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Evaluation of fermented african yam bean (*Sphenostylis stenocarpa)* and pigeon pea (*Cajanus cajan)* seed meals in diets of broiler chickens

Abioye, A. A., *Ojediran T. K. and Emiola, I. A.

Department of Animal Nutrition and Biotechnology, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

Corresponding Author: tkojediran@lautech.edu.ng Phone no.: +234-8034104295

Target audience: Farmers, Animal scientist, Nutritionists, Researchers

Abstract

African Yam Bean (AYB) and Pigeon Pea (PP) seeds are rich in crude protein, nitrogen free extract and mineral components, which were marginally enhanced post-fermentation with reduced anti-nutrients. These substrates were fed to a total of 120 1-d old broiler chicks at 50 and 100% replacement for soybean. Five experimental diets were formulated with maize-soybean based diet as the control in a Completely Randomized Design in a 42-day feeding trial. Each treatment consisted of 3 replicates, with 8 birds per replicate. The results showed that there were significant ($p<0.05$) differences among treatments in average daily feed intake (ADFI), average daily gain (ADG) and feed conversion ratio (FCR). The ADFI and ADG were depressed in birds fed 100% FAYB compared with those fed 50% of either of the two legumes while the FCR of those fed 50% of the substrates compared favourably with the control. Birds fed diets containing 100% FPP had higher digestibilities of Ether Extract and ash compared with those fed 50% FPP but similar to those obtained for birds in the control and FAYB. This study revealed that broiler chicks could tolerate 50% FAYB and FPP without detrimental effect on growth performance.

Keywords: African yam bean; broilers; growth; nutrient retention; pigeon pea

Description of problem

The competitiveness of some convectional feedstuffs such as soybean and groundnut with man has increased the cost of poultry production in recent times. Consequent upon these, there is serious need to develop the use of non-conventional feedstuff to replace these highly scarce and expensive conventional feedstuffs. Example of such cheaper alternative plant protein source are African yam bean (AYB) and Pigeon pea (PP) which had been reported by (1) and (2) to be rich in protein and minerals. (3) and (4) reported that African yam bean, an under-utilized grain legumes possess high crude protein content between 22-30% while Pigeon pea was reported to have protein ranging from 18-26% (5).

Pigeon pea seed has been recommended as an alternative to soybean meal or groundnut cake at 10-20% inclusion level in the diets of layers (6), broilers (7) and pullet chicks (8) in Nigeria. Although, the use of these legume seeds is limited due to the presence of anti-nutritional factors. (2) has identified the presence anti-nutrients including trypsin inhibitors, saponin, tannin and phytate. Nevertheless, the use of several processing

methods have been suggested by several authors (9, 10, 11) as a means of improving the nutritional quality of legume seeds. Processing methods such as heating and soaking can be used to reduce the anti-nutritional factors and improve the nutritional value of *Sphenostylis stenocarpa* products and its by-product (12).

Therefore, this study investigated the effect of fermentation on the nutrient composition of African yam bean and Pigeon pea meals and their effect on the performance of broiler chickens.

Materials and Methods

Experimental site: The experiment was carried out at the Poultry Unit of Teaching and Research Farm, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Oyo state, Nigeria. Ogbomoso is located on Longitude $4^{o}15'$ East of the Greenwich meridian and latitude $8^{o}15'$ North of the equator in the derived savanna zone of Nigeria. The latitude is between 300 and 600 meters above sea level. The mean annual temperature is about 27^{0}C while that of average rainfall is 1247mm. The vegetation of the study area is in the derived savannah zone.

Sources of Test ingredients: Two different legumes seeds namely: African yam bean (*Sphenostylis stenocarpa*) and Pigeon pea (*Cajanus cajan)* were used in this study. African yam bean was purchased from local markets in Iseyin in Oyo State where it is grown in commercial quantity while Pigeon pea was purchased from Bodija market, Ibadan, Oyo State.

Processing Methods of Test Ingredients: The processing method employed on both legume seeds was unconventional (Traditional) fermentation as described by (13).100kg each of both seeds were ground into granules and wet with water (10 litres of water to 100kg seed) and bagged in small packs of 5kg inside white-cellophane paper. They were then packed inside two different black plastic drums and covered. The drums were well covered to prevent oxygen from penetrating. The drums were opened on the seventh day at room temperature (14) and the seeds were sun-dried for four day before milling.

The raw and the fermented seeds were milled to pass through 0.5mm sieve and samples were stored separately in clean sealed cellophane papers until required for further analysis.

Experimental Diet: A total of five experimental diets were formulated. A maize-soybean diet served as the control diet. Fermented African yam bean and Pigeon pea were included in the diets at 50 and 100% at the expense of soybean meal in the control diet; and these represented dietary treatments 2 & 3 and 4 & 5 respectively. The feed composition for starter and finisher broiler diets are shown in Tables 1 and 2 respectively while Table 3 shows the determined proximate compositions of the experimental diets.

Experimental birds and Management: A total of one hundred and twenty (120) day old broiler chicks were obtained from a reputable commercial hatchery within the study area. The birds were weighed on arrival and were allocated to the five dietary treatments in a Completely Randomized Design (CRD). Each treatment had twenty four (24) birds, which were further sub-divided into three (3) replicates of eight (8) birds each. Feed and water were provided *ad libitum* throughout the period of the experiment. Standard management practices and routine vaccination were strictly observed. The experiment lasted for 42 days. Weight gain was measured weekly while feed intake was recorded daily.

Data Collection

Data were collected on average daily feed intake and average daily gain. Feed to gain ratio was calculated from data collected on average daily gain and average daily feed intake.

Table 1: Gross Composition of Broiler Starter Diets (1 – 3weeks)

	Treatment				
Parameters (%)	**T1** Control	**T2** 50%PP	**T3** 100%PP	**T4** 50%AYB	**T5** 100% AYB
Maize	54.93	47.93	46.93	47.93	46.93
Soybean Meal	38.34	19.17	0.00	19.17	0.00
FPP	0.00	19.17	38.34	0.00	0.00
FAYB	0.00	0.00	0.00	19.17	38.34
Fish Meal	0.00	7.00	8.00	7.00	8.00
Vegetable Oil	3.00	3.00	3.00	3.00	3.00
Bone Meal	1.52	1.52	1.52	1.52	1.52
Limestone	1.39	1.39	1.39	1.39	1.39
Salt	0.2	0.20	0.20	0.20	0.20
Lysine	0.12	0.12	0.12	0.12	0.12
Methionine	0.25	0.25	0.25	0.25	0.25
*Vit. Premix	0.25	0.25	0.25	0.25	0.25
Total (kg)	100	100	100	100	100
Calculated nutrient composition					
Crude Protein (%)	23.10	23.18	23.20	23.20	23.23
ME* (kcal/kg/DM)	3217.00	3212.00	3292.00	3281.00	3220.00
Phosphorus (%)	0.55	0.64	0.56	0.64	0.56
Calcium (%)	1.04	1.43	1.46	1.43	1.46

FPP=Fermented Pigeon Pea; FAYB=Fermented African Yam Bean; ME=Metabolizable Energy.
*Broiler vitamin and mineral premix contained (/Kg): 11.7 g dicalcium phosphate; 4.5 g salt; 6500 IU vitamin A 2000 IU vitamin D_3, 35mg vitamin E; 5mg vitamin B_2; 0.01 mg vitamin B_{12}; 30mg niacin 30; 0.2 mg folic acid; 0.2 mg biotin; 500mg choline; 3 mg dicalcium phosphate.

Table 2: Gross Composition of Broiler Finisher Diets (4 – 6 weeks)

Parameters (%)	Treatment				
	T1 Control	**T2** 50%PP	**T3** 100%PP	**T4** 50%AYB	**T5** 100% AYB
Maize	54.00	47.00	46.00	47.00	46.00
Soybean Meal	30.00	15.00	-	15.00	-
Wheat Offal	9.58	9.58	9.58	9.58	9.58
FPP	0.00	15.00	30.00	-	-
FAYB	0.00	0.00	-	15.00	30.00
Fish Meal	0.00	7.00	8.00	7.00	8.00
Vegetable Oil	3.00	3.00	3.00	3.00	3.00
Bone Meal	1.50	1.50	1.50	1.50	1.50
Salt	0.30	0.30	0.30	0.30	0.30
Limestone	1.00	1.00	1.00	1.00	1.00
Lysine	0.12	0.12	0.12	0.12	0.12
Methionine	0.25	0.25	0.25	0.25	0.25
Vit. Premix*	0.25	0.25	0.25	0.25	0.25
Total (kg)	100	100	100	100	100
Calculated nutrient composition					
Crude Protein (%)	21.10	21.18	21.18	21.10	21.16
ME* (kcal/kg/DM)	3053.51	3072.40	3090.11	3076.00	3080.11
Phosphorus (%)	0.88	1.28	1.31	1.26	1.31
Calcium (%)	0.53	0.64	0.58	0.64	0.58

FPP=Fermented Pigeon pea, FAYB=Fermented African yam bean; ME=Metabolizable Energy
*Broiler vitamin and mineral premix contained (/Kg): 11.7 g dicalcium phosphate; 4.5 g salt; 6500 IU vitamin A 2000 IU vitamin D_3, 35mg vitamin E; 5mg vitamin B_2; 0.01 mg vitamin B_{12}; 30mg niacin 30; 0.2 mg folic acid; 0.2 mg biotin; 500mg choline; 3 mg dicalcium phosphate.

Digestibility study

Feacal Collection: At the end of the fifth week of the experiment, two birds were randomly picked per replicate, weighed, tagged and transferred to metabolic cages for digestibility study. Three days of acclimatization in the cage was observed. On the fourth day, the feed intake of each bird was measured and faecal sample collected in aluminum foil for three consecutive days and the fresh weight was recorded.

Faecal samples collected were first air dried during the period of collection and later oven dried at a temperature of 60^0C for 48 hours to a constant moisture level. Dried faeces were ground using mortar and pestle to obtain a homogenous mixture for subsequent analysis.

Chemical Analysis

Proximate composition of the two legumes, feed and faecal samples (in triplicates) were analyzed using the methods of AOAC, (15). Energy determination was done using equation for metabolizable energy: M.E (Kcal/kg) =37 x%CP+81.1x%Fat+35x%NFE (16). Mineral contents were determined using atomic absorption spectrometer and Sodium through flame photometer and as described by (15).

Determination of Anti-nutritional factors

Trypsin inhibitors were determined using the method of (17); Tannin was determined using the method of (18). The determination of total saponin was done using a spectrophotometric method described by (19). Phytate was determined using the procedure recommended by (20).

Statistical Analysis

All data collected were subjected to one-way analysis of variance (ANOVA) using the statistical Analysis System version 8.1 (21) and where significant differences were observed in the means, Duncan multiple range test of the same software was used to separate the means.

Results

Proximate composition of test Ingredients

The results of the proximate composition of raw and fermented African yam bean (AYB) and Pigeon pea (PP) are presented in Table 4. Fermentation improved the crude protein content of AYB and PP by 2.53% and 4.70% respectively. The crude fibre and ether extract content was reduced in the fermented AYB and PP. Fermentation improved the ash content in the two legume seed meal. There was an increase in the Nitrogen free extact in both legumes post fermentation.

Mineral contents of test Ingredients

The results of the mineral composition of raw and fermented African yam bean and Pigeon pea are presented in Table 5. The results showed that raw Pigeon pea was more abundant in calcium compared to African yam bean. However, raw African yam bean had higher contents of iron (Fe), Magnesium (Mg), and zinc (Zn) compared to Pigeon pea meal. Fermentation reduced Ca content in Pigeon pea, whereas, it had minimal effect on the calcium content in African yam bean. Fermentation increased the contents of Phosphorus and Zinc in the two legume seed meal. Iron content was reduced by fermentation in African yam bean while it was increased in Pigeon peal meal.

Residual anti-nutritional factors in the tested Ingredients

Trypsin inhibitor, Tannins, Saponin and Phytate were analyzed in the raw and fermented meals of African yam bean and pigeon pea and the results are presented in Table 6. Raw African yam bean had higher trypsin inhibitor compared with Pigeon pea while the content of phytate, tannins and saponin were higher in raw Pigeon pea meal than in the African yam bean meal. Fermentation marginally reduced the contents of trypsin inhibitor, phytate, tannin and saponin in the two legumes.

Table 3: Determined proximate compositions of the experimental diets (%DM)

	Treatments				
Parameters (%)	**T1** Control	**T2** 50%PP	**T3** 100%PP	**T4** 50%AYB	**T5** 100% AYB
Starter phase					
Dry Matter	87.82	90.13	91.89	87.57	89.89
Crude Protein	20.28	19.63	20.13	20.08	19.13
Crude Fibre	7.25	5.68	7.53	4.92	6.11
Ether Extract	6.11	8.23	8.78	8.35	7.04
Total Ash	8.15	9.03	8.21	7.62	7.59
NFE	50.11	52.10	54.21	53.26	55.77
Finisher phase					
Dry Matter	7.82	90.13	91.89	87.57	87.87
Crude Protein	19.68	18.88	19.57	19.49	18.46
Crude Fibre	8.75	7.65	8.56	6.87	7.79
Ether Extract	6.36	7.27	6.89	7.41	6.05
Total Ash	8.02	9.00	8.55	8.12	7.98
NFE*	51.14	53.12	56.10	53.67	57.11

*NFE= Nitrogen free extract

Table 4: Proximate Composition of Raw and Fermented African Yam bean (AYB) and Pigeon Pea (PP) meal (% DM)

Parameters (%)	**African Yam bean**		**Pigeon Pea**	
	Raw	Fermented	Raw	Fermented
Crude Protein	22.90	23.48	21.06	22.05
Ash	2.29	3.15	2.57	3.16
Crude Fibre	4.50	4.40	4.57	4.38
Ether Extract	2.30	2.20	3.89	3.82
Nitrogen Free extract	61.50	62.85	66.70	68.71
Moisture	10.96	10.05	11.73	8.80

Table 5: Mineral composition of Raw and Fermented African Yam bean and Pigeon Pea meals

Parameters %	**Ca**	**P**	**Mg**	**K**	**Na**	**Mn**	**Fe**	**Cu**	**Zn**
Raw Africa Yam Bean	0.06	0.24	0.17	0.89	25.80	27.81	119.19	2.40	6.27
Raw Pigeon Pea	0.63	0.25	0.13	1.47	27.37	21.77	37.21	1.40	4.90
Fermented Africa Yam Bean	0.05	0.27	0.17	0.95	25.88	22.04	64.54	2.22	7.95
Fermented Pigeon Pea	0.12	0.32	0.15	1.15	25.63	9.63	82.10	3.57	5.86

Table 6: Residual Anti – Nutritional Factors in Raw African Yam Bean and Pigeon Pea meal

Parameters	African yam bean		Pigeon Pea	
	Raw	Fermented	Raw	Fermented
Trypsin Inhibitor (Tiu/mg)	46.75	36.71	21.23	21.20
Phytate (%)	0.24	0.21	0.31	0.29
Tannin (%)	0.32	0.28	0.41	0.37
Saponin (%)	0.68	0.67	0.83	0.80

Growth Performance

The performance characteristics of broiler chickens fed fermented African yam been and Pigeon pea meal diets are shown in Table 7. Significant differences were observed in ADFI, ADG and FCR ($P<0.05$). Birds fed the control diet consumed more feed compared to those that received any of the other four diets. The ADFI in birds fed the control and 50%PP diets were not significantly different ($P>0.05$) while that the birds fed 50% PP, 100%PP and 50% AYB were also not significantly different ($P>0.05$). ADFI and ADG were depressed in birds fed 100% AYB. Average daily gain (ADG) were different across the dietary treatments ($P<0.05$). Birds fed the control diet had higher ADG compared to those fed any of the other dietary treatments. The least ADG was observed in birds fed 100% AYB. Similarly, the birds fed control diet and those that received 50% PP and 50%AYB had superior feed to gain ratio compared with those fed other dietary treatments.

Nutrient digestibility

The result of nutrient digestibility of broilers fed fermented African yam bean and Pigeon pea meal based diets are presented in Table 8. There were no significant difference ($P>0.05$) in the digestibilities of dry matter, crude protein and crude fibre. There were significant ($P<0.05$) differences in the digestibility of ash and ether extract. Digestibility of ash in birds fed diets 2, 3 and 4 were similar and the values were significantly higher ($P<0.05$) than those fed other dietary treatments. Birds fed the control diet had the lowest digestibility of ash. Birds fed diet 3 had the highest digestibility of ether extract and the value was similar to those fed diets 1, 4 and 5 while those that were fed diet 2 had the least value.

Table 7: Performance characteristics of broiler chicken fed fermented African yam bean and Pigeon pea based diets

Parameters	T1 100%SBM	T2 50%PP	T3 100%PP	T4 50%AYB	T5 100%AYB	SEM
Initial weight (g)	37.38	36.99	37.37	37.40	37.37	0.06
Final weight (g/b)	$1620^{a}.00$	$1570^{a}.00$	$1330^{b}.00$	$1420^{a}.00$	$950^{c}.00$	3.21
Weight gain (g/b)	1582.62	1533.01	1292.63	1382.60	927.38	3.15
ADFI (g/b/d)	122.97^{a}	115.93^{ab}	107.73^{b}	100.71^{b}	77.01^{c}	7.30
ADG (g/b/d)	38.57^{a}	37.38^{b}	31.67^{c}	30.80^{c}	22.62^{d}	2.50
FCR	3.19^{b}	3.10^{b}	3.40^{a}	3.26^{b}	3.40^{a}	0.09

^{abcd} Means in the same row with different superscript are significantly different ($P<0.05$)

SEM= Standard error of mean, FCR=Feed conversion ratio

T_1-100%SBM, T_2-50%PP & 50% SBM, T_3-100%PP, T_4-50%AYB & 50%SBM, T_5-100%AYB, SBM=Soy bean meal, PP=Pigeon pea, AYB=African yam bean; ADFI=Average daily feed intake; ADG=Average daily gain; FCR=Feed conversion ratio

Table 8: Digestibility of Raw and Fermented AYB and PP in broiler chicken

Parameters (%)	T1 100%SBM	T2 50%PP	T3 100%PP	T4 50%AYB	T5 100%AYB	SEM
Dry matter	90.15	88.52	87.90	90.00	88.45	2.60
Crude Protein	74.27	65.07	75.56	82.82	66.05	3.04
Crude fibre	59.67	40.82	68.38	45.15	43.63	5.12
Ether extract	93.74^{ab}	86.56^{b}	97.48^{a}	90.70^{ab}	91.46^{ab}	1.40
Ash	35.25^{b}	53.70^{a}	50.57^{a}	52.67^{a}	45.19^{ab}	8.68
NFE	75.02	82.71	81.50	80.36	64.45	2.80

^{ab}Means in the same row with different superscripts are significantly different ($P < 0.05$)
SEM= Standard error of mean
T_1-100% SBM, T_2-50% PP & 50% SBM, T_3-100% PP, T_4-50% AYB & 50% SBM, T_5-100% AYB

Discussion

The Crude protein contents in raw African yam bean (AYB) and Pigeon pea (PP) were similar to the results of (22), (23) and (5). However, the values (23-28%) were lower than those reported by (1), (2) and (24). The observed differences could be attributed to the effect of geographical locations where the crop was grown and age at harvesting. The result of the effect of fermentation on the proximate compositions of African yam bean and Pigeon pea agreed with the results of fermented samples by (25). In contrast, (26) reported a reduction in the CP and ether extract contents. Fermentation reduced the content of ether extract (EE) and ash in African yam bean and Pigeon pea.

There were variations in the mineral composition of the two legumes seeds. The most abundant mineral was potassium with values of 0.89% in raw African yam bean (RAYB), 0.95% in Fermented African yam bean (FAYB) and 1.47% in raw pigeon pea (RPP) and 1.15% in fermented pigeon pea (FPP). These results are in agreement with those reported for raw and processed African yam bean, mucuna bean and kidney bean by (25), (5), (27). (1), (2) and (28) had reported that legumes contained low amounts of sodium. The phosphorus contents reported for raw and processed African yam bean and Pigeon pea is in agreement with the values reported by (1) and (25). The calcium content of legumes under study was comparatively low when compared with the values reported by (1) and (2). These authors reported a low value of calcium in African yam bean, Pigeon pea and Jack bean when compared with soybean. The levels of magnesium in the raw African yam bean are in agreement with value reported by (25) and (2).

The concentration of Phosphorus, Magnesium and sodium appeared to be relatively high in both legumes which are similar to the report of (28). However, the potential of any legume as a source of mineral elements depends on the availability rather than the total content (29). Processing technique affects the mineral contents of legume seeds. (2) observed decreases in mineral content of legume seeds after cooking, soaking and decortication. The observed decrease may be as a result of leaching of minerals during cooking and soaking.

The anti-nutritional factors in legumes constitute a major constraint to the utilization of legume seed for human and animal consumption. The results of the trypsin inhibitor activities in the raw and fermented African yam bean and Pigeon pea seeds revealed that both legumes studied contained varying amounts of this inhibitor. The

variation observed could be due partly to genetic differences among the two legumes. Recent studies by (30) reported that trypsin inhibitor activities in soybean, cowpea, lima bean, pigeon pea and African yam bean were 18.5, 249.9, 81.0, 43.00Tiu/mg protein respectively. The results obtained in this study and suggests that trypsin inhibitors are common constituents of most edible legumes. The relatively high trypsin inhibitor activity obtained in African yam bean than in Pigeon pea may pose a more detrimental effect on its usefulness. The result of the present study shows that fermentation was not effective in the elimination of trypsin inhibitors in the legumes as relatively high trypsin inhibitors activities were observed in the fermented African yam bean and Pigeon pea seeds. Consequently, (2) reported significant reduction of trypsin inhibitors activities through dehulling prior to cooking.

The phytate concentration was higher in Pigeon pea (0.31 raw and 0.29 fermented) and lower in African yam bean (0.24 raw and 0.21 fermented). This is similar to the report of (22). Phytate chelates metals such as calcium, phosphorus, copper, magnesium and iron and forms complexes with proteins in the legumes thereby reducing the nutritive value (3). Phosphorus deficiency occurs in animals when phytate combines with phosphorus. (31) reported that soaking and boiling for ten minutes reduced the content of phytate in seeds. Whereas, (32) reported that lower losses obtained when the legume seeds were subjected to cooking and toasting, thus, confirmed the heat stability of phytic acid, which may be ascribed to the strong electrostatic forces that exists between oxygen atoms of contiguous phosphate radicals within the phytate structures.

Post fermentation, the contents of tannin reduced by 12.5% in AYB and 9.76% in PP. Thus, the report of this study revealed that fermentation partially reduced the concentration of tannin in African yam bean and Pigeon pea seeds, just like the report of previous researchers that different processing procedure decreased tannin in animal feed. (22) confirmed that tannins are water soluble phenolic metabolite concentrated beneath the testa of the seed Consequently, Tannin contents were removed from sorghum (33) and African yam bean (3) by soaking in water all night. Tannins forms strong insoluble complexes with proteins and divalent metals which results in poor digestibility and palatability in monogastrics animals (3)

The saponin content was higher in Pigeon pea than in African yam bean. The value of saponin obtained is slightly lower than the values reported by (22) but similar to values reported by (23) on African yam bean.

The results of these studies showed that there were significant differences ($P<0.05$) in average daily feed intake and average daily gain of the control and dietary treatments. Linear decrease was observed in birds fed 50% AYB and 100% PP while the birds fed 100% AYB had the lowest. These negative effects reported in this study could be due to the presence of residual anti-nutrients such as trypsin inhibitors, phytate and tannins in diets that resulted in reduced palatability and reduced weight gain (34). In this experiment, feed conversion ratio (FCR) was not significantly different ($P>0.05$). This is in line with the report of (35) who recommended 50% fermented Pigeon pea inclusion in cockerel diets. Similarly, the result of this study corroborates the work of (36), who substituted soya bean meal with African yam bean in broiler diet.

The improved dry matter, crude protein, crude fibre and nitrogen free extract apparent digestibilities recorded in this study revealed that fermentation is a good method of reducing trypsin inhibitor and tannins in legume seeds. (37) had reported that trypsin inhibited protein digestion in broiler chickens. Nevertheless,

fermented African yam bean and Pigeon pea were as digestible as soybean meal. The results of ether extract and ash digestibility is comparatively similar among the test diets and the control. In contrast, (37) and (35) reported low nutrient digestibility in African yam bean and Pigeon pea based diets, respectively.

Conclusion and Applications

1. The report of this study revealed, not only the importance and usefulness of the two under-utilized legumes (African yam bean-*Sphenostylis stenocarpa* and Pigeon pea-*Cajanus cajan*) in poultry industry but also their proximate, mineral and anti-nutritional factors present as well as the nature of toxic effects of the residual anti-nutritional factors in broiler chickens.
2. The results of the proximate and mineral composition indicated that these legume seeds are relatively high in protein, ether extract and that they have adequate minerals such as potassium, calcium, phosphorus, sodium, magnesium and iron. Moreover, fermentation improved the nutritional quality marginally.
3. The results of this study revealed that fermentation as a means of processing African yam bean and Pigeon pea meal reduced the anti-nutritional factors (ANFs), thus, broiler chickens could tolerate up to 50% of FAYB and FPP as a replacement for Soybean meal without detrimental effect on growth performance.

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