Performance characteristics and apparent nutrient digestibility of broiler finisher fed African yam bean cake as partial replacement for soybean meal

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Additional keywords

Weight gain.
Feed conversion ratio.

SUMMARY

A three-week study was conducted to evaluate the performance characteristics and apparent nutrient digestibility of broilers finisher fed African Yam Bean Cake (AYBC). Treatment 1 had 0% African yam bean cake and served as control while treatments 2, 3, 4 and 5 contained 5, 10, 15 and 20% African yam bean cake respectively. One hundred and fifty-3-week old unsexed Marshal R broilers were carried over from starting phase and randomly allotted to the 5 dietary treatments in a completely randomized design (CRD). Each dietary group had 30 birds with 10 birds per replicate and replicated three times. Birds fed treatment 3 had the highest mean weight gain (1430 g) that was not significantly ($p>0.05$) different from others, treatment 1 gave the least feed conversion ratio (1.57) while least protein efficiency ratio (1.32) was obtained on birds fed treatment 3. Therefore, birds fed treatment 1 gave the best nutrient utilization. In conclusion, African yam bean cake enhanced performance characteristics and apparent nutrient digestibility of broiler finisher. Therefore, inclusion level of African yam bean cake beyond 20% should be researched on.

Características productivas y digestibilidad aparente de nutrientes de broilers en terminación alimentados con torta de ñame en sustitución parcial de harina de soja

Palabras clave adicionales

Ganacia de peso.
Conversión alimenticia.

RESUMEN

Durante tres semanas, se realizó un estudio para evaluar las características productivas y digestibilidad aparente de los nutrientes en 150 broilers Marshal R, no sexados de 3 semanas de edad, acabados con torta de ñame africano (AYBC). Los tratamientos 1, 2, 3, 4 y 5 contenían 5, 10, 15 y 20% de torta de ñame africano respectivamente. Los animales fueron asignados aleatoriamente a uno de los tratamientos en un diseño completamente al azar. Cada grupo estaba compuesto de 30 aves (tres repeticiones de diez aves cada una). Los animales que consumían el tratamiento 3 tuvieron mayor ganancia de peso (1430 g) pero no fue significativamente diferente de los restantes. La mejor conversión de alimento (1,57) se registró en el tratamiento 1, mientras que la peor eficiencia proteica se registró en el tratamiento 3. Por ello, las aves del tratamiento 1 presentaron la mejor utilización de nutrientes. La torta de ñame africano mejoró los rendimientos y digestibilidad aparente de los nutrientes en los broiler. Por ello debe investigarse la inclusión de torta de ñame africano por encima del 20%.

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INTRODUCTION

The two main protein sources for livestock feed are protein crops (e.g. legumes) and animal by-products. Large amounts of animal by-products come from industry (mainly meat and fish meal). The technologies for manufacturing these products are strict in order to avoid health crises (e.g. BSE). Even if their use is limited to certain animal species, in some regions (like the European Union) their use is currently legally forbidden. The safety assessment of animal protein for animal feed can also be performed directly at the farm level.

Legumes seeds are important sources of nutrients and can serve as high quality dietary protein sources to meet nutrient requirements (Perumal *et al.,* 2001; Escudero *et al*., 2006). Legume seeds have an average of twice as much protein as cereals and the nutritive value of the proteins are usually high (Vijayakumari *et al.,* 1997). The under-utilized legumes such as African yam bean seeds which have tremendous potential for

commercial exploitation but remain ignored, offer a good scope in this context (Bhag Mal, 1992).

The African yam bean (*Sphenostylis stenocarpa*) is a climbing plant which twines and climbs to a height of over 3 m, requires staking, with each pod containing several edible seeds and is adapted to lowland tropical conditions (Wikipedia, 2005). It is one of the lesser known legumes (Ikhajiagbe *et al.*, 2007b, Apata and Ologhobo, 1990), widely cultivated in the southern parts of Nigeria for its edible seeds and tuberous roots (Ikhajiagbe *et al.*, 2007a). The African yam bean is also cultivated in many other parts of Africa. The leaf and floral arrangements as well as the shape and color of seeds of this crop have been determined (Ikhajiagbe *et al.*, 2007b and Klu *et al.*, 2000). The leaves are stipulate with petioles 4-8 cm and rachis 1-3 cm. The African yam bean is partly cultivated in very poor soils often mixed plantings with yams, maize, okra and other vegetables (Ikhajiagbe *et al.*, 2007a). The seed contains anti nutritional factors which reduce its nutritive values.

Anti-nutritional factors could penalize choosing some legume species. Many of the legumes in the tropics that are potentially valuable sources of protein contain anti-nutritional factors that can depress animal performance, such as trypsin inhibitors, oxalic acid, tannins and saponins. However, many of these can be inactivated to a greater or lesser extent by various processing methods, such as heat treatment, biological, chemical, urea fertilizer and mechanical. But mechanical processing is attracting interest in this finding because there is little information on African yam bean seeds. Therefore, this findings directed toward performance and apparent nutrient digestibility of broiler finisher fed African yam bean cake as partial replacement for soybean meal.

MATERIAL AND METHODS

Experimental site

The experiment was carried out at the poultry unit, Teaching and Research Farm Oyo state College of Agriculture Igbo-ora, Oyo State Nigeria. The experimental site is in savannah forest zone of Latitude 7.43 °N and longitude 3.8 °E, with an elevation 140 m above sea level. The average minimum temperature is about 21.50 °C and maximum temperature of 32.50 °C. The average humidity in the area is 58.0 %. The double maximum rainfall is about 214.3 mm in June and 165.2 mm in September.

Procurement of african yam bean and other ingredients

African yam bean was procured at Bodija market in Ibadan North local government, while Other ingredients like maize, Soybean meal, methionine, lysine, di-calcium phosphate, limestone were obtained from Adom feed mill, Orogun area, Ibadan, Oyo State, Nigeria.

Sorting and processing of the test ingredient

The bean was sorted to remove stone, dirt and other spices apart from African yam bean seed (Brown variety). The bean was toasted for 35 minutes at a temperature of 110 °C in a popcorn popper pot and subjected to extrusion by mechanical method using kernel extraction machine and formed African yam bean cake.

Chemical composition of african yam bean cake

The chemical composition of African yam bean cake **(table I)** was determined in the laboratory by using method of A.O.A.C. (1990). While the metabolizable energy was determined by using formula (Pauzenga, 1985). (37 × Cp) + (81.8 × C. fat) + (35.5 × NFE). While NFE was determined by using the following formula: 100 - (Cp - CF - Fat - Ash - MC).

Table I. Percentage composition of broiler finisher (Composición de la dieta de finalización).

Ingredients (kg)	T1 (0 %)	T2 (5 %)	T3 (10 %)	T4 (15 %)	T5 (20 %)
Maize	69.00	66.44	63.87	61.25	58.70
Soybean	26.00	24.70	23.41	22.10	20.80
AYBC	0.00	3.86	7.72	11.65	15.50
DCP	2.50	2.50	2.50	2.50	2.50
Lime stone	1.50	1.50	1.50	1.50	1.50
Methionine	0.25	0.25	0.25	0.25	0.25
Premix (B)	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
ANALYSIS RESULTS					
Energy ME (kg/Cal)	3066.07	3049.43	3021.45	3010.45	3007.50
Crude Protein (%)	19.79	20.28	19.96	20.39	20.43
Crude Fibre (%)	3.86	3.94	3.97	4.03	4.07
Ether Extract (%)	3.54	3.62	3.57	3.66	3.64
Ash (%)	0.90	1.00	1.12	1.25	1.31
Calcium (%)	0.98	0.99	0.99	1.02	1.03
Phosphorus (%)	0.69	0.70	0.69	0.71	0.71

AYBC: African yam bean cake; DCP: Di-calcium phosphate. A kg premix contained Vitamin A: 110,000,000 IU; Vitamin D: 2,500,000 IU; Vitamin E: 20,000 mg; Vitamin K_3: 3000 mg; Vitamin B_3: 3000 mg; Vitamin B_2: 7000 mg; Vitamin B_6: 5000 mg; Vitamin B_{12}: 25 mg; Pantothenic acids: 10,000 mg; Iron: 4000 mg; Folic acid: 8000 mg; Biotin: 50 mg; Manganese: 80,000 mg; Zinc: 60,000 mg; Copper: 8,000 mg; Cobalt: 250 mg; Lodine: 1,000 mh; Selenium (180): 150mg; Chlorin: 200,000 mg and Antioxidant: 100,000 mg. ME: Metabolizable energy.

Experimental diets

Five diets were formulated to meet or exceed NRC recommendations (NRC, 1994). All diets were having percentage crude protein ranging between 17.58-16.67 %. Maize was the major source of energy while soybean meal and African yam bean cake were sources of protein. Diet one was corn-soybean based (control) while African yam bean cake was added to diets 2, 3, 4, and 5 at the rate of 5, 10, 15, and 20 % inclusion rate respectively to replace soybean meal. The Microsoft excel package was used to formulate experimental diets.

Experimental birds and their management

A total of 150 unsexed day-old marshal R strain broiler chicks were carried over from starting phase to finishing phase of five weeks. Thirty were randomly allotted to each of 5 dietary treatments and were repli-

cated 3 times with 10 birds per replicate in a Completely Randomized Design (CRD). The birds were fed *ad-libitum* with the experimental starter from day old for 5 weeks and placed on broiler finisher for 3 weeks. Litter were regularly turned and changed every 2 weeks to remove accumulating gasses from bird droppings. The feed given to the birds were weighed on daily basis with left over while cool, cleaned water was supplied unrestricted every day and the birds were weighed on weekly bases.

Performance data

Data collected daily on feed intake, records of body weight were taken weekly while record of mortality were kept throughout the period of the study.

Feed intake

Feed intake was determined by subtracting the weight of feed left over from the feed given.

Body weight gain

The birds were weighed on weekly basis and the weight was calculated by subtracting the weight in the preceding week from the current week.

Feed conversion ratio

This was calculated as the ratio of feed consumed to the weight gain.

$$\text{Feed conversion ratio} = \frac{\text{Feed intake}}{\text{Weight gain}}$$

Protein efficiency ratio

Protein efficiency ratio was calculated as the ratio of weight gain to the protein intake.

$$\text{Protein efficiency ratio} = \frac{\text{Weight gain}}{\text{Protein intake}}$$

Metabolic trial

At the end of seventh weeks, 3 birds per treatment with one bird from each replicate were picked randomly and housed in a metabolic cage. The birds were given 4 days to adapt to the new environment, a polythene bag was tied underneath. The feaces were collected from each bird for the remaining three days. Feed given to them were weighed and clean water was supply to the birds. The feaces collected from each bird were air dried for a week and crushed to granules then mixed and analyzed at the laboratory to know its nutritive values.

Statistical analysis

All data were analyzed as a completely randomized design using one-way ANOVA (SPSS 2008). The differences were considered to be significant at $p<0.05$.

RESULT AND DISCUSSION

Table II show performance characteristics of broiler finisher. The feed intake for broiler finisher on test diets were higher than control diets. The level of feed intake was increased with increased level of African yam bean cake (AYBC). The higest values (2440.00 g) was recorded on treatment 3 (10 %) while least (1644.00 g) being in the control. This disagreed with (Adeniji, 2011) who reported decreased feed intake by broiler finisher as the blood vegetable waste meal increased in the diets. No significant differences ($p>0.05$) between final live weight, weight gain and feed intake of the experimental broiler finisher, means that nutrient to nutrient replacement level of soybean to African yam bean cake (AYBC) possessed a good protein content and possibly it has growth stimulating effect, as high level of protein is essential for body growth. This is in aggreement with the report of Adeniji (2012). Further more, improved feed conversion ratio of dietary inclusiion of AYBC shows that AYBC is a promising feedstuff and can reduce competition for soybean between monogastric animal, human being and industries, therefore, the need to use AYBC as alternative feedstuffs for monogastirc animals can not be overemphasised. Protein efficience ratio (PER) values were significantly ($p<0.05$) lower and similar for broiler on 5 % and 10 % inclusion of AYBC than control. This implies that AYBC was better utilized by broilers fed test diets.

Table II. Performance characteristics of broiler finisher fed African yam bean cake (Caracteristicas productivas de los broiler alimentados con torta de ñame africana).

Parameters (g)	T1 (0 %)	T2 (5 %)	T3 (10 %)	T4 (15 %)	T5 (20 %)	SEM
I W	1950^{a}	1400^{a}	1350^{b}	1500^{b}	1500^{b}	0.06
FLW	3000^{a}	2580^{a}	2780^{a}	2430^{a}	2330^{a}	0.12
W.G	1050^{a}	1180^{a}	1430^{a}	930^{a}	830^{a}	0.07
FCR	1.57^{a}	1.96^{a}	1.71^{a}	2.61^{a}	2.84^{a}	0.12
PER	1.76^{ab}	1.33^{b}	1.32^{b}	2.10^{a}	2.07^{a}	0.12
F I	1644.00^{a}	2313.33^{a}	2440.00^{a}	2430.00^{a}	2360.00^{a}	145.84
MORT (%)	10.00^{a}	6.00^{a}	3.00^{a}	0.00^{a}	0.00^{a}	1.02

^{abcd}means on the same row with the same superscript are not significantly different ($p>0.05$). I W= Initial weight; FLW= Final live weight; WG= Weight gain; FCR= Feed conversion ratio; PER= Protein efficiency ratio; FI= Feed intake; MORT= Mortality; SEM= Standard error of mean.

Table III. Apparent nutrient digestibility of broiler finisher fed African yam bean cake (Digestibilidad aparente de nutrientes en broiler acabados con torta de ñame africana).

Parameters (%)	T1 (0 %)	T2 (5 %)	T3 (10 %)	T4 (15 %)	T5 (20 %)	SEM
Crude protein	38.86^{a}	40.42^{a}	39.31^{a}	39.97^{a}	39.95^{a}	0.32
Ether extract	53.63^{a}	52.02^{a}	52.60^{a}	52.23^{a}	52.97^{a}	0.27
Crude fibre	63.72^{c}	64.08^{bc}	63.76^{c}	64.68^{ab}	65.11^{a}	0.19
Ash	78.32^{a}	77.70^{b}	77.28^{c}	77.31^{bc}	77.53^{bc}	0.13
Dry matter	96.97^{a}	96.93^{a}	96.68^{a}	96.46^{a}	96.45^{a}	0.12

^{abcd}Means on the same row with the same superscript are not significantly different ($p>0.05$).

Table III show nutrient digestibility of broiler finisher. The percentage dry matter, crude protein and ether extract values followed similar trends and were not significant ($p>0.05$) different accross dietary treatments. It means that the improved digestibility with higher level of AYBC implied that experimental broilers were able to effectively digest and utilised higher levels of

AYBC which could have been excreted and decompose in the soil. Both crude fibre and ash were significantly ($p<0.05$) different. The crude fibre digestibilty values were significantly ($p<0.05$) higher in the test diets (AYBC) than control. This indicates that antinutritional factors (ANFs) levels in the test diets did not significantly impair the utilization of these nutrients which aggreed with reports obtained from literature (Aletor and Omolara, 1994 and Amaefule *et al.*, 2004). The lower values of the nutrient digestibility of control diet (0 % AYBC) clearly indicate that anti nutritional factors especially trypsin inhibitor in the soybean may have gotten a threshold were impairment of growth becomes apparent as a result of poor utilization.

CONCLUSION

The result of this study showed that African yam bean cake can be incorporated in diets of broiler finisher birds up to 20 % inclusion level without any deleterious effect on the performance characteristics and apparent nutrient digestibility of the birds. Therefore, inclusion level of African yam bean cake beyond 20 % should be researched on.

BIBLIOGRAPHY

Adeniji, A.A. 2011. Effects of replacing groundnut cake with blood vegetable waste meal for soyabean meal in broiler diets. Scholarly journal of agricultural science, 3: 21-24.

Adeniji, A.A. 2012. Effect of replacing groundnut cake with blood vegetable waste meal in the diets of weaner rabbits. *ISRN Veterinary Science,* Article ID 321516. 4 pp. doi:10.5402/2012/321516.

A.O.A.C. 1990. Official Method of Analysis. Association of Officiating Analytical Chemists. Washington. D.C.

Aletor, V.A. and Omodara, O.A. 1994. Studies on some leguminous browse plants with particular reference to their proximate, mineral and some endogenous anti nutritional constituents. *Anim Feed Sci Technol,* 46: 343-348.

Amaefule, K.U.; Nwokoro, C.C. and Iheukwumere, F.C. 2004. The effect of feeding graded levels of raw pigeon pea *(Cajanus cajan)* meal on the performance of nutrient retention and carcass characteristics of weaned rabbits. *Niger J Anim Prod,* 31: 194-199.

Apata, D.F. and Ologhobo, A.D. 1990. Some of the biochemistry and nutritive value of African Yam Bean *(Sphenostylis stenocarpa)* seeds. *Food Chem,* 36: 271-280.

Bhag M. 1992. Biodiversity utilization and conservation in under-utilized plants: Indian perspective. *Indian J Plant Genet Resour,* 5: 1-12.

Escudero, N.L.; Zirulnik, F.; Gómez, N.N.; Mucciarelli, S.I. and Giménez, M.S. 2006. Influence of a protein concentrate from *Amaranthus cruentus* seeds on lipid metabolism. *Exp Biol Med,* 231: 50-59.

Ikhajiagbe, B. 2003. African yam bean in Nigeria: the stone that the builders rejected. *Raw Materials Digest,* 1: 2-4.

Ikhajiagbe, B.; Mgbeze, G.C.; Folu, M. and Dania, O. 2007a. Responses of African yam bean *(Sphenostylis stenocarpa)* seeds (Hochst Ex. A. Rich) Harms to salinity stress I: Germination and Vegetative Growth. *Nigeria J Biotech,* 20: 69-82.

Ikhajiagbe, B.; Mgbeze, G.C.; Folu, M. and Ogbe, D. 2007b. Responses of *Sphenostylis stenocarpa* (Hochst Ex. A. Rich) Harms (African yam bean) to salinity stress II: Yield, yield components and chemical composition. *Nigeria J Biotech*, 20: 83-92.

Klu, G.Y.P.; Amoaley, H.M.; Bansa, D. and Kumanya, E.K. 2000. Cultivation and use of African yam bean *Sphenostylis stenocarpa* in the Volta region of Ghana. *Plant Genet Resources Newsletter,* 124: 13-16.

National Research Council. 1994. Nutrient requirements of poultry. 9th rev. ed. National Academy Press. Washington. DC.

Pauzenga, U. 1985 . Feeding parent stock journal of zoological technology international. pp. 22-24.

Perumal, S.; Klaus, B. and Harinder, P.S.M. 2001. Chemical composition, protein fractionation essential amino acid potential and anti metabolic constituents of an unconventional legume, Gilabean *(Entada phaseoloides* Merrill*)* seed kernel. *J Sci Food Agr,* 82: 192-202.

SPSS, 17.0 window. 2008. S.P.S.S.Inc. Chicago, IL.

Vijayakumari, K.; Siddhuraju, P. and Janardhanan, K. 1997. Chemical composition, amino acid content and protein quality of the little - known legume *Bauhinia purpurea L. J Sci Food Agr,* 73: 279-286.

Wikipedia C. Yard. 2005. Long bean. In free encyclopedia; http://es.wikipedia.org/wiki/Vigna_unguiculata_subesp._sesquipedalis (26/05/2015).