



Effects of Low Protein Diets Supplemented with High Amino Acids (Methionine or Lysine) on Performance of Broilers

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Authors' contributions

Author EAI designed the study and contributed to literature search. Authors OOL and ASP managed the analyses of the studies performed the statistical analysis. Author FAA wrote the protocol and the first draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study is to evaluate the effects of high level methionine or lysine supplementation on the performance and carcass characteristics of broilers fed low crude protein diets.

Study Design: The experiment employed a complete randomized design; all data generated were subjected to analysis of variance.

Place and Duration of Study: The experiment was carried out at the Teaching and Research Farm of the University of Ibadan, Nigeria between April and July 2011.

Methodology: One hundred and ninety two unsexed day old broiler chicks were used in a six-week feeding trial. For each study four experimental diets were formulated such that they contained methionine at four dietary levels of 0.0%, 0.35%, 0.45% and 0.55% while the other four set contained lysine at four dietary levels of 0.0%, 0.60%, 0.70% and 0.80% respectively. The crude protein (CP) levels of T1-T4 in methionine or lysine diets are 24.25%, 19.70%, 15.15% and 10.60%.

Results: Results indicated that broilers fed diet 1 with normal protein level without methionine and lysine had higher ($P<0.05$) body weight gain compared with others. Feed conversion also had the same statistical trend. It was observed that level of crude protein, lysine and methionine significantly reduced feed intake of the broilers. It was reported that

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reduction of CP levels in the diets of the broilers with methionine or lysine supplementation did not give desirable result. This supplementation resulted in reduced feed intake, poor feed conversion and reduced body weight gain of the experimental broilers.

Conclusion: The aim of the poultry farmer is to achieve optimum production with least inputs. From this study, it was concluded that reduction of crude protein content supplemented with lysine or methionine in broiler diets resulted in reduced feed intake and suboptimal body weight gain of the broilers.

Keywords: Lysine methionine low protein broiler.

1. INTRODUCTION

Worldwide poultry production has increased significantly over the past fifty years to accommodate rising demand. Broilers make up a large part of the industry with chicken meat accounting for 86% of the world poultry meat output (Economic Research Service/USDA [1].

With the increasing human population the consumption of meat is increasing in the world and intensive animal production has many more challenges to solve including environmental pollution and animal welfare Ishibashi and Yonemochi [2].

The prevailing scarcity and cost of conventional plant protein supplements such as full fat soybean meal and groundnut cake have resulted in the recent high cost of commercial feeds and poultry products in Nigeria Ogbonna [3]. This major constraint necessitates intensified research on the possibilities of increasing the levels of amino acids and reducing the crude protein in the diets of poultry. Schutte and Pack [4] reported that in practical poultry diets methionine is the first limiting amino acid followed by lysine. Although the advantages of the digestible amino acid system are recognized, diet formulation on the basis of total amino acid content is still widely practiced Bryden et al. [5]. Therefore supplementation of methionine and lysine to practical poultry diets provide a means of increasing the efficiency of protein utilization and as a result nitrogen excretion will be reduced. In the past swine and poultry diets were formulated using a specified crude protein level that was proven to provide an acceptable level of production. However widespread commercial production of supplemental amino acids and further redefining of monogastrics amino acid requirements have provided nutritionist with the option of reducing dietary crude protein without comprising performance levels Moehn et al. [6]. The crude protein and amino acid status of a diet influence the carcass composition of broilers with increased carcass protein and reduced carcass fat accompanying increase in dietary protein or essential amino acid content Carbel et al. [7]. The positive benefits of using supplemental amino acids has been reported to include decreased nitrogen in manure, decreased ammonia emission into the air, decreased water consumption by the experimental birds and decreased manure volume up to 5% Moehn et al. [6]. When the CP is lowered the ability of the diet to supply essential amino acids in a ratio that the birds require is impaired. The use of supplemental amino acids allows nutritionists to use a wide range of alternative ingredients in the diet that otherwise may not be economically or nutritionally practicable. The aim of this study was to investigate the effects of methionine and lysine in low crude protein diets on performance and carcass characteristics of broilers.

2. MATERIALS AND METHODS

The experiment was carried out at the Teaching and Research Farm of the University of Ibadan Nigeria. Maize and cassava flour were the major energy sources while soybean was the major protein source. In the experiment, eight diets were formulated Diet 1 which served as the control and contained 24.25% crude protein while diets T2, T3 and T4 had 19.7, 15.15 and 10.6% respectively. First set of diets 2, 3 and 4 had recommended level of lysine with varying levels of methionine while the other set contained recommended level of methionine with varying levels of lysine (Table 1).

Table 1. Gross composition of the experimental diet

| Ingredients (%) | Methionine Diets | | | | Lysine Diets | | | |
|----------------------------|------------------|-------|-------|-------|--------------|-------|-------|-------|
| | T1 | T2 | T3 | T4 | T1 | T2 | T3 | T4 |
| Maize | 54.00 | 53.90 | 53.80 | 53.70 | 54.00 | 53.90 | 53.80 | 53.70 |
| Soybean meal | 40 | 30 | 20 | 10 | 40 | 30 | 20 | 10 |
| Cassava flour | 0 | 10 | 20 | 30 | 0 | 10 | 20 | 30 |
| Methionine | 0.25 | 0.35 | 0.45 | 0.5 | 0.25 | 0.25 | 0.25 | 0.25 |
| Lysine | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.60 | 0.70 | 0.80 |
| TiO ₂ | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| Bone meal | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 |
| Oyster shell | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 |
| Salt | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| *Premix | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Calculated nutrient | | | | | | | | |
| Crude protein % | 24.25 | 19.70 | 15.15 | 10.60 | 24.25 | 19.70 | 15.15 | 10.60 |
| ME kcal/kg | 2822 | 2895 | 2970 | 3045 | 2822 | 2895 | 2970 | 3045 |
| Methionine (%) | 0.60 | 0.64 | 0.67 | 0.71 | 0.60 | 0.54 | 0.47 | 0.41 |
| Lysine (%) | 1.84 | 1.54 | 1.24 | 0.93 | 1.84 | 1.64 | 1.44 | 1.23 |

*2.5 kg Premix used supplied vitamin A, 12,500000iv; vitamin D, 2500000iv; vitamin E,40,000mg; vitamin K3,2000mg;vitamin B1, 3000mg; vitamin B2 5500mg Niacin, 55000mg;calcium pantothenate, 11500mg vitamin B6, 5000mg; vitamin B12, 25mg; Folic acid,1000mg;biotin,80mg;choline chloride 500000mg;manganese, 120000mg; Iron100,000mg;zinc,80000mg;copper 8500mg;iodine 1500mg cobalt 3000mg;selenium 120mg and anti-oxidant 120,000mg.

One hundred and ninety two day old broilers of Anak strain bought from a reputable farm at Ibadan were used for these feeding trials. The broilers were raised on deep litter with conventional feed during the first week to allow for acclimatization. They were weighed on the eight day and then randomly assigned to the experimental diets in such a way that each dietary treatment had 24 birds replicated thrice. The experimental feed and water were supplied *ad libitum*. Routine vaccination and necessary medications were administered. Records of feed intake were taken daily, body weight gain on weekly basis and mortality records were also taken.

At the last week of the experiment an indigestible marker Titaniumdioxide (TiO₂) was included in the diets to monitor digestibility of the feed. Four birds per replicate were slaughtered and ilea digesta were collected in different bowls which were freeze dried and analyzed. The slaughtered birds were scalded in moderately hot water and defeathered then eviscerated by carefully removing the gastro intestinal tracts. Weights of the drumstick and breast muscle were taken.

2.1 Chemical Analysis

Proximate analysis of the experimental diets and ilea digesta were carried out using AOAC methods AOAC [8].

2.2 Statistical Analysis

The experiments employed a complete randomized design, all data generated were subjected to analysis of variance in case of significance the means were separated with Duncan multiple range test using SAS package [9].

3. RESULTS AND DISCUSSION

The gross composition of the experimental diets is shown in Table 1. The first four sets of diets are designated as methionine diet where the CP varied from 10.60 to 24.25% and methionine inclusion from 0.25 to 0.50. While the other four sets had lysine inclusion of 0.50 to 0.80 and methionine on the same level. The feed intake of broilers on control diets were significantly higher ($P<0.05$) compared with others for both trials (Table 2). It implied low level of crude protein with either high methionine or lysine depressed feed intake of broilers. The body weight gain had a similar statistical trend as the feed intake. Those fed control and T2 had higher weight significantly ($P<0.05$) different from others (data for T2 are insignificant when compared to values from T3 and T4). However there were no significant differences ($P>0.05$) among the dietary feed considering the feed conversion ratio. From this trial it is apparent that in the methionine experiment feed intake in the treatments T2, T3 and T4 were similar being 2.43kg, 2.38kg and 2.32kg respectively. This is at variance with the reports of Hickling et al. [10], Morgan and Bilgili [11], Schuttle and Pack [4], Jianlin et al. [12] that methionine levels above National Research Council (NRC) recommendations improves body weight, feed efficiency and breast meat yield. It had earlier been stated by NRC [13] that poultry do not actually have a protein requirement as much as an amino acid requirement and it is these amino acids that are used in the body for a variety of functions.

Table 2. Performance and carcass characteristics of broiler fed experimental diets

| Parameter | METHIONINE | | | | | LYSINE | | | | |
|-------------------------|-------------------|--------------------|--------------------|--------------------|------|-------------------|--------------------|--------------------|-------------------|------|
| | T1 | T2 | T3 | T4 | SEM | T1 | T2 | T3 | T4 | SEM |
| Feed intake, kg/bird | 2.75 ^a | 2.43 ^b | 2.38 ^b | 2.32 ^b | 0.03 | 2.67 ^a | 2.41 ^a | 2.32 ^b | 2.01 ^c | 0.02 |
| Weight gain, kg/bird | 1.18 ^a | 1.03 ^{ab} | 0.88 ^b | 0.85 ^b | 0.01 | 1.06 ^a | 0.93 ^b | 0.87 ^b | 0.55 ^c | 0.00 |
| Feed conversion ratio | 2.33 | 2.36 | 2.70 | 2.73 | | 2.52 | 2.60 | 2.67 | 3.65 | |
| Drumstick, % liveweight | 0.24 ^a | 0.18 ^b | 0.20 ^{ab} | 0.19 ^{ab} | 0.03 | 0.28 ^a | 0.20 ^{ab} | 0.21 ^{ab} | 0.15 ^b | 0.00 |
| Breast, % liveweight | 0.19 ^a | 0.14 ^a | 0.18 ^a | 0.16 ^a | 0.09 | 0.19 ^a | 0.15 ^{ab} | 0.17 ^{ab} | 0.13 ^b | 0.00 |

abc-means in the same row with different superscripts differs significantly ($P<0.05$)

Feed intake values across the methionine and lysine diets decreased as the amino acid inclusion level increased, this was contrary to the findings of Sterling et al. [14] who reported increased feed consumption in low CP diet supplemented with lysine in broiler. This however agrees with Al-saffar and Rose [15] that broiler chickens given a very high dietary concentration of a single amino acid reduce their voluntary feed intake, consequently reducing growth rate and feed conversion efficiency. The decreased feed intake of the broilers fed low crude protein supplemented with high levels of methionine and lysine could probably be due to reason mentioned by D'mello [16] that high methionine and lysine diets could result in amino acid imbalance. It was further reported that amino acid imbalance has

negative effect by reducing feed intake. The reduced feed intake coupled with the imbalance in the ratio of methionine and lysine may have contributed to the significantly ($P < 0.05$) lowered body weight gain recorded by broilers across the diets. This confirmed the assertion that feed intake is influenced by dietary crude protein and amino acid levels Aletor et al. Sklan and Plavnik [17,18]. This is in agreement with the findings of Jianlin et al. [12], who reported that broiler chicks receiving a low protein starter diet had inferior body weights and feed conversion ratio at four weeks of age compared with those receiving the required amount. This is contrary to Razaee et al. [19] who reported no adverse effect on feed intake of growing broilers fed low crude protein with supplemental methionine. The non-significant trend of feed conversion efficiency across the diets is an indication that low crude protein diet supplemented with methionine and lysine can be fed to broilers but with increased cost which is not economical. This could possibly be due to reason adduced by Birkett and de Lange [20] who stated that greater growth efficiency is expected when protein deposition is maximized and the ratio of protein synthesis to protein deposition is minimized. In the view of Reeds [21] it could implied that increases in nutrient intake above those required for nitrogen equilibrium are moderated by increases in both synthesis and degradation. Therefore inclusion levels of lysine and methionine in these trials above those required for optimal growth increases protein synthesis. The reduced feed intake observed could also be explained by the assertions of Gietzen [22] that competition between the limiting amino acid and the amino acids in the imbalancing mixture for transport from blood into brain. Such decrease in the concentration of a limiting amino acid in specific regions of the brain is followed by behavioral effects, especially a decrease in feed intake.

These results indicated that reduction up to 10.6% in the CP level of the broiler diets had no effect on the feed conversion ratio during the experimental period of eight weeks because the diets were supplemented with high methionine and lysine. It was similar with other reports of Bregendahl et al., Zarate et al. [23,24] who observed an improvement in the feed conversion ratio of birds fed diets with low CP supplemented with essential amino acids in hot summer months. This agrees with other authors Jensen [25] and Schuttle [26] that lower protein content supplemented with amino acid will improve efficiency of protein utilization because equal gain is achieved from a lower protein intake and this amount to reduced cost of production. According to Urdaneta and Leeson [27] it is reasonable to expect that maximum protein deposition and growth rate is associated with an optimum requirement of crude protein and amino acid, where amino acid levels above those needed for growth does not improve deposition likely due to increased rate of protein catabolism.

The breast weight of the broilers among the treatment groups on methionine diets was not significantly different. Possibly implying muscle accretion reached a plateau in response to methionine at each level of CP but at high cost. This result is contrary to the report of Alsafar and Rose [15] that increased methionine but not lysine significantly improved breast weight and feed conversion ratio at six weeks of age not at three weeks. This result contradicted previous work Hickling et al. [10] who stated that lysine above NRC levels did not improve breast meat yield unless methionine was also greater than the recommended level. This result further revealed that there are significant interaction between methionine and lysine in broiler diets for carcass parameter with respect to drum stick and breast. This is at variance with the conclusion of Alsafar and Rose [15] that there were no significant interactions between methionine and lysine levels in broiler diets for any parameter studied whether fed amount recommended or in excess. In the main the results of this study can be summarized in the words of Aftab et al. [28] that feeding low protein with amino acid supplementation causes changes in dietary electrolyte balance which resulted in depression in performance of the broilers.

4. CONCLUSION

Each poultry farmer is directed to achieve optimum production with least inputs. The reduced feed intake coupled with poor body weight in this study bears an important and practical implication for a commercial production of broiler as it implied a loss.

ETHICAL APPROVAL

All authors hereby declare that "principles of laboratory animal care" (nih publication no. 85-23, revised 1985) were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee"

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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