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Effect of varying dietary lysine on growth performance, nutrient digestibility, organ weight and carcass characteristics of broiler chickens

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Target audience: Farmers, Livestock Scientist, Nutritionist and Animal Physiologist.

Abstract

The study was conducted to investigate the effect of varying levels of dietary lysine on growth performance, nutrient digestibility, organ weight and carcass characteristics of broiler chickens. One hundred and eight (108) 1-d old broiler chicks were randomly assigned to three dietarygroups (T_1 = 0.20%, T_2 = 0.40%, T3=0.60% lysine inclusion) of thirty-six birds replicated six times. The experiment lasted for six weeks. Significant differences ($P < 0.05$) were observed in the total weight gain, average daily weight gain and feed conversion ratio at the finisher phase. Birds fed T_2 and T_3 had improved crude protein digestibility ($P < 0.05$) compared to those fed T_1.Moreover, birds fed T_2 had a significantly higher thighweight ($P <0.05$). Conclusively, birds on T_3 had better performance in terms of total weight gain, average daily weight gain and feed conversion ratio. Although, high level of lysine in feed adequate in crude protein beyond 0.40% may not translate to higher thigh yield.

Keywords: Carcass; Growth; Lysine; Nutrient retention; Organ weight.

Description of Problem

Protein is a critical component of poultry rations, which is essential for life along with the other major nutrient classes (1, 2). Intact proteins are broken down by hydrolysis during digestion to yield amino acids, which are then utilized in the body to fulfill a variety of functions, which include: as structural components of skin, feathers, and muscle, as well as filling important metabolic roles as blood plasma proteins, enzymes, hormones, and immune antibodies which are all individually involved in specific functions in the body (2). These amino acids have been classified as essential and non essential because the former cannot be synthesized by the body either at all or in amounts great enough to meet physiological need while the latter could be synthesized by the body (1).

Commercial poultry diets are routinely supplemented with essential amino acids due to the deficiency of these nutrients in most feed ingredients. According to (3), some of the advantages of amino acid supplementation include a reduction in the cost of production, an increase in weight gain, optimization of meat yield, a decrease in carcass fat and uniformity in nutrient intake. Amino acid supplementation also helps to conserve resources and reduces waste (nitrogen excretion) through better utilization for protein synthesis.

Depending on the basal feedstuffs used in diet formulated, methionine and lysine occupies an important position in poultry nutrition and generally ranks as the first or second limiting amino acid. Most of the data used in setting the requirements standards pre-dates the 1990s, so, in essence, the modern broiler chick is being raised on nutrient requirements that are 30 or more years old. Meanwhile, modern broilers are fast growing than the earlier ones, thus their nutrient requirements must have changed.

Methionine has been associated with feather production in broiler chicks (4). The authors observed that feather yield was higher in the birds that received the highest methionine levels (0.48%) than in broilers fed lower methionine levels (0.30%). Diet formulated with high level (0.98%) of lysine has been reported to promote growth, and efficient carcass in broiler chicken, compared with diet formulated with low level (0.78%) of lysine (5, 6). (7) found that interaction of protein and lysine in broiler diet influence growth positively. Carcass yield and quality is important in poultry industry, due to increasing consumer interest in lean birds, and low cholesterol diet (8). It is important that the nutritional regimes meet the birds' needs for maintenance and growth so that breast meat and thigh meat accretion is optimized. Among the different nutritional components, protein and the amino acid type in the diet are fundamental, because they are related with synthesis of structural tissues (9).

It is necessary to note that bird requirements for efficient carcass are based on amino acids in the diet and not on crude protein (9), but the crude protein and amino acid status of a diet also influence the carcass composition of broilers with increased carcass protein and reduced carcass fat (10). Notably, adverse effects in performance and carcass yield are perfectly possible in this period due to lysine limitation, since its contents in meat are exceptionally high. Besides, breast meat represents around 30% of total broiler meat and 50% of total edible protein (11). This study examined effect of varying lysine levels on the growth performance, nutrient digestibility, organ weight and carcass characteristics of broiler chickens.

Materials and Methods

Experimental site

The experiment was conducted at the LadokeAkintola University of Technology Teaching and Research Farm, Ogbomoso, Nigeria.

Experimental birds and management

One hundred and eight (108) 1-d old unsex chicks were purchased from a reputable hatchery. They were housed in coal pot heated brooding house. The birds were randomly allotted into 3 dietary treatments of 36 birds each replicated six times. The birds were weighed at the beginning of the experiment and subsequent weights were taken and recorded at weekly intervals. Heat was supplied for the first 3 weeks to provide brooding temperature of 35^0C, 33^0C, 31^0C for the 1st, 2nd and 3rd week respectively.

The birds had free access to feed and water throughout the entire six (6) weeks of the experiment. All necessary vaccinations and preventive medications were given to the birds.

Source of Test ingredient

The lysine used is a brand of L-Lysine Hcl manufactured by Ajinimoto Heartland Inc., with 98.5% L-lysine monohydrochloride.

Data collection

Growth Performance

A known weight of feed was weighed out and given daily. The leftovers after each day's meal were weighed. Feed consumption for each day was obtained by the difference between the total feed given and the leftovers each day. Average feed consumption per bird per replicate for the day was calculated by dividing the total weight of feed consumed by the number of birds in each replicate. Birds in each replicate were weighed on arrival and subsequently weighed at the end of each week. The average body weight per birds per week was obtained from each replicate by dividing the total body weight in each replicate by the total number of birds in the replicate.

Digestibility Study

Four birds were randomly selected from each replicate and transferred to metabolic cages at day 35 of the experiment. A three-day acclimatization period was allowed prior to a three-day faecal collection period. The labelled faecal samples were oven dried at 85°C. Dry matter, ether extract, crude fibre, and crude protein were determined as described by (12). The gross energy of the diets and excreta samples was determined using an adiabatic bomb calorimeter (Gaallenkamp,). The apparent metabolisable energy (AME) content of the diets was calculated (12).

Organ and Carcass Evaluation

At the end of 6 weeks feeding trial, 2 birds similar in weight were randomly selected from each replicate. After 6 hours of feed withdrawal, the birds were weighed and then slaughtered using the cut-throat method and were allowed to bleed completely, Visceral organs (liver, kidney, pancreas, gizzard, spleen, heart, and lungs were eviscerated before scalding and defeathering) and carcass cuts (wing, thigh, drum stick, breast, and shank) were weighed using a sensitive weighing balance and expressed as percentage of live weight.

Experimental Design andStatistical Analysis

Complete Randomised Design was employed. All data were subjected to One-way Analysis of Variance using of (13) software package. Significant means were separated using Duncan multiple range test of the same package.

Results

Tables 1 and 2 shows the gross composition of the experimental diets at the starter and finisher phases respectively, while their determined proximate composition is shown in Table 3. The determined crude protein (except for starter phase, T1), crude fibre and ether extract of the diet is slightly higher when compared with the calculated composition.

Table 4 shows the growth performance of broilers fed varying levels of lysine at starter and finisher phases. All the growth parameters showed no significant ($p>0.05$) changes at the starter phase but a quadratic progression from treatment 1 to 3 was noticeable. Birds on Treatment 2 had slightly higher values than both treatments 1 and 3. At the finisher phase, weight gain, average daily gain (ADG) and feed conversion efficiency were significantly influenced ($p < 0.05$). Increasing lysine in the diets increased the weight gain and ADG, although, the feed conversion efficiency showed significant ($p < 0.05$) linear decrease from treatment 1 to 3.

Table 5 shows the digestibility coefficients of broiler chickens fed varying levels of dietary lysine at 35-41 days of the study. The CP digestibility showed significant ($p < 0.05$) changes with birds on treatment 2 similar to treatment 3; both were significantly ($p<0.05$) higher than those birds fed treatments 1. Relative value of carcass cut-up parts of broilers fed varying lysine is shown in Table 6. Dietary lysine concentration did not influence ($p > 0.05$) all the carcass part examined except the thigh ($p < 0.05$) and the response was quadratic. Birds fed diet 2 (0.04) had higher thigh weight compared to those fed diets 1(0.02) and 3 (0.06). Table 7 shows the relative value of organ weight of broilers fed varying dietary lysine. The weight of the heart, liver, gizzard, gizzard fat, proventriculus and abdominal fat were not significantly ($p > 0.05$) influenced.

Discussion

The observed difference in the calculated and determined nutrient composition could be attributed to variation in chemical composition of the ingredients used and the higher inclusion of lysine in these diets.

At the starter phase, similar observations on growth parameters were reported by (14) not to be significant. The authors reported that the increase in lysine levels may decrease feed intake not weight gain contrary to the observation of (15).

A linear increase observed in weight gain and ADG as the lysine increases at the finisher phase agrees with the report from (16) who reported an increasedgrowth and carcass protein. Linear decrease in feed conversion efficiency was reported by some researchers (14, 17, 18) who observedthat increasing lysine level in the diet decreased FCR. In contrast, the result of this experiment disagrees with the findings of (19). Nevertheless, (20) and (21) noted significant increase in weight of the birds fed essential amino acid (EAA) compared to those fed a diet with 23% CP.

The result on digestibility of CP may implied that synthetic lysine could play significant role in the digestibility of nutrients in feeds, more especially since synthetic lysine is an essential building block for protein in the body (15).

Carcass weight and composition of broiler chicken are receiving considerable attention in recent time. There is emphasis on increasing meat yield and decreasing fat content of the broiler chicken carcass (22). (15) also reported an increase in thigh size with increasing lysine inclusion which agrees with the observation of this study. Nevertheless, thigh weight climaxed at treatment 2.

Conclusion and Application

The result of this study indicates that:

1. Birds on treatment 3 (0.60% lysine inclusion) had better performance in term of weight gain, average daily gain and feed conversion efficiency.
2. Use of lysine at 0.60% in feed formulation for broilers recorded better carcass quality, which will translate to higher market price for the birds.
3. Higher lysine in feed that is adequate in crude protein above 0.40% may not translate to higher thigh yield.

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Table 1: Gross composition of experimental diets at starter phase (%DM)

Ingredients	Treatment 1	Treatment 2	Treatment 3
Maize	50.18	50.18	50.18
Soybean	30.50	30.50	30.50
Rice bran	8.06	7.86	7.66
Fish meal	6.00	6.00	6.00
Oyster shell	1.00	1.00	1.00
Bone meal	3.00	3.00	3.00
Lysine	0.22	0.42	0.62
Methionine	0.24	0.24	0.24
Salt	0.30	0.30	0.30
Vitamins premix[#]	0.50	0.50	0.50
Total	100	100	100
Calculated nutrient composition			
Crude protein	23.58	23.56	23.53
ME Kcal/kg	2866.30	2861.42	2856.54
Lysine	1.49	1.65	1.80
Ether Extract	4.09	4.07	4.04
Crude Fibre	3.92	3.90	3.88

[#]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; Iron 100,000mg; zinc, 80000mg; copper 8500mg; iodine 1500mgcobalt 3000mg; selenium 120mg and anti-oxidant 120,000mg.

Table 2: Gross composition of experimental diets at finisher phase (%DM)

Ingredients	Treatment 1	Treatment 2	Treatment 3
Maize	40.00	40.00	40.00
Soybean	10.00	10.00	10.00
Rice bran	29.76	29.56	29.36
Groundnut cake	15.00	15.00	15.00
Oyster shell	1.00	1.00	1.00
Bone meal	3.00	3.00	3.00
Lysine	0.20	0.40	0.60
Methionine	0.24	0.24	0.24
Salt	0.30	0.30	0.30
Vitamins premix	0.50	0.50	0.50
Total	100	100	100
Calculated nutrient composition			
Crude protein	18.36	18.34	18.31
ME Kcal/kg	2713.64	2708.76	2703.88
Lysine	0.92	1.08	1.24
Ether extract	6.74	6.72	6.69
Crude fibre	5.78	5.76	5.74

Table 3: Chemical composition of the experimental diet in percentage of dry matter (%)

Treatments	CP	CF	ASH	EE	NFE	DM
Starter phase						
1.	21.03	5.90	9.50	10.50	53.07	89.38
2.	25.87	5 .25	9.45	11.50	47.93	89.88
3.	24.46	5.45	8.75	10.50	50.84	89.69
Finisher phase						
1.	16.75	7.40	10.00	9.25	56.60	90.1
2.	17.45	6.65	11..25	10.50	54.14	88.95
3.	16.30	7.15	9.50	11.45	55.6	89.13

CP=Crude protein, CF=Crude fibres, EE=Ether extract, DM=Dry matter, NFE=Nitrogen free extract

Table 4: Performance characteristics of broilers fed varying dietary lysine at starter and finisher phases

	Treatments			SEM	P value
Parameters	1	2	3		
Starter phase					
Initial weight(g)	43.20	43.47	43.89	0.75	0.63
Final weight(g)	568.06	584.72	568.06	13.88	0.64
Weight gain(g)	524.86	541.25	524.17	14.01	0.64
ADFI(g/bird/day)	45.03	46.00	45.43	0.77	0.67
ADG(g/bird/day)	24.99	25.77	24.96	1.63	0.65
FCR	1.81	1.79	1.82	0.03	0.82
Finisher phase					
Final weight(g)	1388.33	1431.67	1423.06	16.03	0.18
Weight gain(g)	820.27^{c}	846.94^{b}	855.00^{a}	12.66	0.002
ADFI(g/bird/day)	132.82	134.60	132.87	1.54	0.66
ADG(g/bird/day)	39.06^{c}	40.33^{b}	40.71^{a}	0.60	0.002
FCR	3.40^{a}	3.34^{ab}	3.26^{b}	0.05	0.007

^{a,b} means the superscript differs significantly at ($p<0.05$) within the same row

Table 5: Nutrient digestibility of broiler chickens fed varying dietary lysine

	Treatments				
Parameters	1	2	3	SEM	P Value
Dry matter	92.24	94.22	95.00	1.22	0.05
Crude protein	84.20^{b}	86.10^{a}	86.00^{a}	1.09	0.04
Crude fibre	72.14	78.20	80.10	2.10	0.05
Ether extract	82.14	87.2	87.1	1.04	0.05
Ash	65.23	67.21	68.11	0.23	0.14

^{a,b} means the superscript differs significantly at ($p<0.05$) within the same row

Table 6: Relative value of carcass cut-up parts of broilers fed varying dietary lysine

Cut-up parts	Treatments			SEM	P-value
	1	2	3		
Head	3.54	3.49	3.42	0.09	0.68
Neck	6.18	6.26	6.22	0.30	0.98
Wings	11.73	10.56	10.86	0.45	0.25
Thighs	13.84[b]	14.23[a]	13.22[b]	0.27	0.04
Drumsticks	12.97	13.49	13.32	0.46	0.73
Breast	25.33	25.51	26.66	0.60	0.26
Back	20.15	20.06	20.21	0.56	0.98
Shanks	6.25	6.40	6.10	0.25	0.73

[a,b] means the superscript differs significantly at ($p<0.05$) within the same row

Table 7: Relative value of organs of broilers fed varying dietary lysine

Organs	Treatments			SEM	P-value
	1	2	3		
Heart	0.68	0.63	1.05	0.15	0.37
Liver	2.84	2.96	3.27	0.17	0.20
Gizzard	3.02	2.96	2.98	0.36	0.97
Gizzard fat	0.73	0.80	0.74	0.11	0.87
Proventiculus	0.71	0.70	0.69	0.33	0.92
Abdominal fat	1.48	1.38	1.48	0.12	0.88

[a,b] means the superscript differs significantly at ($p<0.05$) within the same row