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Evaluation of Growth Characteristics and Haematological Variables of Broiler - Chickens Fed Diets Containing Groundnut Cake Replaced with Either Cooked Jack Bean Meal or Roasted Devil Bean Meal

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Abstract : Four hundred and twenty growing broiler-chicks (3-6 weeks of age) were used in the experiment to assess the effect of replacing groundnut cake (GNC) with either cooked jack bean meal (CJBM) or roasted devil bean meal (RDBM) on the growth characteristics, blood, total serum and liver proteins. Seven diets were used for the trial. Diet 1 contained 150 gkg^{-1} groundnut cakes and this was replaced in diets 2, 3 & 4 with CJBM at 5, 10 & 15% while it was replaced in diets 5, 6 & 7 with RDBM. The birds were fed their dietary treatments for 21 days. The results showed that the average final live weight of birds fed CJBM and RDBM decreased respectively with 17.7 - 34.5% and 3.7 - 7.2% of the weight of those fed on the control. The average weekly weight gain and average feed consumption decreased with increased level of GNC substitution with CJBM and RDBM. The N-retained by birds fed the control diet and those on 5% CJBM and 10% RDBM - based diets were identical while the N- retained was lowest in bird fed 15% CJBM - based diet. Of all the organs measured only the relative weight of the gizzards was significantly ($P<0.5$) influenced by the dietary treatment. Also, the blood variables, serum and liver metabolites measured were not significantly ($P<0.05$) influenced by the dietary treatment. It was concluded that while CJBM could only be included at not more than 100 gkg^{-1}, the RDBM could be included even more than 150 gkg^{-1} of the diets for broilers. The use of these lesser-known legumes in the feeding of broilers in the third world countries, if properly harnessed and processed, will enhance broiler production and consumption among the poor populace.

Key words : Cooked, Roasted, jack bean, devil bean

Introduction

The acute protein shortage particularly, in developing countries has necessitated the investigation of several novel protein resources. One of the plant sources that have attracted considerable research attention in recent times is grain legume. The role of grain legumes in the diets of animal and man in developing countries is well - documented (Oke et al; 1995; Agbede, 2000). Essentially, the use of groundnut cake in animal feeding has received a lot of research attention. However, the high consumption of groundnut by man has limited its use in animal feeding. The concomitant effect of this is that, the cost of groundnut cake has increased by over 250 % in recent times. Consequently, there is a need to seek for alternative feed resources that can partially or totally replaced the groundnut cake (GNC) in diets for non-ruminant animal, especially poultry.

Two-grain legumes that could be considered as alternatives to GNC are jack bean (*Canavalia ensiformis*) and devil beans (*Mucuna pruriens*). Jack bean is usually planted in Nigeria as an ornamental plant, grown near houses and allowed to trail on walls and trees (Udedibie, 1990). It is also the most common tree in the North Coast of Columbia (Sanchez and Moreno, 1992). In fact, a record yield of up to 3.08 ton per hectare in an experimental trial has been reported (Addison, 1957). Jack bean has potential as feeding resource that could be exploited for its forage and seeds (Agbede and Aletor, 2003b). When the seeds were subjected to various processing treatments, the seed has 200-270 gkg^{-1} crude proteins and 17.0 - 20.7 $MJkg^{-1}$ gross energy with a good array of amino acids, though limited in sulphur containing amino acids (Agbede and Aletor, 2003b).

The devil beans commonly known as " werepe" in South West of Nigeria or "A dua apea" in Ghana, is a weak stemmed, hairy annual climber growing up to about 8m long, with trifoliate leaves, dark purple flowers and pods with irritant hairs. The pods are straight or S-shaped and have bristle hairs when ripe. The pod contains between 5 and 6 seeds, and crude protein and crude fibre content of 240-280 and 29-82 gkg^{-1}, respectively (Ahenkora *et al*, 1994; Agbede and Aletor, 2003b).

However, both jack bean and devil bean contained some inherent anti-nutritional factors. For instance, while devil bean contains phytin, tannin and TIA (Ravindran and Ravindran, 1988, Agbede and Aletor, 2003b), jack bean has been reported to contain concanavalinA (Jaffe, 1980), saponin, cyanogenic glycosides, terpenoids (Udedibie, 1990), haemagglutinin, trypsin inhibitor and canavanine (Ologhobo et al, 1993, Agbde and Aletor, 2003b). The adverse effects of these anti-nutrients could be reduced by heat treatment. For instance, Agbede and Aletor (2003b) reported that a significant proportion of the anti-nutrients in jack bean and devil bean could be reduced or inactivated by cooking and roasting, respectively. This thus explains the choice of processing for the jack bean and devil bean for this trial.

The present study was therefore designed to evaluate the growth performance and haematological variables of broiler chicken fed diet in which GNC was replaced with either cooked jack bean meal (CJBM or roasted devil bean meal (RDBM).

Materials and Methods

Preparation of Jack and Devil Bean Meal : The choice of processing was informed by the previous report of Agbede and Aletor, (2003b) that cooking and roasting significantly inactivated the anti-nutritional factors in jack bean and devil bean, respectively.

The seeds of jack bean were processed using the two stage cooking. The cooking was done with aluminum pot using one part of the seeds to 15 parts of clean water on an electric cooker. Other details about the cooking are as reported elsewhere (Agbede and Aletor, 2003b). The seeds of the devil bean were roasted in fine sand and stirred, using the electric cooker until a characteristics brownish coloured seed was obtained which, indicated complete roasting.

The sun-dried cooked jack bean and roasted devil bean meal were milled using a laboratory hammer mill (DIETZ,7311 Dettingen - Teck, West Germany) and used for the formulation.

Experimental Diets : Seven (7) iso - nitrogenous (215gkg^{-1} crude protein) diets were formulated with the basal composition shown on Table 1 while the analyzed proximate composition is as presented in Table 2. Diet 1 was the control diet and it contains 150gkg^{-1} GNC. Diets 2, 3 and 4 had the GNC in diet 1 replaced with cooked jack bean meal (CJBM) at 5, 10 and 15%, respectively while diets 5, 6 and 7 had the GNC in diet 1 replaced with roasted devil bean meal (RDBM) at 5, 10 and 15%, respectively.

Table 1: Basal composition of the experimental diets (gkg^{-1})

Ingredients	Cooked jack bean meal				Roasted devil bean meal		
	Diet 1 0%	Diet 2 5%	Diet 3 10%	Diet 4 15%	Diet 5 5%	Diet 6 10%	Diet 7 15%
Maize	386.0	353.0	358.0	301.0	353.0	323.0	288.0
Maize offal	200.0	200.0	200.0	200.0	200.0	200.0	200.0
Soya bean meal (Ext)	147.0	180.0	205.0	232.0	180.0	210.0	245.0
Groundnut cake	150.0	100.0	50.0	-	100.0	50.0	-
Cooked jack bean meal [(a)]	-	50.0	100.0	150.0	-	-	-
Roasted devil bean meal [(b)]	-	-	-	-	50.0	100.0	150.0
Others*	117.0	117.0	117.0	117.0	117.0	117.0	117.0
Total calculated	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0
Crude protein (gkg^{-1})	221.0	222.0	220.0	220.0	221.0	220.0	220.0
ME (MJKg^{-1})	11.9	119	11.8	11.8	11.8	11.8	11.7

* contained (gkg^{-1}) fish meal = 40.0; rice bran = 40.0; bone meal = 25; oyster shell = 5.0; vitamin premix 2.0 and salt = 5.0

(a) On analysis contained crude protein 261g; crude fibre 51g; crude fat 121g, ash 27g and NFE 541gkg^{-1}DM

(b)On analysis contained crude protein 237g; crude fibre 56g, crude fat 115g; ash 47g and NFE 545gkg^{-1}DM

Table 2:Proximate chemical composition gkg^{-1} of the experimental diets

	Cooked jack bean meal				Roasted devil bean mealComposition		
	Diet 1 0%	Diet 2 5%	Diet 3 10%	Diet 4 15%	Diet 5 5%	Diet 6 10%	Diet 7 15%
Dry matter	927	875	828	736	837	856	915
Crude protein	217	211	218	216	215	212	215
Crude fibre	45	55	75	79	51	69	61
Crude fat	118	112	108	105	108	95	102
Ash	87	73	82	83	79	88	100
NFE	533	549	517	517	547	536	522

Experimental Layout : A total of 420 day old ANAK 2000 broiler-chicks were purchased from S&D Farms, Abeokuta, Nigeria and electrical brooded at the Teaching and Research Farm of the Federal University of Technology, Akure, Nigeria for 3-weeks. Thereafter, the chicks were weighed and 60 chicks were randomly assigned to each of the 7 dietary treatments in 3 replications of 20 chicks each, such that the mean group weight per replication was identical. The design of the experiment was of the completely randomized design (CRD) and the chicks were fed their respective experimental diets *al bitum* until they were 6 weeks old during which records on daily feed consumption and weekly group weight changes were taken. This phase (i.e. 3-6 weeks of age) was chosen for the trial because it is believed that; this is the phase that broiler eat most to meet up with their growth needs (Aletor, *et al* 2000). Faeces voided during the last 5 days were collected, weighed, dried at 55-60°C in an air – circulating oven for 72 hrs; and preserved while the corresponding feed intake was measured.

Blood / Serum Collection and Analysis : Three hours to the close of the feeding trial, the birds were starved. Thereafter, the birds, were weighed, stunned and slaughtered by severing the jugular veins with a sharp surgical knife. The blood was then allowed to flow freely into labeled bijour bottle one of which contained a speck of EDTA while the others were without EDTA. While the blood with EDTA was used for the determination of haematological variables, serum was separated from the one without EDTA and processed for serum protein as described by Lamb, (1981). Detailed procedure has been reported elsewhere by Agbede and Aletor (2003a). Also, the total liver proteins of the birds were determined as described by Lamb, (1981).

Relative organs measurement : After slaughtering, the liver, kidney, pancreas, spleen, heart, bursa of fabricus, lungs and gizzard were dissected out from 10 carcasses per replicate. The organs were blotted clean with tissue paper, weighed and the weight expressed in gkg^{-1} body weight.

Chemical and statistical Analysis : The proximate composition of the individual ingredients, the diets as well as the N- content of the faeces were determined as described by b AOAC (1995) methods. All data obtained were subjected to analysis of variance (Steel and Torrie, 1960). Where significant differences were observed, the means were compared using the Duncan's Multiple Range Test (Duncan, 1995).

Results

Table 3 shows that the average final live weight (AFW), average weekly weight gain (AWG), average feed consumption (AFC) and nitrogen retention (NR) were significantly (P<0.05) influenced by the dietary treatment. The AFW and the AWG of chicken fed roasted devil bean meal (RDBM) were not significantly (P>0.05) different from those fed the control diet. Among the test diets, birds fed on 15% cooked jack bean meal (CJBM) based diet had the lowest AFW and AWG. The AFC of birds fed 5-10% CJBM and 5 – 10 % RDBM-based diets were not significantly (P>0.05) different from those fed the control diet. However, the N-retained by the birds on the control diet, 5% CJBM-based diet and those fed 10% RDBM-based diet were identical and they were all significantly (P<0.05) higher than those fed 10-15% CJBM and, 5 and 15% RDBM based diets.

The relative weights of the liver, kidney, pancreas, spleen, heart, bursa of fabricus and lungs of the birds fed the control diet and those on the test diets were not significantly (P>0.050 different (Table 4). However, the relative weight of the gizzard of birds fed the test diets was significantly (P<0.05) higher than those fed the control diet. While the relative weight of the gizzard on the test diets increased with increased level of CJBM, it decreased with increased levels of RDBM in the diets. Tables 5, 6 and 7 show that the blood variables, serum and liver proteins measured were not significantly (P>0.05) influenced by the dietary levels.

Table 3: Performance and N-utilization of broiler – chicks fed either cooked jack bean meal or roasted devil bean meal in place of groundnut cake aged 21-42 days.

	Cooked jack bean meal				Roasted devil bean mealParameters		
	Diet 1 0%	Diet 2 5%	Diet 3 10%	Diet 4 15%	Diet 5 5%	Diet 6 10%	Diet 7 15%
Average initial live weight (g)	275.0	269.4	276.3	268.0	276.3	266.8	270.9
Average final live weight (g)	917.9[a]	755.6[a]	751.8[b]	600.8[c]	883.8[ab]	865.7[ab]	851.7[ab]
Average weekly weight gain (g/chicks/week)	214.3[a]	162.1[b]	158.5[b]	107.5[c]	203.8[a]	199.6[a]	1936[a]
Average feed consumption (g/chick/week)	531.2[a]	469.2[a]	446.6[a]	348.1b	511.3[a]	502.5[a]	485.1[a]
Feed efficiency	2.5	2.9	2.8	3.2	2.5	2.5	2.5
Nitrogen retention (g N/chick/Day)	2.2[a]	2.0[a]	1.5[d]	0.5[c]	17[cd]	1.8[abc]	1.6[cd]

Means are for 60 chicks /diet

Means with differing superscripts in the same horizontal row are significantly different (P<0.05)

Table 4:Relative organ weights (gkg^{-1} body weight) of broiler-chickens

Diets	%GNC replaced by CJBM/RDBM	Liver	Kidney	Pancreas	Spleen	Heart	Bursa	Lungs	Gizzards
1	0	20.0±2.0	8.4±0.2	4.1±0.5	1.3±02	6.2±0.9	2.8±0.8	7.1±0.8	37.9±4.3^{d}
Cooked jack bean meal (CJBM)									
2	5	26.2±3.3	6.5±1.8	5.2±0.7	1.1±0.1	6.6±0.5	3.3±1.1	6.6±0.5	40.7±0.1^{c}
3	10	23.4±2.6	8.9±4.0	4.8±0.4	0.8±0.6	5.6±1.7	2.9±0.5	6.7±0.5	48.8±3.8^{ab}
4	15	19.4±6.1	7.1±1.1	4.2±1.1	1.1±0.1	6.6±1.5	2.8±0.2	6.0±1.2	49.8±7.6^{a}
Roasted devil bean meal (RDBM)									
5	5	23.2±3.0	7.5±1.5	4.4±02	1.1±0.2	6.5±1.4	2.8±1.2	5.9±1.3	49.1±1.3^{a}
6	10	23.9±17	10.3±1.7	3.8±0.7	0.9±0.1	7.5±1.6	2.8±0.6	6.5±0.5	44.9±5.7^{ab}
7	15	22.9±1.0	8.3±3.4	5.7±2.0	1.4±1.0	6.7±11	3.7±1.0	6.5±0.9	43.8±3.7^{bc}

Means with differing superscript in the same column are significantly different ($P<0.05$).

Table 5:Haematological variables of broiler - chickens

Diets	% GNC replaced by either CJBM or RDBM	PCV (%)	Hbc (g/100g)	RBC (per mm^3)	MCHC (%)	MCH (pg)	MCV(lm ^{3})
1	0	33.0±4.6	3.6±02	2.2±0.6	11.1±2.0	175±4.4	164.9±70.2
Cooked jack bean meal (CJBM)							
2	5	27.0±2.7	3.4±03	2.6±0.6	12.5±0.4	13.5±3.4	107.5±23.5
3	10	27.0±4.6	3.6±0.1	2.7±0.2	13.7±2.0	13.5±0.7	99.8±9.5
4	15	27.7±1.5	4.0±0.1	2.5±0.2	14.5±1.2	16.2±1.3	112.4±13.1
Roasted devil bean meal (RDBM)							
5	5	35.0±7.8	3.7±0.6	2.6±0.4	10.8±1.6	14.6±2.4	138.9±38.9
6	10	28.0±3.0	3.8±0.4	2.6±03	13.6±0.7	14.6±0.1	107.9±5.9
7	15	28.0±2.0	3.8±0.4	2.7±05	13.5±1.4	14.1±1.9	106.0±23.4

GNC - Groundnut cake; - CJBM - Cooked Bean Meal; RDBM - Roasted Devil Bean Meal
PCV - Packed Cell Volume; Hbc - Haemoglobin concentration; RBC - Red Blood Cell
MCHC - Mean Cell Haemoglobin Concentration; MCH - Mean Cell Haemoglobin
MCV - Mean Cell Volume

Table 6: Serum and Liver Metabolites of broiler - chicken

		Serum		Liver			
Diets	% GNC replaced by either CJBM or RDBM	Total serum protein (g/100g)	Albumin (g/100g)	Globulin (g/100g)	Total liver protein (g/100g)	Albumin (g/100g)	Globulin (g/100g)
1	0	3.7±0.6	2.6±1.1	1.2±0.6	2.4±0.0	1.8±0.6	0.6±0.6
Cooked jack bean meal (CJBM)							
2	5	3.5±0.6	2.6±1.3	0.9±0.6	2.4±0.0	12±0.5	1.2±0.5
3	10	3.2±0.4	1.6±1.4	1.6±1.1	28±0.7	0.9±0.6	2.0±0.8
4	15	3.3±1.3	1.6±0.3	1.7±1.0	2.4±0.0	1.2±0.1	1.2±0.1
Roasted devil bean meal (RDBM)							
5	5	3.2±0.4	2.0±1.4	1.2±1.2	28±0.7	1.3±0.5	1.5±1.1
6	10	4.0±0.9	1.7±0.9	2.3±1.8	2.4±0.0	1.3±0.0	1.1±0.0
7	15	3.2±0.4	2.0±0.7	1.2±0.4	2.4±0.0	1.3±0.0	1.1±0.0

Means within the same column with different superscript are significantly different ($P<0.05$)

Discussion

The AFW, AWG and AFC of the birds fed on the RDBM compared favourably, in most cases with those fed the control diet. This tend to suggest that roasting had actually, to some extent, inactivated some of the anti-nutrients earlier reported by Agbede and Aletor, (2003b) that are inherent in raw devil beans. On the contrary, birds fed the diets containing CJBM had lower, AFW, AWG and AFC than those on the control diet. This tends to suggest three possibilities; first, that the two stage cooking adopted for the processing of jack bean has not effectively inactivated the anti - nutrients, especially the haemagglutinin contents, to the extent that the CJBM could not be used to enhance growth by the birds. Essentially, anti-nutrients have been reported to be capable of retarding growth (Martinez *et al*, 1995) and lowered digestibility and absorption of dietary nutrients (Putztai *et al*, 1995). Second, the study confirmed the report of Udedibie, (1990) and Esonu et al, (1997) that cooking could not improve the nutritive value of jack bean for broiler - chicks beyond 10% inclusion level. Consequently, while the RDBM could be used up to 150gkg^{-1} in the diet for broilers, to have a comparable AFW and AFC like the control diet, CJBM could only be used up to 100gkg^{-1} in the formulation. Third, the level of crude fibre in CJBM-based diets was in most cases higher than those found in the control and RDBM based diets (Table 2).

The least N-retention was obtained for birds fed 150gkg^{-1} CJBM - based diet. This further confirmed that cooking could not totally inactivated the anti-nutritional factors in jack bean (Agbede and Aletor, 2003a), and consequently could not be included in the broiler diets in excess of 100gkg^{-1} of the diet (Esonu *et al*, 1997). Thus, the residual anti-nutritional factors in the CJBM used in this study are still very potent as to inhibit the utilization of the dietary nitrogen by the birds.

From this study, it evident that neither the control diet nor the test diets had significant influence (except the relative weight of the gizzard) on the organs measured, implying that similar relative organs weights were enhanced

by the control diet as well as the CJBM and RDBM -based diets. However, the relative weight of gizzard from the birds fed the CJBM depressed with increased level of CJBM substitution for GNC while it was the reverse with the RDBM-based diets. The increased weight of the gizzard on the CJBM might be due to the increased level of crude fibre (Table 2) owing to the CJBM substitution. Thus in an attempt to handle the higher fibre content of the CJBM - based diets, the birds tend to develop high muscularized gizzard for efficient utilization (Agbede, 2000)
Reports by Aletor *et al* (1998) and more recently, Agbede and Aletor (2003a) showed that blood variables most consistently affected by dietary treatments include Rbc count, PCV and Hb concentration. The values of PCV and Rbc obtained in this study were comparable with those reported by Agbede and Aletor, (2003a) when broiler were fed leaf protein concentrates in place of fish meal protein, but higher than those reported by Igene (1999) for birds of the same age fed winged bean diets. The lack of significant difference in MCHC, MCH and MCV among the dietary treatments points to the fact that all blood samples collected for analysis had identical haemoglobin content. The dietary substitution of GNC with either CJBM or RDBM did not significantly affect the serum and liver metabolites. This suggests that, though the test diets did not enhance the same performance with that of the control (Table 3) the test diets enhanced similar healthy growth of the chickens. Serum and liver protein are most important in the maintenance of the proper osmotic pressure between the circulatory fluids and fluid in the tissue spaces, so that exchange of materials between blood and the cell is facilitated.

Conclusion

The study showed that CJBM could not be included in broiler diet for more than 100gkg^{-1} while RDBM could be used in the formulation in excess of 150gkg^{-1}. Thus, while efforts to improve the nutritive quality of jack bean have become imperative further research is suggested to evaluate increased level of RDBM inclusion in the diet for growing broiler - chicken. If this is achieved, it will enhance higher economic returns to the farmers, especially now that devil bean is not been used for any economic purposes.

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