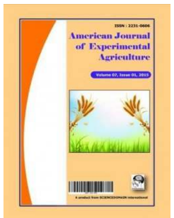

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Response and Economic Indices of Broilers on Low Crude Protein Diets Fortified with Lysine

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Authors' contributions

This work was carried out in collaboration between all authors. Author TKO designed the study. Author OBO managed the literature searchs. Authors BSO and EUA wrote the first draft of the manuscripts. Author IAE managed the analyses of the studies performed the statistical analysis. All author read and approved the final manuscript.

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ABSTRACT

Aims: This study is to evaluate the growth performance, flock uniformity, feather weight, carcass characteristics and economic indices of broilers fed low protein diets fortified with synthetic lysine.
Study Design: All data generated were subjected to analysis of variance in a complete randomized design.
Place and Duration: The experiment was carried out at the Teaching and Research Farm of the Ladoke Akintola University of Technology, Ogbomoso, Nigeria, between November and December 2014.
Methodology: One hundred and eighty unsexed Abor Acres strain day old broiler chicks were used in a seven-week feeding trial. Five experimental diets were formulated. Diets 1 and 2 were negative and positive control respectively with 22.23% crude protein while diets 3, 4 and 5 contained 18.2% each at the starter phase and 17.8% at the finisher phase. They all had recommended level of methionine with varying levels of synthetic lysine inclusion ranging from 0.40% in diet 1 to 0.65% in diet 5 at the starter phase and 0.40 to 0.60% at the finisher phase.

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Results: The result indicated that birds on diet 3 with 18.26% crude protein (CP) and high lysine inclusion had a higher (*P*<0.05) daily gain and least feed to gain ratio at the starter phase, although, the birds on low protein diets had a numerical increase in feed intake but weight gain decreased as the lysine inclusion increased beyond diet 3. The fortification with lysine resulted in a least cost input but an increased profit, economic efficiency of growth, live weight and thigh.

Conclusion: From this study, the objective of the poultry farmer to achieve optimum production with least input is possible using a low crude protein diet supplemented with lysine. This will result in increased profit, economic efficiency of growth, live weight and thigh size.

Keywords: Broilers; low crude protein; lysine; flock uniformity; feather weight; carcass.

1. INTRODUCTION

Various researchers have attempted to reduce the cost of broiler production using alternative feedstuffs especially for plant protein source convectional ingredients like soybean meal. Examples are Mucuna seed meal [1], Cotton seed meal [2,3], Castor seed meal [4], *Jatropha curcas* kernel meal [5] etc. Such non-convectional feedstuffs comes with anti-nutritional factors which has to be removed or reduced using various processing methods which could be time and money demanding.

Broiler production has encountered several changes within the last ten years due to improved genotype which has tremendously improved the growth rate, efficiency and carcass composition. This has led to a substantial change in nutritional needs of these birds and particularly for the nutrients potentially limiting for growth and protein deposition like amino acids (AA) [6]. Low protein diets fortified with synthetic AA have been the subject of extensive research. Supplementing low-CP diets with synthetic AA has been shown to save cost [7] and decrease nitrogen excretion [8] and control of ammonia emmission [6]. Besides environmental benefits, low CP diets also impact upon bird health by reducing the occurrence of digestive disorders and by improving health status of the animal environment [Relandeau and Le Bellego, [6]. However, excessive low-CP diets are still not recommendable even with AA fortification [9]. According to Awad et al., [9], many studies have been conducted to evaluate the effect of supplementing low-CP diets with essential amino acid EAA in levels higher than the NRC [10] requirements [11-14]. Although, Deschepper and DeGroote [11] showed that equaling the EAA levels of low-CP diets to that of standard improved performance, Waldroup et al. [13], Si et al. [12] and Iyayi et al. [14] found otherwise.

Most of previous research [11,13,15] dealing with NEAA or further EAA fortification to low-CP diets in poultry was carried out under temperate condition with little or no available data on such fortification effect under the hot and humid tropical condition.

2. MATERIALS AND METHODS

The experiment was carried out at the Teaching and Research Farm of the Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Maize and cassava flour were the major energy sources while soybean was the major protein source. Five experimental diets were formulated. Diets 1 and 2 were negative and positive control respectively with 22.23% crude protein while diets 3, 4 and 5 contained 18.2% each at the starter phase and 17.8% at the finisher phase. They all had recommended level of methionine with varying levels of synthetic lysine ranging from 0.40% in diet 1 to 0.65% in diet 5.

A total of one eighty (180) day old broiler chicks of Abor Acres strain were purchased from a reputable hatchery at Ibadan. They were assigned to five (5) dietary treatments of three (3) replicates of twelve (12) birds per replicate. A week of acclimatization was observed before randomly assigning the birds to dietary treatment on the eight day. The birds were reared on a deep litter system in an open sided house for three (3) weeks for each phase. Normal brooding procedure and management were provided throughout the experimental period.

The following parameters were calculated as follows:

Average daily feed intake (ADFI) (g/bird/day) = cummulative feed intake / (number of birds x number of days)

Average daily gain (ADG) (g/bird/day) = (final weight gain-initial weight) / number of days

Feed conversion ratio (FCR) = cummulative feed intake (kg) / total weight gain(kg)

At the last week of the experiment, an indigestible marker Titaniumdioxide (TiO_2) was included in the diets to monitor nutrient digestibility. Individual birds were weighed on day 28 and 49, and flock uniformity was calculated using the formula:

Flock uniformity (%) = 100 – [standard deviation (g) / average body weight (g) x 100].

Economic indices were calculated thus; Feed cost/kg = sum (cost of each ingredients x unit cost of each ingredients) % / 100.

Feed cost per kg weight = feed cost/kg x total feed intake (kg) / total weight gain.

Income per per kg weight = Selling price/bird / total weight gain(kg)

Profit per kg weight gain = Income per per kg weight – feed cost/kg weight gain

Economic efficiency of growth (EEG) = (profit per kg weight gain / feed cost per kg weight gain) x 100.

Three birds per treatment were sacrificed to measure feather weight at day 28 and 49 of age. The birds were randomly choosen, weighed and killed by neck dislocation to prevent blood loss. After scalding and defeathering, the birds were weighed to obtain feather weight. Another three birds were slaughtered per treatment, eviscerated carefully to obtain the organs. Carcass weight, drumstick, thigh and breast weight were taken and expressed as percentage of liveweight.

2.1 Statistical Analysis

The experiments employed a completely randomized design, all data generated were subjected to analysis of variance and means were separated using the Duncan multiple range test using SAS [16] package.

3. RESULTS AND DISCUSSION

The gross composition of the experimental diets is shown in Tables 1 and 2 for the starter and finisher phase respectively. The first two diets contained a CP of 22.48% while the other three diets had 18.26%. The diets had lysine inclusion from 0.40 to 0.65% with same level of methionine. The finisher diets is similar to the starter diets but for decrease in diets 3 to 5 with 17.87% CP while the lysine is from 0.40 to 0.60% with same level of methionine. The average daily feed intake, average daily gain, feed to gain ratio and feather weight were significantly influenced at the starter phase. Birds fed the low protein diet compared favourably with those of the control diets. Birds on low protein diets had a numerical increase in feed intake. It implied low level of protein with high lysine improved feed intake of broilers at the starter phase. The daily gain of birds on Diet 3 (18.26% CP and 0.55% lysine inclusion) were significantly higher (P<0.05), although, those on diets 1 to 4 were comparable but the weight gain decreased as the lysine inclusion increased within the low CP diets. Birds on diet 3 had the least feed to gain ratio. The feed to gain ration increases with the lysine inclusion within the low protein diets. Feather weight of birds fed the negative control diet (D1) and those on diet 4 were significantly different from each other. This signifies that the level of lysine inclusion does not actually affect feather weight. However, there was no significant differences (P>0.05) among the dietary feed considering the flock uniformity. Findings on the feed intake is similar to the findings of Sterling et al [17] who reported increased feed consumption in low CP diet supplemented with lysine in broiler. The observations on weight gain within the low CP diet could be due to reasons mentioned by D'mello [18] that amino acid imbalance may have resulted to decrease in weight with increasing lysine inclusion beyond 0.55%. The result indicated that at 18.26% CP and 0.55% lysine inclusion, the plateau may have been reached going by the weight gain and feed to gain ratio.

The effect of low crude protein diet supplemented with varying levels of dietary lysine on the economic indices of broiler chickens in the starter and finisher phases are presented in Tables 5 and 6. Cost (kg), feed cost (perkgwt), income, profit and economic efficiency of growth (EEG) were significantly affected by the dietary treatment (p<0.05) at the starter phase while only EEG was significantly different at the finisher phase. A decrease in cost per kg with decreasing crude protein was observed. A similar trend was also observed for feed cost per kg weight at the starter phase. The result shows an increase in the profit and EEG with decreasing crude protein. This result is in line with the report of Mehrdad, [19] who supported the hypothesis that it is possible to produce more healthy and economic poultry meat by supplementation of excess lysine and methionine to broilers diets and contrary to the earlier report of Waibel et al. [20] who suggested that economical performance with reduced gain and breast meat yield may be obtained with lower protein diet.

Table 7 shows the carcass characteristics of broiler chickens fed low crude protein diet supplemented with varying levels lysine at the finisher phase. Of all the carcass parameters considered, liveweight and thigh which showed significant difference (P<0.05). Observations on thigh is contrary to the earlier findings of Ogunbode et al. [21] who reported a decrease in the weight of thigh as dietary crude protein decreases. Report on breast is similar to the previous work of Hickling et al. [22] who stated that lysine above NRC [10] levels did not improve breast yield unless methionine was also greater than the recommended level. Nonetheless, Kamran et al. [23] concluded that dietary protein level of broilers could be reduced from 23 to 20% with beneficial effects on growth performance, carcass characteristics and increased economic returns.

Table 1. Gross composition of experimental diet for broiler starter (1-4 weeks)

Ingredients (%)	D1	D2	D3	D4	D5
Maize	54.30	54.20	54.15	54.10	54.05
Soybean meal	40.00	40.00	30.00	30.00	30.00
Cassava flour	0.00	0.00	10.00	10.00	10.00
Lysine	0.40	0.50	0.55	0.60	0.65
*Fixed ingredients	5.30	5.30	5.30	5.30	5.30
Calculated	**Nutrients**				
Crude protein	22.49	22.48	18.265	18.26	18.255
ME (Kcal/Kg)	2944.66	2941.23	2989.51	2987.79	2986.08
Lysine	1.63	1.73	1.50	1.55	1.59
Methionine	0.58	0.58	0.53	0.53	0.53

**Fixed ingredients are Titanium dioxide, Dicalcium phosphate, Limestone, Salt, Premix and Methionine. ME-metabolizable energy*

Table 2. Gross composition of experimental diet for broiler finisher (5-7 weeks)

Ingredients (%)	D1	D2	D3	D4	D5
Maize	54.34	54.30	54.24	54.19	54.14
Soybean meal	40.00	40.00	29.00	29.00	29.00
Cassava flour	0.00	0.00	11.00	11.00	11.00
Lysine	0.40	0.45	0.50	0.55	0.60
Fixed ingredients	5.30	5.30	5.30	5.30	5.30
Calculated	**Nutrients**				
Crude protein	22.49	22.49	17.92	17.92	17.91
ME (Kcal/Kg)	2946.04	2944.66	2997.60	2995.88	2994.17
Lysine	1.64	1.68	1.43	1.48	1.52
Methionine	0.55	0.55	0.48	0.48	0.48

**Fixed ingredients are Titanium dioxide, Dicalcium phosphate, Limestone, Salt, Premix and Methionine. ME-metabolizable energy*

Table 3. Growth performance, flock uniformity and feather yield of broiler chicks fed low crude protein diets supplemented with varying levels of dietary lysine (1-4 weeks)

Parameters	D1	D2	D3	D4	D5	SEM±
ADFI (g/b/d)	73.20^{ab}	72.25^{b}	74.29^{ab}	73.78^{ab}	75.03^{a}	0.34
ADG (g/b/d)	40.54^{ab}	40.26^{ab}	41.93^{a}	39.77^{ab}	38.31^{b}	0.47
FCR	1.81^{ab}	1.80^{ab}	1.77^{b}	1.86^{ab}	1.97^{a}	0.03
FU (%)	90.00	90.72	90.88	91.17	88.54	0.61
FW (g $x10^{-1}$)	0.84^{a}	0.71^{ab}	0.64^{ab}	0.57^{b}	0.61^{ab}	0.08

ab-means in the same row with different superscripts differs significantly (P<0.05); ADFI- Average daily feed intake, ADG: Average daily gain, FCR: Feed conversion ratio, FU: Flock uniformity, FW: Feather weight

Table 4. Growth performance, flock uniformity and feather yield of broilers fed low crude protein diets supplemented with varying levels of dietary lysine (5-7 weeks)

Parameters	D1	D2	D3	D4	D5	SEM±
ADFI (g/b/d)	188.28	180.95	192.23	179.90	191.98	2.62
ADG (g/b/d)	63.28	57.55	52.63	56.67	55.03	2.50
FCR	2.99	3.26	3.69	3.37	3.53	0.16
FU (%)	89.24	90.27	87.29	89.71	87.55	0.59
FW (g)	0.08	0.08	0.14	0.08	0.13	0.02

ab-means in the same row with different superscripts differs significantly (P<0.05); ADFI- Average daily feed intake, ADG: Average daily gain, FCR: Feed conversion ratio, FU: Flock uniformity, FW: Feather weight

Table 5. Economic analysis of feeding broiler chicks with low crude protein diets supplemented with varying levels of dietary lysine (1-4 wks)

Parameters	D1	D2	D3	D4	D5	SEM
Feed cost/kg	106.10^{a}	110.01^{a}	93.83^{b}	94.11^{b}	94.90^{b}	2.16
Feed cost/kgwt	192.29^{a}	197.23^{a}	166.24^{b}	174.59^{ab}	186.24^{ab}	4.05
Income (₦/kg)	494.36^{ab}	496.90^{ab}	477.01^{b}	503.39^{ab}	531.44^{a}	7.41
Profit (₦/kg)	388.25	386.89	383.19	409.27	436.54	8.02
EEG (%)	202.67^{b}	196.47^{b}	230.94^{a}	234.64^{a}	234.24^{a}	5.47

ab-means in the same row with different superscripts differs significantly (P< 0.05); EEG: Economic Efficiency of Growth

Table 6. Economic analysis of feeding broiler chicken with low crude protein diets supplemented with varying levels of dietary lysine (5-7 wks)

Parameters	D_1-ve C	D_2+ve C	D3	D4	D5	SEM
Feed cost/kgwt	314.95	342.84	339.67	310.62	327.55	15.29
Income (₦/kg)	1348.52	1525.02	1566.16	1572.70	1630.45	62.50
Profit (₦/kg)	1242.96	1419.17	1473.90	1480.73	1538.76	63.15
EEG (%)	395.20^{b}	412.41^{ab}	456.11^{ab}	484.58^{a}	455.67^{ab}	12.22

ab-means in the same row with different superscripts differs significantly (P< 0.05); EEG: Economic Efficiency of Growth

Table 7. Carcass characteristics of broiler chickens fed low crude protein diets supplemented with varying levels of dietary lysine (5-7 weeks)

Parameters	D1	D2	D3	D4	D5	SEM
Live weight (kg/b)	2.21^{ab}	2.06^{b}	2.37^{a}	2.33^{a}	2.29^{ab}	0.04
Carcass weight	71.26	68.92	71.05	70.10	71.40	0.59
Drumstick	11.08	10.03	10.94	10.64	11.31	0.21
Thigh	9.60^{ab}	8.96^{b}	10.70^{ab}	10.50^{ab}	11.85^{a}	0.37
Breast (%)	24.06	24.83	22.20	23.54	21.53	0.65

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

The result of this study can be summerized in the words of Mehrdad, [19] who supported the hypothesis that it is possible to produce more healthy and economic poultry meat by supplementation of excess lysine (and methionine) to broilers diets.

4. CONCLUSION

From this study, the objective of the poultry farmer to achieve optimum production with least input is possible using a low crude protein diet supplemented with dietary lysine. This will result in increased profit, economic efficiency of growth, live weight and thigh size which bears an important and applied implication for a commercial investment in broiler production.

ETHICAL APPROVAL

All authors hereby declear 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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