Utilization of coconut meal based diets supplemented with lysine by broiler chicken

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Abstract

Coconut meal (CM) was included in a broiler diet to supply 40% of the total groundnut cake protein. The diet was formulated based on the recommendations of a previous study that coconut meal protein can replace 40% of groundnut cake (GNC) in broilers diet. A control diet was formulated containing 22% GNC, the protein of which was replaced by coconut meal protein. Five diets were prepared. The control (Diet A) and 4 others that contained essentially the same proximate composition (Diets B- E) were supplemented with synthetic lysine at 0.30, 0.60, 0.90, and 1.20% dietary levels. 240 broiler chicks were allotted into 5 dietary treatment groups of 3 sub-groups. Each sub-group contained 16 birds. The dietary lysine content from diets A-E were 1.20, 1.15, 1.45, 1.76 and 2.00% respectively and were fed to the broilers for a period of 56 days. Performance indices, average feed consumption, average body gain, live weight, feed conversion ratio (FCR), protein efficiency ratio (PER) were monitored. The dry matter, protein and ether extract retentions were all equally monitored twice at the 4th and 8th week. Hematological and enzyme assays were investigated at 4th and 8th week. The average feed consumption and FCR were significantly increased ($P < 0.05$) by the increasing level of lysine supplementation both at the 4th and 8th week. The body gain also decreased significantly ($P < 0.05$) at the 4th and 8th week while the live weight was significantly ($P < 0.05$) better in the control and 0.6% lysine supplementation at the 56th day of the study. The dry matter, nitrogen and ether extract retentions significantly decreased ($P < 0.05$) at the 4th and 8th week. The total protein and albumin decreased significantly ($P < 0.05$) at the 4th and 8th week while, creatinine and urea increased with increasing level of lysine supplementation. The serum glutamate amino transaminase and alanine amino transaminase both increased significantly ($P < 0.05$) at the 4th and 8th week. The study indicated that 0.6% lysine supplementation (of diet containing coconut meal contributing 40% protein of the major vegetable protein source) enhanced the utilization of the coconut meal by broilers.

Keywords: Coconut meal, lysine supplementation, broilers, diet.

Introduction

The indispensable roles of protein in the nutrition of farm animal has become of significant importance which largely depend on its amino acid compositions. Coconut meal, where available is one of the relatively cheaper vegetable protein sources. It could be used to

substitute for soybean or groundnut cake (GNC) protein in chicks ration (Dairo, 1999; 2000) but it is not balanced in amino acid composition (Thorne *et. al.*, 1992). This however limits its use at higher levels in chicks ration (Dairo, 2000). Copra meal was reported to have variations in nutrient composition due to the different

processing methods with a range of 15.4 – 21.8% crude protein (Thorne *et al.*, 1989). It has been found to be deficient in lysine (Onwusu-Domfeh *et al.*, 1970; Creswell and Brooks, 1971a; Mee and Brooks, 1973; Thorne *et al.*, 1988). Lysine is the first limiting amino acid and it is 0.48% in coconut meal as reported by Creswell and Brooks (1971a) while Thorne *et al.*, (1992) reported a value of 0.50%. Olomu and Offiong (1980) recommended a total lysine dietary level of 1.01-1.26% for broilers to obtain optimum performance while Fetuga (1984) reported that a range of 1.1-1.30% as adequate for both broilers and pullet chicks. Morris and Abebe (1990) also indicated the importance of lysine and methionine to the growth of pullet and broiler chicks. They recommended a maximum dietary level of 1.20% lysine at the starter phase. The availability of the amino acid and their balance in the diet has continually been an area of focus towards improved utilization of feedstuffs especially coconut meal that is limiting in lysine as mentioned earlier. Though the amino acid profile of the local coconut meal was not analyzed, report from literature (Webb *et al.*, 1977; Yeong, 1980) makes it empirical therefore to investigate the growth performance and nutrient utilization of broilers fed diets containing locally produced coconut meal.

Materials and Methods

Preparation of experimental diet

The test ingredient (coconut meal) was obtained and processed as described by Dairo (1999). The processed coconut meal (proximate composition in Table 1) was included in a formulated diet shown in Table 2 to supply 40% of the major vegetable protein source i.e. GNC. Synthetic lysine was added at 0.30, 0.60, and 1.20% of the diet. The lysine was added to the control diet (A) i.e. 0% coconut meal at 0.30% to give a maximum dietary content of 1.20% which is the recommended requirement for the broiler chicks (Olomu and Offiong 1980; Fetuga, 1984). Diets

B-E were supplemented at 0.30, 0.60, 0.90 and 1.20% respectively to contain a maximum dietary lysine level at 1.15, 1.45, 1.76, and 2.0% correspondingly. This arrangement provides for lysine supplementation below and above the requirement of the broiler chicks. Groundnut cake and coconut meal are both deficient in lysine.

Experimental design, procedure and animal management.

The experiment was arranged in a completely randomized design. 240 broiler chicks were divided into 5 groups of 3 replicates each. There were 16 birds in each replicate (i.e. 48 birds in a group). The 5 groups were fed the 5 diets i.e. the control and 4 dietary lysine supplementation levels at 0.30, 0.60, 0.90 and 1.20% respectively. Replicate groups were randomly allotted to pens in the brooder/rearing house of the Teaching and Research Farm of the Lagos State Polytechnic, Ikorodu. Heat was supplied using a combination of kerosene stoves, coal pots, and 200-watts bulbs alternately depending on the intensity of the cold weather. Water and experimental feed were fed *ad libitum*. The chicks were given anti-stress orally for 7 days in water. Standard medication programme peculiar to broiler chicken production was followed. The birds were fed starter diets for 4 weeks and finisher diets for the rest of the experiment (Table 2)

Digestibility trial

On the 15th and 42nd day of the experiment digestibility trials were conducted respectively. Five birds from each replicate were transferred to an adapted metabolic cage equipped with feeders and drinkers. Polythene sheets were spread underneath each of the cell to collect faecal samples. A 7-day adaptation period was observed prior to the faecal collection. Total collection approach was employed. 4% butyric acid solution was sprayed on the droppings to prevent deterioration through oxidation and growth of maggots. The droppings were weighed wet. Faecal samples collected were labelled, weighed and dried in the Gallenkamp oven at 60°C until

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Table 1. *Determined percent proximate composition of coconut meal.*

Parameters	%
Dry matter	87.85
Crude protein	19.63
Crude fibre	16.00
Ether extract	14.18
Ash	4.01
Nitrogen Free Extract (NFE)	31.03
Metabolizable Energy (M.E.) (Calculated)	11.95 MJ/Kg

a constant weight was obtained. Dried samples were kept in desiccators to prevent uptake of moisture and were later used to determine the dry matter, nitrogen and ether extract. Values obtained were used in calculating nutrient retention.

Blood sample collection and enzyme assays.

The blood samples were collected from the right wing veins at 28th and 56th day of the experiment respectively. The blood samples collected were immediately emptied into heparinized bottle to prevent clotting. The heparinized blood samples were transported to the laboratory for centrifugation using Gallenkamp table centrifuge at 3,000 rpm for 10 minutes. The sera were separated and stored at -10°C prior to analysis. The serum total protein was determined according to Weichelbaum (1946) procedure. The globulin was assayed according to the procedure described by Rodkey (1965) and the albumin as described by Doumas and Briggs (1972). Serum urea and creatinine were determined by the methods of Fawcett and Scott (1966) and Scott (1965) respectively. The method of Reitman and Frankel (1957) was employed in the analysis of alanine amino transaminase and glutamate transaminase.

Proximate analysis and statistical analysis

The feed samples at the starter and finisher phases as well as the faecal samples and the test ingredient were analyzed according to AOAC

(1995). The statistical analysis was done according to Steel and Torrie (1980)

Results and Discussion

The growth performance and the nutrient utilization of the broilers are shown in Table 3. During the starter phase, the average daily feed consumption increased significantly ($P<0.05$). The highest intake (52.47g) was recorded on diet with 1.20% lysine supplementation or having 2.0% total lysine while the diet with 1.20% total lysine i.e. the control diet had the lowest feed intake (48.0g). The feed intake was also significantly increased ($P<0.05$) both at the finisher phase and at the 56th day which almost following the pattern observed at the starter phase. The average daily weight gain did not follow this trend but was also significantly influenced ($P<0.05$) both at the starter and finisher phases. The birds on diets A with total lysine content 1.20% had the highest daily body gain (14.36g) while diet E having 2.0% total lysine recorded the lowest (12.64g) at the starter phase. However, birds on 0.60% lysine supplementation or 1.45% total lysine (diet C) recorded the highest daily weight gain (25.84g) and those on the same diet E had the lowest gain (22.85g) at the finisher phase. At the end of the 8th week, birds on diets A, B and C had comparable live weight (2192.4g, 2138.27g and 2238.88g respectively) which significantly differ ($P<0.05$) from those on diets C and D.

Table 2: Percent composition of experimental diets

Ingredients/Diets	Starter Phase					Finisher Phase				
	% Lysine Supplementation					% Lysine Supplementation				
	Control	B	C	D	E	Control	B	C	C	E
Maize	45.00	34.00	34.00	34.00	34.00	45.25	36.21	36.21	36.21	36.21
Maize offal	11.00	10.00	10.00	10.00	10.00	12.00	10.00	10.00	10.00	10.00
Wheat offal	10.00	11.00	11.00	11.00	11.00	10.00	10.00	11.00	11.00	11.00
Groundnut cake	22.00	13.20	13.20	13.20	13.20	22.00	13.20	13.20	13.20	13.20
Coconut meal	-	20.20	20.20	20.20	20.20	-	20.20	20.20	20.20	20.20
Blood meal	6.00	6.00	6.00	6.00	6.00	4.00	4.00	6.00	6.00	6.00
Bone shell	3.70	3.50	3.20	3.00	20.20	3.70	3.50	3.50	3.00	3.00
Oyster shell	1.00	0.80	0.80	0.70	0.70	2.00	1.80	1.50	0.50	0.50
*Premix	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
L-lysine-HCL	0.30	0.30	0.60	0.90	1.20	0.30	0.30	0.60	0.90	1.20
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Calculated Analysis										
Crude Protein (%)	21.89	21.03	21.03	21.03	21.03	20.19	19.17	19.17	19.17	19.17
Crude fiber (%)	4.17	6.76	6.76	6.76	6.76	4.30	6.71	6.71	6.71	6.71
M.E.(Kcal/kg)	2808.39	2824.4	2824.4	2824.4	2824.4	2746.18	2780.32	2780.32	2780.32	2780.32
Lysine	1.20	1.15	1.45	1.76	2.0	0.78	0.77	0.80	0.83	0.86
Methionine	0.87	0.73	0.73	0.73	0.73	0.85	0.85	0.85	0.85	0.85

* Supplied the following Kg⁻¹ diet. Vit.A8x10³ iu; Vit D. 2x10³ iu; Vit K, 2mg; Riboflavin, 4.20mg; pantothenic acid, 5mg; nicotinic acid, 20mg; folic acid, 0.5mg; Choline 3mg; Mg. 56mg; Iodine 1 mg; Fe 20mg; Cu, 10mg; Zn, 50mg; Co, 1.25mg.

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Table 3: Performance and nutrient utilization of broilers fed coconut meal ration supplemented with lysine.

Diets	% Lysine Supplementation					*SEM
	Control A	0.30 B	0.60 C	0.90 D	1.20 E	

Determination at the 4th Wk. (Starter phase)						
Average daily feed consumption (g)	48.0 ^b	48.93 ^{ab}	49.51 ^{ab}	52.15 ^a	52.47 ^a	4.01
Average daily body gain (g)	14.36 ^a	14.00 ^a	14.13 ^a	13.00 ^b	12.64 ^b	0.98
Feed to gain ratio (FCR)	3.34 ^b	3.49 ^b	3.50 ^b	3.99 ^a	4.13 ^a	13.00
Protein efficiency ratio (PER)	1.38	1.38	1.27	1.20	1.15	0.36 ^{NS}
Dry matter digestibility (%)	48.68 ^a	43.40 ^b	43.45 ^b	43.28 ^b	41.98 ^b	2.89
Nitrogen retention (%)	58.50 ^a	53.08 ^{bc}	55.01 ^b	51.43 ^{cd}	49.75 ^d	2.99
Ether extract retention (%)	84.15 ^a	81.81 ^b	82.83 ^{ab}	80.88 ^{bc}	79.72 ^c	1.79
Determination at the 8th Wk. (Finisher phase)						
Average daily feed consumption (g)	83.47 ^b	84.22 ^b	84.64 ^b	86.49 ^a	86.62 ^a	1.73
Average daily body gain (g)	24.79 ^{ab}	24.18 ^b	25.84 ^a	23.54 ^{bc}	22.85 ^{bc}	1.35
Feed to gain ratio (FCR)	3.37 ^{bc}	3.49 ^b	3.27 ^c	3.68 ^a	3.79 ^a	0.179
Protein efficiency ratio (PER)	1.47 ^b	1.50 ^b	1.59 ^a	1.42 ^{bc}	1.38 ^c	0.086
Dry matter digestibility (%)	82.18 ^a	79.38 ^b	76.82 ^c	75.72 ^c	73.58 ^d	1.35
Nitrogen retention (%)	81.97 ^a	79.38 ^b	76.82 ^c	75.72 ^c	73.58 ^d	1.62
Ether extract retention (%)	86.78 ^a	85.92 ^a	84.72 ^b	83.14 ^c	82.91 ^c	0.98
Overall Performance at 56 days						
Average daily feed consumption (g)	131.47 ^b	133.15 ^{ab}	134.15 ^{ab}	138.64 ^a	139.09 ^a	6.46
Average body live weight (g)	2192.4 ^a	2138.27 ^a _b	2238.88 ^a	2048.79 ^b _c	1987.48 ^c	107.74
Feed: Gain ratio	3.37 ^b	3.49 ^b	3.36 ^b	3.79 ^a	3.92 ^b	0.195

Mean values with different superscript differ significantly ($P < 0.05$)

* Standard Error of Mean.

The increase in feed intake at the starter and finisher phases and throughout the experimental period must have been influenced definitely not by the fibre content of the feed but the treatment. Lysine supplementation does not have direct influence on the feed intake of birds. However, the level of supplementation must have influenced the metabolic processes which may have altered the trend of growth. Excess of amino acid in the diet has been reported to have harmful effect on the utilization of other amino acid (Baldini and Rosenberg, 1955). Jones (1964)

indicated a lysine-arginine antagonism, which influence intake and decreased weight gain. The average daily gain was optimum at the starter phase for birds on diet A i.e. 1.20% total lysine content followed by 0.60% lysine supplementation, diet C (i.e. 1.45% total lysine). The body weight gain values decreased as the total dietary lysine levels increased from 1.45-2.0%. This is an indication that there is optimum level of lysine in the diet that can support growth which agrees with the findings of Olomu and Offiong (1980) and Latshaw, (1993).

The dry matter digestibility, nitrogen and the ether extract retention all decreased significantly ($P < 0.05$) as the lysine supplementation level increased at the 4th and 8th week respectively. This obviously is a result of the nature of the fibre in the test ingredient. Teves *et. al.*, (1992) identified galactomannan and other polysaccharide components of coconut meal fibre as being responsible for its under- utilization. He reported that coconut meal fibre utilization could be improved if treated with mannanase, an enzyme from *streptomyces* specie no 17 isolated from soil. The feed to gain ratio increased significantly ($P < 0.05$) as the dietary levels of lysine supplementation increased. Birds on the control diet A had the best feed to gain ratio (3.34) at the starter phase while diet C (3.27) recorded the best at the finisher phase but not significantly different from diet A (3.37). The protein efficiency ratio (PER) was significantly ($P < 0.05$) better for diet C followed by diet A with values of 1.59 and 1.47 respectively at the finisher phase but not significant at the starter phase. This trend was almost followed at the end of the 56th day as diets A- C had comparable FCR.

The values of the blood metabolites investigated are shown in Table 4. The total protein and albumin values were significantly ($P < 0.05$) decreased both at the 4th and 8th week, while those of creatinine and urea were increased by the lysine supplementation levels. At the starter phase, birds on diets E and D had significantly high levels of creatinine and urea in their blood (0.83 and 0.79 respectively) while diets A and C were lower (0.68 and 0.73). This trend was repeated at the finisher phase. The decreasing values of the total protein and albumin fraction is an indication of protein under-nutrition (Cantarow and Schepartz, 1967) while the increasing values of creatinine and urea suggest a decline in the quality of protein as the coconut meal dietary level increased. However, the supplementation with lysine improved the quality of protein as the values for diets A and C did not significantly differ. Excess lysine supplied often

result in the indiscriminate activation of the kidney arginase by lysine, which consequently degrades the arginine of the diet to ornithine and urea (Jones *et. al.*, 1967; Latshaw, 1993). This was further confirmed by the serum enzyme activities shown in Table 5. The mean values of the glutamate amino transaminase (EC 2.6.1.1.1) and alanine transaminase increased significantly ($P < 0.05$) which indicated that diets with total lysine contents of 1.20-1.45 had better biological value of protein (Eggum, 1970). This is translated in the overall growth performance of the broilers with those on 1.45% total lysine exhibiting the highest live weight.

Conclusion

It can be concluded therefore, that lysine supplementation of ration containing coconut meal at 0.60% to give total lysine content of 1.45% will enhance utilization of the vegetable protein source in broiler diet.

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Table 4: Mean value of some blood metabolites of broilers fed coconut meal ration supplemented with lysine.

Diets	% Lysine Supplementation					*SEM
	Control A	0.30 B	0.60 C	0.90 D	1.20 E	
Determination at the 4 th Wk. (starter phase)						
Total protein (g/dl)	6.01 ^a	5.66 ^b	5.29 ^{bc}	5.12 ^{bc}	4.90 ^c	0.50
Albumin (g/dl)	3.75 ^a	3.38 ^a	3.11 ^a	2.93 ^b	2.35 ^b	0.64
Globulin (g/dl)	2.26	2.28	2.18	2.9	2.55	0.37 ^{NS}
Creatinine (mg/dl)	0.68 ^b	0.71 ^b	0.73 ^b	0.79 ^a	0.83 ^a	0.05
Urea (gldl)	18.65 ^d	19.83 ^b	18.72 ^d	19.61 ^{bc}	20.90 ^a	0.70
Determination at the 8 th week						
Total Protein (g/dl)	5.85 ^a	5.58 ^{ab}	5.41 ^{bc}	5.28 ^{bc}	5.23 ^c	0.33
Albumin (g/dl)	4.05 ^a	3.81 ^{ab}	3.56 ^{bc}	3.42 ^{cd}	3.22 ^d	0.25
Globulin (g/dl)	1.0	1.77	1.85	1.86	2.01	0.26 ^{NS}
Creatinine (mg/dl)	1.48 ^d	1.58 ^{cd}	1.63 ^{bc}	1.68 ^{ab}	1.72 ^a	0.08
Urea (gldl)	25.39 ^c	25.98 ^b	25.54 ^c	26.11 ^b	26.98 ^a	0.161

Mean values with different superscripts are significantly different (P<0.05).

* Standard Error of means.

Table 5: Serum glutamate amino transaminase and alanine amino transaminase of broilers fed coconut meal supplemented with lysine.

Diets	% Lysine Supplementation					*SEM
	Control A	0.30 B	0.60 C	0.90 D	1.20 E	
Determination at the 4 th Wk.						
Glutamate amino transaminase (IU/L)	131.33 ^d	145.67 ^c	149.33 ^c	155.00 ^b	163.67 ^a	5.27
Alanine amino transaminase (IU/L)	37.00 ^c	51.67 ^b	56.33 ^b	63.33 ^a	67.33 ^a	5.96
Determination at the 8 th week						
Glutamate amino transaminase (IU/L)	151 ^d	153.67 ^{cd}	155.00	157.00 ^{ab}	158.67 ^a	2.80
Alanine amino transaminase (IU/L)	44 ^e	46.67 ^d	49.0 ^c	51.33 ^b	54.0 ^a	1.35

Mean values with different superscripts are significantly different (P< 0.05)

* Standard Error of means.

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