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RESEARCH OPINIONS IN ANIMAL & VETERINARY SCIENCES

Effects of feeding low protein diets with methionine and lysine supplementation on the performance and nitrogen economy of broilers

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Abstract

A study was conducted to evaluate the effects of supplementation of low protein diets with synthetic methionine and lysine on performance and N economy of broilers. Chicks were allotted to corn-soy diets in a completely randomized design for forty-two days. The diets were 22 and 20% of crude protein (CP) with methionine + lysine content balance and, 22 and 20% CP diets with 110% NRC recommendation of methionine and lysine. Feed intake, daily weight gain, feed conversion ratio (FCR) and mortality showed no significant ($P>0.05$) treatment effect. However, there was significant improvement ($P<0.05$) in the performance of birds fed lower (20%) CP diets with synthetic amino acid supplementation, which made it to be at par with those on higher dietary protein (22% CP) level. Similarly, dressing percentage and faecal N were significantly improved ($P<0.05$) with methionine and lysine supplementation. Serum protein and urea reduced slightly but significantly ($P<0.05$) with decreasing dietary CP and with methionine and lysine supplementation of the diets. Consequently, the observed trend in serum protein and urea in the present study suggests improved in biological value of the 22% and 20% CP diets with methionine and lysine supplementation. It was, therefore, concluded that to achieve significant improvement in the performance while maintaining considerable reduction in faecal nitrogen of broilers fed CP diets as low as 20%, the diet should be supplemented with methionine and lysine above the levels recommended.

Keywords: Broilers; nitrogen economy; faecal N; amino acid supplementation; performance

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Introduction

Economic production, desirable carcass characteristics and composition and protection of the environment through decreased nitrogen excretion are current considerations in poultry production (Aletor et al., 2000). Recent emphasis given to decreased pollution of the environment and the need to take proactive measures to mitigate and/or build resilient strategies for coping with the impacts of climate change has rekindled researchers' interest in the use of low protein diets for broilers. In this consideration, however, it is important to ensure that factors that are vital to broiler production are not compromised. This is essential because of the crucial roles of dietary protein in determining the weight gain, feed efficiency and carcass quality such as yield of edible meat and fat contents of broilers (Bartov and Plavnik, 1998; Bryden and Li, 2004; Laudadio et al., 2012). In addition, there has been conflicting reports on the effects of feeding low crude protein diets to broilers. Corzo et al. *(*2004) have shown improvements in N utilization measured in terms of plasma uric acid as well as dietary N intake, excretion and retention without negative effects on growth performance of chicks when fed low crude protein diets. On the other hand, various negative consequences such as depressed weight gain, increased FCR and excessive N excretion, etc., have been

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reported due to reduced crude protein levels in the diets of broilers (Aletor et al., 2000; Bregendahl et al., 2002; Sklan and Planvik, 2002; Malomo et al., 2013).

While some of the discrepancies have been attributed to the differences in crude protein level, amino acid fortification, amino acid requirements imposed, level of knowledge of amino acid requirements, age and strain of birds (Waldroup et al., 1976; Waldroup, 2007), it has been demonstrated that there is a limit to which the dietary protein levels could be reduced without any detrimental effect on the performance of broilers (Waldroup et al., 2005; Malomo et al., 2013). However, supplementation of poultry diets with synthetic amino acids have been reported to improve the overall balance of amino acid and alleviating some of the negative effects associated with feeding low protein diets to broilers (Jiang et al., 2005; Waldroup et al., 2005). Increment in lysine over and above NRC (1994) recommendation was reported to improve weight gain, feed efficiency and breast meat yield (Si et al., 2004) and reduced excess fat deposition in chicken carcass (Moran and Bilgil, 1990). The objective of the study was examine the effect of supplementing methionine and lysine beyond the levels recommended by NRC (1994) on the performance and nitrogen economy of broiler chicks fed 22% and 20% CP diets.

Materials and Methods

One hundred and sixty eight (168) day old and mixed sex Arbor Acre Plus broiler chicks were purchased and randomly allocated to twelve pens (at a density of 0.1 m^2/bird). Birds were given water and feed *ad libitum* (Table 1) for a study period of 6 weeks.

Dietary treatments and management of experimental Birds

Dietary crude proteins (22 and 20%) and amino acids (lysine and methionine) supplementation were the treatments in this study. Four diets were used to study the effect of feeding low protein diets supplemented with methionine and lysine on performance and nitrogen economy of broilers. The four diets are 22% CP with NRC (1994) Methionine + Lysine; 22% CP with 110% Methionine + Lysine of NRC (1994) recommendation; 20% CP with NRC (1994) Methionine + Lysine recommended level and 20% CP with 110% Methionine + Lysine of NRC (1994) recommendation. The compositions of the diets on as calculated basis are presented on Table 1. Birds were randomly allocated to these treatments in three units (replicates) of 14 birds each. Birds were vaccinated against Newcastle disease at 1 week and 3 weeks of age as well as Infectious Bursa Disease at two weeks of age. The study was conducted for six weeks.

Data collection

Data were collected daily on feed intake and weight gain. The FCR was computed from the data of daily feed intake as a ratio of weight gain. At the end of the third week of the study, a nutrient retention study was conducted in metabolic cages. Feed was weighed and given to birds and faecal samples collected over a period of 72 hours employing total collection method. Faecal samples were oven-dried, ground and analyzed for N content (Malomo et al, 2013).

Carcass analysis and haematological assay

At the end of the study, three birds per treatment were starved for 12 h prior to slaughtering by head decapitation. After evisceration of the carcass, a carcass characteristics assessment was conducted. Also, blood samples were taken from 3 birds from each treatment into bijou bottles containing EDTA (anticoagulant). PCV, haemoglobin concentration, total RBC, were evaluated according to Dacie and Lewis (1997). Serological samples were taken from blood (without anticoagulant), centrifuged at 4000 rpm for 3 minutes and supernatant sera harvested in bijou bottles for the determination of specific serum biochemical indices. Proximate compositions of feed and faecal samples were carried out using the methods of AOAC (1990). Response criteria were subjected to analysis of variance and treatment means separated by Duncan Multiple Range Test using the Statistical Analytical System (SAS, 1985) software.

Results and Discussion

The performance of broilers fed the four experimental diets is presented at Table 2. There was no significant treatment effect on feed intake, daily weight gain, feed conversion ratio (FCR) and mortality. Feed intake data showed similarity across treatments due to general acceptability of the diets. Observations from this study suggest that lower dietary proteins supplemented with methionine and lysine encouraged daily weight gain. Thus, lowering dietary crude protein does not essentially translate to a reduction in the overall quality of the diet, particularly when the balance of amino acid is maintained at some reduced dietary CP levels, as indicated by the results of this study. Also, when compared with the results from an earlier study by Malomo et al. (2013), the addition of methionine and lysine to 20% CP diets caused significant improvement in the body weight of broilers. Consequently, amino acid supplementation of 20% CP diet improved the performance of the birds as compared to bird fed higher crude protein diets. This observation is consistent with Waldroup (2000) who reported improved and comparable weights for birds fed low CP diet supplemented with methionine and lysine

Table 1: Composition of Experimental Diet (g/100g DM)

Ingredients	22% CP	22% CP with 110% Met + Lys	20% CP	20% CP with 110% Met + Lys
Maize	52.6	52.6	58.3	58.3
SBM	31.3	31.3	25.6	25.6
WB	6.2	6.2	6.2	6.2
Fish Meal	4.0	4.0	4.0	4.0
Palm oil	2.6	2.44	2.45	2.3
Bone Meal	0.5	0.5	0.5	0.5
Lysine	0.2	0.31	0.3	0.4
Methionine	0.1	0.15	0.15	0.2
Salt	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Oyster Shell	2.0	2.0	2.0	2.0
Total	100.0	100	100	100
Composition of Diets on as calculated basis				
ME	2969	2956	3014	3002
Crude Protein	21.95	21.95	19.94	19.94
Methionine	0.52	0.55	0.52	0.57
Lysine	1.40	1.50	1.37	1.47
Ca	1.05	1.06	1.05	1.05
P	0.54	0.54	0.52	0.52

Table 2: Performance Characteristics of Broilers Fed diets supplemented with methionine and lysine at various levels

Parameters	22% CP with 100% Met + Lys	22% CP with 110% Met + Lys	20% CP with 100% Met + Lys	20% CP with 110% Met + Lys	SEM
Feed intake (g/b/d)	65.17	65.66	66.19	67.35	1.43
Weight gain (g/b/d)	32.90	33.50	33.60	34.20	0.73
Feed Conversion Ratio	1.98	1.96	1.97	1.97	0.01
Dressing percentage (%)	73.47^{b}	72.5^{bc}	71.0^{c}	76.9^{a}	0.66
Mortality	0.33	0.00	0.33	0.33	0.29
N-intake (g/b/d)	3.26^{a}	3.29^{a}	2.63^{b}	2.51^{b}	0.19
N-output (g/b/d)	1.04^{a}	0.87^{a}	0.68^{b}	0.64^{b}	0.06
Faecal N (%)	2.14^{a}	2.08^{a}	2.05^{b}	1.99^{c}	0.02
N-retention	67.97^{b}	73.60^{a}	74.27^{a}	74.23^{a}	1.44

^{a,b,c} values on the same row with different superscripts are significantly different (P<0.05)

Table 3: Haematological and serological parameters of broilers fed diets supplemented with methionine and lysine

Parameters	22% CP with 100% Met + Lys	22% CP with 110% Met + Lys	20% CP with 100% Met + Lys	20% CP with 110% Met + Lys	SEM
Serum protein (mmol/L)	3.10^{a}	2.90^{b}	2.90^{b}	2.80^{b}	0.04
Urea (mg)	0.76^{a}	0.67^{ab}	0.74^{ab}	0.65^{ab}	0.03
PCV (%)	32.07^{ab}	32.97^{a}	31.37^{ab}	30.67^{b}	0.56
RBC ($x10^{12}$/L)	3.47	3.20	4.20	4.50	0.45
WBC ($x10^{9}$/L)	4.20	3.87	4.97	5.17	0.42
Haemoglobin (g/dl)	10.30	9.37	9.50	9.80	0.29

^{a,b,c} values on the same row with different superscripts are significantly different (P<0.05)

compared with those fed 23% and 22% CP diets. In the same vein, Waldroup et al. (2005) noted that addition of a mixture of essential amino acids to a 20% CP diet resulted in improved performance similar to that of 22% CP. Increasing the limiting amino acid levels from 100 to 110% of NRC increased body weight and improved the FCR of chicks fed 20% CP (Waldroup, 2007).

However, dressing percentage, total nitrogen intake, faecal N, N output and N retention showed significant (P<0.05) treatment effect. Broilers fed 20% CP diet supplemented with 110% methionine and lysine had the highest and lowest (P<0.05) dressing percentage and faecal nitrogen, respectively, when compared with other treatments. Huyghebaert and Pack (1996) reported an increase in slaughter and breast meat yield as well as reduced fat deposition when sulphur amino acids were added to the low protein diets fed to broilers. This response in meat yield is suggestive of important economic benefit for further meat processing. The N economy data in the present study also

corroborates other studies which revealed that manipulation of protein sources, especially using synthetic amino acids and high biological value protein sources, in poultry diets can alter the nitrogen content of the litter and thereby reduce the emission of nitrogenous compounds (Angel et al., 2006; Richert and Sutton, 2006). In addition, nitrogen retention has been reported to be enhanced significantly through supplementation with crystalline sulphur amino acid, which led to reductions of up to 30% in the amount of nitrogen excreted per kg weight gain (Huyghebaert and Pack, 1996). Therefore, feeding required levels of amino acids rather than overall crude protein level reduced faecal nitrogen available for denitrification (Misselbrook, 1998).

Haematological and serological parameters of broilers fed the experimental diets are shown in Table 3. Serum protein, uric acid and PCV levels showed significant treatment effects ($P<0.05$), while RBC, WBC and blood haemoglobin levels showed no treatment effects. Serum protein and urea reduced slightly but significantly ($P<0.05$) as dietary CP level decreases and with methionine and lysine supplementation of the low protein diets. Serum protein has been indicated to be an index of dietary protein intake (Annongu, 1997). Also, uric acid and serum creatine values are measures of amino acid degradation (Shukla and Pachaurii, 1995) and an indicator of effectiveness of kidney and liver functions (Annongu, 1997). Therefore, the quality and quantity of protein in any diet are expected to influence blood protein concentration. According to Hevia and Clifford (1977), protein sources with greater biological value lead to greater nitrogen retention and higher growth rate. They further noted that it would be expected that a dietary protein source with higher biological value would result in lower serum urea and uric acid concentrations when compared with those with lower biological values. Therefore, urea and uric acid can be important criteria to assess the bio-availability of a single or combination of protein sources. Consequently, the observed trend in serum protein and urea in the present study suggests an improvement in biological value of the 22% and 20% protein diets with methionine and lysine supplementation.

Conclusion

Essentially, economy of production/productivity, quality of output and protection of the environmental from nitrogenous pollutants, are considered in poultry production operations. Consequently, there is a need to strike a balance among these considerations in order to reduce conflicts of interest. Reducing dietary crude protein for broilers showed great promises as a tool for reducing the amount of faecal nitrogen available for denitrification. It is however clear that there is a limit to which dietary protein of broilers could be reduced without any detrimental effects on the performance and nitrogen economy of the birds. Therefore, supplementation of the amino acid profile of low protein diet has a promising future in this regard. The results of this study showed that to achieve significant improvement in performance of broilers while maintaining appreciable reduction in faecal nitrogen of birds when fed CP diets as low as 20%, supplementation with methionine and lysine above the levels recommended by NRC (1994) is a viable option.

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