carcass characteristics, and growth performance were assessed. Using a completely randomized design with a 3×3 factorial arrangement of dietary treatments, the GLM procedure of SAS [8] was applied to all recorded data, and DMRT was used to determine differences. The model was:

$Yijk = m + Meti + Lysj + (Met \times Lys)\ ij + eijk$,

Where, Yijk is the response variable, μ is the overall mean, Meti is the fixed effect of Met level (i = 3), Lys j is the fixed effect of Lys level (j = 3), (Met × Lys) ij is the first order interaction, and eijk is the random residual error.

Lysin and Methionine levels in the diet:

Each period was 9 treatments and Lysine and Methionine levels are given below:

Results

The results showed that the interaction between the levels of lysine and methionine in the hilly chickens' diet affected their body weight, weight gain, and feed conversion ratio (FCR) in T_1. Methionine and lysine levels in the diet had no further influence on carcass characteristics. In comparison to the other treatments, the T_1 treatments showed increased unit production (UP), unit return index (URI), and production efficiency factor (PEF). In the end, adding more or less methionine (Met) and lysine (Lys) produced no additional results. The BLRI-improved hilly chicken exhibited optimal growth performance when the dietary contents of methionine (Met) and lysine (Lys) were in accordance with the 1994 National Research Council (NRC) recommendations.

Table 4 presents the performance outcomes for hilly chickens (0–2 weeks) fed varying levels of dietary lysine and methionine. During the starter phase, differences in dietary Lys and Met levels did not produce statistically significant effects across treatments (P>0.05). None of the parameters measured showed significant variation between treatments (P>0.05). However, the control group (T_1) and treatment T_9 exhibited numerically higher body weights compared to other groups.

Table 5 outlines the effects of varying dietary levels of lysine and methionine on the growth performance of hilly chickens between 3 and 5 weeks of age. The diet following the 1994 National Research Council (NRC) recommendations, containing 1.05% lysine and 0.48% methionine, produced the best growth outcomes during this period. Significant differences were observed in body weight (P<0.039) and weight gain (P<0.041), while feed intake showed no notable effect (P>0.880). Additionally, treatment T_1 demonstrated an improved feed conversion ratio (FCR) compared to other treatments (P<0.03).

Table 6 shows the effects of varying dietary lysine and methionine levels on hilly chicken performance (6–8 weeks). The improved diet for hilly chicken finishers was impacted by varying Lys and Met levels. The T_1 treatment produced a significantly higher body weight than the other treatments when the hilly birds reached the finisher stage. In comparison to the other treatments, T_2 treatments had a better FCR due to their significantly lower feed intake (P<0.05).

Across the entire study period (0–8 weeks), significant differences were observed in body weight, weight gain, and feed conversion ratio (FCR) with varying levels of lysine and methionine. The combination of 1.05% lysine and 0.48% methionine resulted in a reduced FCR (P<0.039) and increased body weight (P<0.042) and weight gain (P<0.043). Overall, the control treatment (T_1) showed the best growth performance, with significant improvements in body weight and weight gain compared to the other treatments. Additionally, the FCR was notably better in the T_1 group than in the other treatments.

Table 7 presents the impact of varying dietary levels of lysine and methionine on the carcass characteristics of hilly chickens. The results showed no significant differences in carcass traits across the treatments. However, the T_1 and T_9 treatments exhibited numerically higher dressing percentages compared to the other treatments. There was also no significant difference found on the cut parts of hilly chickens, therefore no effect of different levels of lysine and methionine on the cut parts of hilly chickens.

Discussion

Our results suggest that higher dietary levels of methionine (Met) and lysine (Lys) do not improve growth performance, despite the expectation that synthetic amino acids would be more accessible than those bound in whole proteins [9-11]. Previous studies, such as Bouyeh and Gevorgyan [12], reported enhanced feed conversion ratios in broilers with Met and Lys supplementation, while El-Wahab et al. [13] observed increases in body weight. Nonetheless, research outcomes on the effects of excess Met and/or Lys remain inconsistent, possibly due to differences in experimental conditions, including amino acid levels and study durations.

Variability in response may also be influenced by factors like feed intake, as some authors suggest that increasing dietary lysine can reduce feed intake rather than promote weight gain, a finding that contrasts with Ojediran et al. [14]. Research on the finisher phase has demonstrated a linear relationship between lysine levels and both weight gain and average daily gain (ADG), aligning with Bedford et al. [12], who observed improvements in growth and carcass protein. Conversely, other researchers, such as Han and Baker [15], Kidd et al. [16], and Dozier et al. [17], reported a linear decrease in feed conversion efficiency with higher dietary lysine levels. Dozier et al. [18] also found that broilers on diets lower in amino acid density compensated by consuming more feed, which led to increased abdominal fat deposits. In contrast with our findings, these variations indicate that excess Met and Lys had no significant effects on carcass characteristics.

In broiler chicks, Meirelles et al. [19] discovered a link between methionine and feather production. They noted that birds receiving higher methionine levels (0.48%) had greater feather yield than those fed lower levels (0.30%). According to Dozier et al. [18], a diet containing a high lysine level (0.98%) enhances growth and carcass efficiency in broiler chickens compared to a diet with lower lysine levels (0.78%). Corzo et al. [20] found that the interaction of protein and lysine in broiler diets has a positive impact on growth. The poultry industry places importance on carcass yield and quality due to growing consumer interest in lean birds and low-cholesterol diets [21]. In order to maximize the accretion of breast meat and thigh meat, dietary regimens must satisfy the birds' maintenance and growth requirements. Protein and the type of amino acids consumed are essential among the many dietary components since they are connected to the formation of structural tissues [22]. It's crucial to remember that effective carcass of bird is determined by the amino acids consumed rather than by crude protein [22]. Broiler carcass composition is significantly affected by the crude protein and amino acid profiles in their diet, often leading to reduced carcass fat and increased protein content [23]. The growth performance and carcass quality in broilers are largely dependent on the dietary levels of methionine (Met) and lysine (Lys) provided [16, 24,25].

Conclusion

According to the present results, the best growth performance during the growing phase and finisher period was achieved by following the NRC's (1994) dietary recommendations for lysine (1.05%) and methionine (0.48%), which showed significant variations in body weight and weight gain. However, during the initial phase, no significant differences were noticed. The meat of hilly chickens showed no correlations between dietary methionine and lysine in terms of carcass characteristics. Therefore, it can be concluded that supplementing with higher and lower doses of lysine and methionine did not have any additional impacts on growth performance and carcass quality. Therefore, it could be concluded that the NRC's (1994) recommendation of dietary levels of methionine and lysine resulted the best growth performance in BLRI-improved hilly chicken.

Acknowledgments

The authors would like to thank the Director General of Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka, for providing the opportunity to conduct this study and for all the technical assistance during this work.

Funding statement

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Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

TABLE 1. Lysine and Methionine levels in the diet

Treatments (%)	Starter 0-2 week	Grower 3-5 week	Finisher 6-8 week
T_1	1.05 Lys; 0.48 Met	1.0 Lys; 0.44 Met	0.95Lys; 0.40 Met
T_2	1.05 Lys; 0.53 Met	1.0 Lys ;0.48 Met	0.95Lys; 0.44 Met
T_3	1.05 Lys; 0.43 Met	1.0 Lys; 0.39 Met	0.95Lys; 0.36 Met
T_4	1.15 Lys; 0.48 Met	1.10 Lys; 0.44 Met	1.04Lys; 0.40 Met
T_5	1.15 Lys; 0.53 Met	1.10 Lys; 0.48 Met	1.04Lys; 0.44 Met
T_6	1.15 Lys; 0.43 Met	1.10 Lys; 0.39 Met	1.04Lys; 0.36 Met
T_7	0.94 Lys; o.48 Met	0.90 Lys; 0.44 Met	0.86 Lys; 0.40 Met
T_8	0.94 Lys; 0.53 Met	0.90 Lys; 0.48 Met	0.86 Lys; 0.44 Met
T_9	0.94 Lys; 0.43 Met	0.90 Lys; 0.39 Met	0.86Lys; 0.36 Met

TABLE 2. Nutrient composition of different rearing periods

Nutrient content	Starter	Grower	Finisher
ME (Kcal/kg)	3000	3000	3100
Dry matter (DM)%	91	91	91
Crude Protein (CP)%	22	20	19
Crude Fiber (CF) %	3.5	3.5	4.0
Ether Extract (EE)%	4-5	5-6	6-8
Calcium (Ca)%	1.05	1.0	0.95
Phosphorous (P) %	0.50	0.46	0.43

TABLE 3. Vaccination Schedule of BLRI improved hilly chickens

Age (day)	Vaccine Name	Strain Name	Dose	Route
5-6	IB+ND (Live)	MA5+Clone30	One drop	Ocular
9-12	IBD	D-78	One drop	Ocular
16-18	IBD	D-78	One drop	Ocular
21-23	IB+ND (Live)	MA5+Clone30	One drop	Ocular
32-35	AE + Pox (Live)	Fowl Pox	One drop	Wing puncture
40-42	ND (Live)	Clone 30	One drop	Ocular

TABLE4. Effects of different dietary lysine and methionine levels on hilly chicken performance (0-2 weeks)

Traits	Treatment									SEM	P Value
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9		
BW(g)	90.63	88.12	89.55	85.96	89.94	89.12	86.12	88.34	90.63	0.68	0.53
WG(g)	61.86	59.68	61.01	57.40	61.15	60.68	57.26	59.65	62.13	0.68	0.56
FI(g)	145.9	142.5	143.19	147.57	136.6	146.48	141.4	140.0	150.8	2.03	0.81
FCR (Feed: Gain)	2.36	2.39	2.34	2.58	2.23	2.42	2.47	2.35	2.43	0.03	0.67

BW, Body Weight, WG, Weight Gain, FI, Feed Intake, FCR, Feed Conversion Ratio

TABLE 5. Effects of different dietary lysine and methionine levels on hilly chicken performance (3-5 weeks)

Traits	Treatment									SEM	P Value
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9		
BW (g)	405.1^{a}	361.2^{b}	361.2^{b}	371.5a^{b}	352.1^{bc}	353.4^{bc}	364.9^{b}	343.4^{c}	356.2b^{c}	5.20	0.093
WG (g)	314.4^{a}	273.1^{b}	271.7^{b}	285.5^{ab}	262.2^{bc}	264.2^{bc}	278.8^{b}	255.1^{c}	265.6^{bc}	4.25	0.041
FI (g)	774.5	722.0	726.2	728.0	723.6	726.7	738.7	708.8	724.6	6.67	0.880
FCR (Feed: Gain)	2.46^{c}	2.7^{ab}	2.8^{a}	2.5^{bc}	2.7^{a}	2.7^{a}	2.6^{ab}	2.7^{a}	2.7^{a}	0.04	0.03

BW, Body Weight; WG, Weight Gain; FI, Feed Intake; FCR, Feed Conversion Ratio

TABLE 6. Effects of different dietary lysine and methionine levels on hilly chicken performance (6-8 weeks)

Traits	Treatment									SEM	P Value
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9		
BW (g)	738.53^{a}	698.28^{b}	722.23^{ab}	715.17^{ab}	710.93^{ab}	667.38^{c}	697.80b	697.52^{b}	684.15^{bc}	5.32	0.042
WG (g)	353.43^{a}	360.98^{a}	337.05^{ab}	343.67^{a}	358.77^{a}	313.97^{bc}	332.86^{ab}	354.05^{a}	291.95^{c}	6.62	0.045
FI (g)	946.87	930.71	941.45	951.96	950.07	951.35	953.19	939.22	948.52	8.09	0.89
FCR	2.67	2.57	2.79	2.76	2.64	3.03	2.86	2.65	3.24	0.07	0.083

BW, Body Weight; WG, Weight Gain; FI, Feed Intake; FCR, Feed Conversion Ratio

TABLE 7. Effects of different dietary lysine and methionine levels on hilly chicken performance (0-8 weeks)

	0-8 weeks of age			
Treatments	Body weight(g)	Weight gain (g)	Feed Intake (g)	Feed conversion ratio
T_1	738.53^{a}	709.76^{a}	1960.74	2.76^{c}
T_2	698.28^{b}	669.78^{b}	1907.05	2.84^{b}
T_3	722.23^{ab}	693.69^{ab}	1968.08	2.83^{b}
T_4	715.17^{ab}	686.61^{ab}	1928.71	2.80^{bc}
T_5	710.93^{ab}	657.82^{ab}	1923.49	2.92^{ab}
T_6	667.38^{c}	638.94^{c}	1949.81	3.05^{a}
T_7	697.80^{b}	668.94^{b}	1933.35	2.89^{ab}
T_8	697.52^{b}	668.83^{b}	1893.60	2.83^{b}
T_9	684.15^{bc}	669.02^{bc}	1926.81	2.88^{ab}
SEM	5.32	5.31	11.30	0.01
P value (Lys x Met)	0.042	0.043	0.72	0.039

TABLE 8. Effects of different dietary lysine and methionine levels on hilly chicken carcass features

Traits (%)	Treatment									SEM	P Value
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9		
Thigh	13.43	14.36	14.2	14.19	14.05	14.44	14.22	13.99	14.42	0.10	0.63
Breast meat	10.97	13.52	13.8	13.04	12.76	12.73	12.97	13.65	10.42	0.36	0.39
Dressing	66.46	65.24	67.2	65.19	67.14	64.48	65.63	63.99	66.84	1.93	0.38
Drip loss	1.41	1.08	1.10	0.95	1.67	1.04	0.89	1.41	1.62	0.09	0.33

TABLE 9. Effects of different dietary lysine and methionine levels on the cut parts of hilly chicken

Traits (%)	Treatment									SEM	P Value
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9		
Leg	7.40	7.17	7.19	7.52	7.37	7.06	7.16	7.14	7.02	0.08	0.91
Head	7.64	5.85	6.12	6.49	6.06	6.14	6.10	6.45	6.45	0.16	0.46
Heart	1.87	0.79	0.96	0.85	0.81	0.73	0.82	0.77	1.50	0.12	0.40
Gizzard	6.95	6.41	5.59	6.34	5.71	5.28	6.21	6.71	7.10	0.16	0.15
Wing	10.78	9.60	9.76	9.64	10.27	10.02	10.05	10.41	10.67	0.16	0.67
Spleen	0.41	0.40	0.42	0.51	0.47	0.48	0.28	0.38	0.43	1.8	0.36

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