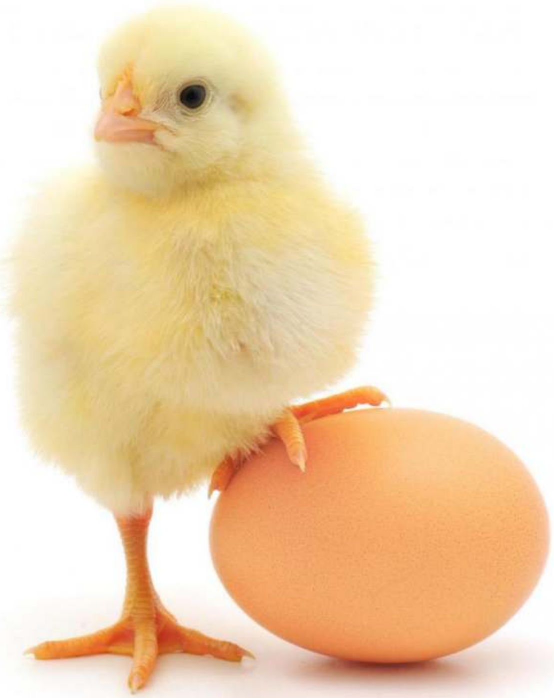
ISSN 1682-8356
ansinet.org/ijps



INTERNATIONAL JOURNAL OF POULTRY SCIENCE

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

International Journal of Poultry Science 4 (10): 765-771, 2005
ISSN 1682-8356

Response of Growing Broiler to Varying Dietary Plant Protein

G.S. Ojewola and U.E. Ewa
College of Animal Science and Animal Health, Michael Okpara University of Agriculture, Umudike,
P.M.B. 7267, Umuahia, Abia State, Nigeria

Abstract: A five-week study was conducted to evaluate the productive performance, apparent nutrient utilization, carcass and organ proportion and economics of production of broilers fed five different plant proteins. Diet 1 contained 30% soyabean meal (SBM) while Diets 2,3, 4 and 5 contained pigeon pea seed meal (PPSM), groundnut cake (GNC), cashew nut meal (CNM) and cotton seed meal (CSM) respectively. One hundred and fifty-3-week old unsexed anak broilers were randomly allotted to the 5 dietary treatments in a completely randomized experiment (CRD). Each dietary group had 30 birds with 10 birds per replicate. Birds fed D5 has the highest mean daily intake (161.31g) that was significantly (P<0.05) different from others while D1 gave the best feed-to-gain ratio (2.30) which is closely followed by D3 and D4 respectively. Birds fed D3 and 4 gave the best nutrient utilization. Calcium and phosphorous retained showed that D3 (66.41; 66.37) and D4 (59.94; 63.52) respectively gave better performance than others. Birds fed D4 gave the least (P<0.05) mean total feed intake/bird (N) (217.13). It also had the highest net gain/bird (N332.87) which was significantly (P<0.05) different from D1 (N 275.37) and D3 (N285.96), while other diets can be said to be comparable. The percent carcass yield ranged from 68.68 (D2) to 73.48 (D1) showing that high live weights lead to high dressed weights. In conclusion, cashew nut meal enhanced productive performance, carcass yield and economics of production while others are comparable.

Key words: Varying plant protein, broiler production, nutrient utilization

Introduction

Poor animal protein intake (Ali-Balogun *et al.,* 2003) has been associated with livestock productivity. Malnutrition has been identified in many countries but under nourishment has been known to be particularly widespread in the developing countries (Ojewola, 1993). According to Iwe and Onadipe (2001), majority of malnourished people live in Asia and Africa, thus negatively impacting on the physical and health condition of its people.

Poultry production has been identified as one major means of solving this problem (Nworgu *et al.,* 1997; 2000). However, feeding poultry presents a great challenge to farmers and nutritionists in Nigeria (Etuk *et al.,* 2002) and several tropical countries. Farmers and feed millers seem to have become addicted to using only the conventional feed ingredients in producing their feeds. Unfortunately, these feed ingredients have become scarce and oftentimes unavailable. These, therefore, calls for re-think and expansion of resource base that can accommodate some unconventional feed ingredients that have comparative nutrient potentials like the conventional ingredients.

Apart from the major conventional plant protein sources (Soybean meal, groundnut cake) for instance, others like pigeonpea seed meal, cottonseed meal, cashew nut meal, sunflower seed meal and lima bean meal had been investigated (Mba *et al.*, 1974; Olomu, 1995; Olunloyo, 1996; Babajide, 1998; Odunsi, 2002; Amaefule *et al.,* 2003) and results indicate that these feedstuffs are capable of providing protein and energy for poultry. For instance, pigeonpea seeds have a crude protein content of about 215g kg-1 (Olomu, 1995; Amaefule and Obioha, 1998. They are also known to be high-yielding, producing up to 7 tonne per ha of seeds (Philips, 1977). The cashew nut tree (*Anarcardium occidentale* L.) is a tropical oil seed plant with great potential and increasing commercial value (Odunsi, 2002). Africa is said to be the third largest global source (100,000t. per year) after Brazil (200,000t. per year) and India (120,000t. per year). Favourable nutrient contents have been reported in undefatted meals from the reject cashew kernels with protein and ether extract of about 22 and 45 percent, respectively (Mba *et al.,* 1974; Piva *et al.,* 1977). South Africa, Zimbabwe, Ivory Coast, Chad and Mali have become major producers of cotton, south of Sahara. Every ton of cotton picked in the field yields about 600kg of seed and 35kg of cotton lint, but the value of the lint is about 7 times that of the seed. Seed is therefore, treated as a by-product of the industry, but it can provide significant quantity of edible oil and a protein-rich food for livestock (Munro, 1987). The chemical composition of cotton seed as given by Obioha (1992) is as follows: 51.20% crude protein; 7.02% crude fibre, 1.6% ether extract, 30.8% NFE; 9.3% ash and 2.71 ME (Mcal/kg) of the solvent, no hull, no lint seed of cotton. Foley *et al.,* (1972) observed that processed form of cottonseed meal contains 35-50% protein while Atteh (2002)

Table 1: Chemical composition of test ingredients used in this Trial

	Test ingredients				
Nutrient	SBM*	PPSM*	GNC*	CKM*	CSM*
Crude Protein(%)	42.38	36.21	41.24	39.96	41.35
Crude fat (%)	1.09	0.39	0.24	15.54	2.18
Crude fibre (%)	1.33	7.82	5.29	0.68	13.16
Ash(%)	5.02	3.97	4.96	4.96	6.14
Dry Matter(%)	91.34	91.87	92.01	91.21	91.06
NFE(%)	49.19	51.96	48.25	38.86	36.17
Moisture(%)	8.66	8.13	7.99	8.79	8.94
MINERALS					
Calcium, (%)	0.09	0.05	0.07	0.04	0.18
Phosphorus (%)	0.34	0.28	0.31	0.66	1.15
Magnesium (%)	0.23	0.18	0.25	0.37	0.54
Sodium (%)	0.09	0.11	0.15	0.04	0.05
Potassium(%)	0.34	0.31	0.29	0.17	1.18

*SBM = Soyabean meal *PPSM = Pigeonpea meal *GNC = groundnut Cake *CKM = cashew kernel *CSM = Cottonseed meal

observed 41-45% protein depending on the method and efficiency of oil extraction.

The objective of this study, therefore, is to further evaluate pigeon pea seed meal, cashew nut meal and cotton seed meal as potential feeding stuffs in the diets of broiler chickens so as to expand the resource base for plant protein sources for the nutritionists, feed millers and broiler producing farmers. These feeding resources, according to Odunsi (2002) may be viable alternatives for achieving optimum performance and curtailing production costs that is presently the bane of poultry production in the developing countries.

Materials and Methods

Dietary treatments: Different plant proteins, namely soyabean meal (SBM), pigeon pea seed meal (PPSM), groundnut cake (GNC), cashewnut meal (CNM) and cotton seed meal (CSM) were included in the diets at equal levels of 30% while other feed ingredients remained constant. Samples of each of the varying plant proteins were analyzed for proximate composition before dietary inclusion using the method of A.O.A.C. (1995).

Five diets were formulated. Diet 1 contained SBM, while diets 2, 3, 4 and 5 contained PPSM, GNC, CNM and CSM, respectively. The percent dietary crude protein ranged from 22.05 to 23.55 while the metabolizable energy (kcal/kg) ranged from 2777.34 to 3084.54.

Management of experimental birds: One hundred and fifty three-week-old unsexed Anak broilers randomly selected for the trial were transferred to the well prepared experimental pen (deep litter) and were randomly allotted to the 5 diets in a completely randomized experiment. Each dietary group had 30 birds, with 10 birds per replicate. The mean live weight of the birds in each replicate was taken and recorded at the onset of the trial. The birds were fed and watered *ad libitum*. Drugs and vaccines were duly administered. The trial lasted 5 weeks.

Data collection: At the beginning of the experiment, the chicks were weighed as individual replicate groups. Weekly feed intake and weight gain were recorded from which feed-to gain ratio was calculated. A week to the end of the trial, a digestibility trial was conducted during which excreta was collected quantitatively over the last seven days of the experiment. Experimental diets and dried excreta from each replicate were analyzed for proximate components according to A.O.A.C. (1995). Carcass evaluation was carried out at the end of the trial. One bird per replicate was randomly selected, fasted over night and slaughtered by severing the jugular vein. After scalding in warm water for about a minute, the feathers were manually plucked, each bird was cut into parts for carcass evaluation according to Ojewola *et al.* (2001). The relative weights of cut-parts are as percentage of dressed weight. The internal organs, such as heart, kidney, gizzard/proventriculus were all weighed separately and recorded using electric micrometer 3000g weighing gauge. Cost analysis was carried out at the end of the trial to assess the economic viability of the test ingredients. Gross margin and total revenue were considered according to Akpodiete and Inoni (2000).

Statistical analysis: All the parameters considered were subjected to statistical analysis using the Analysis of variance (ANOVA). Differences between the treatment means were determined using least significant difference (LSD). All statistical procedures were according to Steel and Torrie (1984).

Results and Discussion

Table 1 shows the chemical composition of the test ingredients, soyabean meal (SBM); pigeonpea seed

Table 2: Composition of experimental diets fed to broiler Birds from 3-8 weeks old

Diets	Ingredient				
	1	2	3	4	5
Maize	56.3	56.3	56.3	56.3	56.3
*SBM	30	-	-	-	-
PPSM*	-	30	-	-	-
GNC*	-	-	30	-	-
CNM*	-	-	-	30	-
CSM	-	-	-	-	30
Fish meal	7	7	7	7	7
Bone meal	4	4	4	4	4
Oyster shell	2	2	2	2	2
Salt	0.25	0.25	0.25	0.25	0.25
VIT. Mineral Premix	0.25	0.25	0.25	0.25	0.25
DL. Methionine	0.1	0.1	0.1	0.1	0.1
Lysine	0.1	0.1	0.1	0.1	0.1
Total	100	100	100	100	100
Calculated composition					
Energy (kcal/kg)	2943.54	3084.54	2925.75	2914.75	2777.34
Crude Protein (%)	23.25	22.05	23.55	22.32	22.35
Determined proximate and mineral composition					
(%)Crude Protein	32.67	23.81	24.29	23.78	22.96
(%) Crude fat	3.97	3.79	3.68	3.84	4.12
Crude fibre	4.36	4.12	3.91	4.23	5.41
(%) Ash	6.81	7.14	6.94	6.83	7.09
(%) Dry Matter	90.24	90.38	90.17	90.46	90.09
(%) Moisture	9.96	9.62	9.83	9.54	9.91
Gross energy(Kcal/kg)	3400	3450	3475	3480	3460
(%) Calcium	1.36	1.45	1.28	1.23	1.04
(%) Phosphorus	0.57	0.68	0.65	0.69	0.66
(%) Magnesium	0.68	0.71	0.62	0.59	0.73
(%) Sodium	0.15	0.91	0.61	0.13	0.18
(%) Potassium	0.22	0.28	0.24	0.21	0.27

Vitamin premix (2.5kg/1000kg): vitamin A (15,000.000 U.I), vitamin D_3 (3,000.000 I.U), and vitamin E (30,000 I. U) vitamin K (2,500 I.U), Thiamin B_1 (2,000mgr), Riboflavin B_2 (6,000mgr). Pyridoxine B_6 (4000mgr) Niacin (40,000mgr), vitamin B_{12} (20mgr), panthothenic B_6 (10,000 mgr), Folic Acid (1,000 mgr), Biotin (80mgr), Chlorine Chloride (500mgr), Antioxidant (125gr). Manganise (96gr), Zinc (60gr), Iron (24gr), Copper (6gr) Iodine (1,4gr), Selenium (24gr), cobalt (12gr).

meal (PPSM); groundnut cake (GNC); cashewnut meal (CNM) and cotton seed meal (CSM) used for this trial. The crude protein content of SBM (42.38%), GNC (41.24%) and CSM (41.35%) compared favourably with the values reported by Olomu (1995) while that of PPSM (36.21%) fall within the range (22-45%) reported by Aduku (1993). The crude fibre, crude fat, ash, NFE, DM and minerals followed the same trend. The slight differences observed from the already established values can be attributed to the different sources of the ingredients, methods of processing, length of storage and storage condition, among other. The calculated composition of the different diets used in this trial is as shown in Table 2.

The energy and protein contents of the test diets ranged between 2777.34 (CSM) to 3084.54 kcal/kg (GNC) and 22.05% (PPSM) to 23.55% (GNC), respectively. The diets were formulated in consonance with the established recommendation for dietary energy and protein in broiler chicken raised in warm wet climates (Oluyemi and Roberts; 2000; Obioha, 1992; Olomu, 1995).

The productive performance of broiler birds fed diets containing the different plant proteins is as shown in Table 3. There were significant ($P<0.05$) differences among the treatment means in all the parameters measured. For mean daily intake, D5 has the highest value (161.31g) that was significantly ($P<0.05$) different from others, whereas D1 (121.45g), D2 (126.94g), D3 (111.70g) and D4 (121.18g) were not significantly ($P>0.05$) different from each other. The highest value observed in birds fed D5 relative to others could be attributed to the low dietary energy value of the diet, hence, the birds increased their feed consumption presumably in an effort to overcome the energy

Table 3: The productive performance of broiler birds fed diets containing different plant protein sources (3-8 Weeks)

Parameters	Treatment					SEM
	D1	D2	D3	D4	D5	
Mean initial body wt gain(%)	340.70	340.147	338.887	350.000	346.297	3.9867NS
Mean final body wt(%)	2440.0^{a}	2031.3^{b}	2285.0^{a}	2268.7^{a}	2374.0^{a}	40.9800*
Mean total body wt gain(g)	2096.7^{a}	1684.0^{b}	1845.3^{ab}	1884..0^{ab}	2024.3^{a}	47.3740*
Main daily body wt gain(g)	59.92^{a}	48.403^{b}	52.723^{ab}	53.830^{ab}	57.840^{a}	1.3623*
Mean daily feed intake 3-8wks(g)	121.45^{b}	126.94^{b}	117.70^{b}	121.18^{b}	161.31^{a}	5.0494*
Mean feed intake 3-8wks(g)	4707.69^{b}	4455.5^{c}	4423.1^{c}	4423.1^{c}	5568.6^{a}	85.553*
Feed to gain ratio	2.033^{b}	2.6233^{ab}	2.2667^{ab}	2.5867^{ab}	2.7933^{a}	0.10657*

a-c values in same row with different superscripts are significantly different (P<0.05). NS=Non- significant.
SEM=Standard error of mean. *=Significant

Table 4: Digestibility trial: percentage nutrient (apparent) retained by broiler birds fed diets containing different plant protein sources (3-8 wks)

Parameters	Treatment					SEM
	D1	D2	D3	D4	D5	
Nitrogen,(%)	77.010^{bc}	73.577	83.633^{a}	82.723^{ab}	70.227^{d}	1.1564*
Ether extract,(%)	88.090^{ab}	88.37^{ab}	90.743^{a}	90.577^{a}	87.643^{b}	0.4894*
Crude Fibre (%)	18.060^{ab}	10.003^{b}	28.467^{ab}	30.593^{a}	28.470^{ab}	3.3400*
Ash (%)	28.043^{b}	34.947^{b}	55.533	51.157^{a}	39.674^{ab}	2.6976*
Dry Matter, (%)	76.133^{abc}	75.297^{bc}	82.213^{a}	81.053^{ab}	73.360	1.11358*

a-d values in same row with different supercripts are significantly different (P<0.05)

deficiency (Keshavarz and Fuller, 1980; Emenalom and Udedibie, 1998). The presence of a substantial amount of crude fibre (13.16%) in the test ingredient is also worthy of note (Duckworth *et al.,* 1950 and Hankanson, 1974).

Mean daily body weight gain showed that D1 (56.67g) and D5 (57.84g) were significantly (P<0.05) different from D2 (48.40g) but not significantly (P>0.05) different from D3 (52.72g) and D4 (53.83g). The significantly lower body weight gain of D2 when compared with D1 and D5 and numerical difference when compared with D3 and D4 can be attributed to residual anti-nutritional factors such as tannin and trypsin inhibitors which have been reported to have negative effect on weight gain (Aletor and Fasuyi, 1997; Amaefule and Obioha, 2001; Akinmutimi, 2004). Trypsin inhibitor, for example, has been reported to hinder protein digestibility by inhibiting the protease enzyme through binding to the active site (Liener and Kakade, 1980). Toasting has been reported to have a partial detoxification on grain legumes such as jack bean and sword bean (Ewa, 1999; Izundu, 1999).

The feed-to-gain ratio exhibited significant difference (P<0.05) only between D1 (2.03) and D5 (2.79). The nutrient content of the diet showed that birds fed D2 were significantly (P<0.05) depressed while others were not, but compared favourably. This could be attributed to the protein quality, availability and the presence of some anti-nutritional factors as mentioned above.

The mean final body weights of all diets fall within the normal range for normal broiler finisher chickens as established by Oluyemi and Roberts (2000) and Obioha (1992). Since rapid growth is of vital concern to a poultry farmer, the performance of birds fed diets 1, 3, 4 and 5 seems to indicate better nutrient adequacy of these diets than diet 2.

The percent apparent nutrient retained by broiler birds fed the treatment diets is shown in Table 4. The various parameters considered were significantly (P<0.05) influenced. Birds fed diet 3 gave the highest percentage nitrogen (86.63), ether extract (90.73), ash (55.53) and dry matter (82.21) retained while birds fed diet 5 gave the least percentage nitrogen (70.23), ether extract (87.64) and dry matter (73.36) retained. The percent crude fibre digested was least (10.00) for birds fed diet 2 while percent ash retained was least (28.04) for birds fed diet 1. Generally, birds fed diets 3 and 4 gave the best apparent nutrient utilization as reflected in the final body weight of birds placed on these diets.

The percent mineral retained by broiler birds fed diets containing different plant protein is shown in Table 5. All the parameters measured showed significant differences (P<0.05) with the exception of magnesium. Calcium and phosphorous retained showed that D3 (63.41; 66.41) and D4 (59.94 and 63.52) gave better performance than others. This signifies a good calcium phosphorous balance which is necessary for good, healthy and strong bone formation (Olomu, 1995). Sodium and potassium retained by birds fed D2 (92.81; 78.47) and D3 (92.49; 80.37) were higher than others, an indication that good nutrient transport to various parts

Table 5: Digestibility trial: percentage mineral retained by broiler birds fed diets containing different plant protein sources (3-8wks)

Parameters	Treatment					SEM
	D1	D2	D3	D4	D5	
Calcium (%)	54.023[a]	56.003[a]	66.413[a]	59.940[a]	33.157[b]	2.5814*
Phosphorus (%)	41.837[b]	50.173[b]	66.373[a]	63.517[a]	44.383[b]	2.1440*
Magnesium (%)	59.297	60.187	65.480	67.067[a]	57.370	2.5639[ns]
Sodium, (%)	64.823[b]	92.813[a]	92.487[a]	65.997[b]	64.987[b]	1.3129*
Potassium, (%)	67.933[b]	78.467[ab]	80.370[a]	75.297[ab]	73.983[ab]	1.90291

*a-b values in same row with different superscripts are significantly different (P<0>05)

NS=Non-significant *=Significant. SEM=Standard error of mean

Table 6: Cut-parts expressed as percentage of dressed weight of broiler birds fed diets containing various plant protein sources (3-8wks)

Parameters	Treatment					SEM
	D1	D2	D3	D4	D5	
Live weight (g)	3000[a]	2416.7[b]	2533.3[b]	2466.7[b]	2600.0[b]	44.5138*
Dressed wt (g)	2200.00[a]	1650.00[c]	1750.00[bc]	1725.00[b]	1841.67[b]	28.3414*
Dressed wt (%)	73.479[a]	68.680[b]	69.085[ab]	69.903[ab]	70.805[ab]	0.6516*
Thigh (%)	17.41[s]	18.097	18.572	19.312	17.653	0.4806[NS]
Chest Cavity (%)	25.070[b]	23.688[ab]	36.190[a]	29.564[ab]	30.942[ab]	0.5062*
Back cavity (%)	23.483[b]	25.139[ab]	23.771	26.720[a]	23.550[b]	0.5251*
Drumstick (%)	14.7763[ab]	15.5937[ab]	14.7620[ab]	13.4920[b]	15.7970[a]	0.3763*
Wings (%)	12.5007	13.5723	13.8093	14.0213	12.6980	0.3679[NS]

a -c values in same row with different superscripts are significantly different (P<0.05)

NS=Non-significant *= Significant. SEM=Standard error of mean

Table 7: Organ parts expressed as percentage of dressed weight of broiler birds fed diets containing various plant protein sources (3-8 wks)

Parameters	Treatment					SEM
	D1	D2	D3	D4	D5	
Heart (%)	0.6216[ab]	0.65033[ab]	0.57733[b]	0.72567[a]	0.7026[ab]	0.02454*
Liver (%)	2.3437	2.9937	2.3177	2.2020	2.3227	0.18795[NS]
Gizzard (%)	2.7830	2.6517	3.1353	2.6733	3.0927	0.09038[NS]
Intestine (%)	4.7470[c]	7.2747[a]	5.4287[bc]	6.5503[ab]	5.3593[bc]	0.21325*
Spleen (%)	0.15967	0.21100	0.20033	0.19500	0.15933	0.0149[NS]
Kidney (%)	0.66200[ah]	0.77867[ab]	0.83867[a]	0.61467[b]	0.79967[a]	0.0332*

a-c values in same row with different superscripts are significantly different (P<0.05)

of the body is obtainable.

Table 6 shows the cut-parts expressed as percent of the dressed weight. There were significant (P<0.005) differences among the treatment diets for all the parameters measured, with the exception of the values for the thigh and wings. The results obtained show that high live weights also lead to high dressed weights. This is in agreement with the work of Hayse and Marison (1973), who confirmed that heavier birds produced a greater eviscerated yield. This is a further confirmation of the fact that plump appearance in broilers was associated with high percentage of edible meat. Birds fed D3 gave the highest value (36.19%) for chest cavity while birds fed D2, D5, D4 and D1 gave less. This shows the ability of test diets to support tissue deposition to particular parts (Bamgbose *et al.*,1998). The back cavity for birds fed D4 (26.72) was significantly (P<0.05) higher than D1 (23.48) and D5 (23.55%) but compared favourably with D2 (25.14) and D3 (23.77). The poorer values exhibited by D1 and D5 could be attributed to different abilities of the test diets to differently induce tissue lay down for the said cut-parts (Abiola, 1999). Differences in drumstick values may be attributed to similar reasons. Therefore, considering the highest numerical values of thigh, wing and back-cut of D4 and favourable comparism with other diets for values of percentage dressed weight, chest cavity and drumstick, D4 seems to be a diet of choice.

Table 8: Economic analysis of broiler birds fed diets containing five different plant protein Sources (3-8wks)

Parameters	Treatment					SEM
	D1	D2	D3	D4	D5	
Cost/kg Diet (N)	52.51	59.21^{b}	52.31^{c}	49.61^{c}	45.11^{c}	0.000*
Mean total feed consumed (kg)	4.6600^{b}	4.333^{b}	4.5200	4.3767^{b}	5.4667^{a}	0.1177*
Mean total feed consumed bird (N)	274.63^{b}	256.57^{ab}	234.04^{ab}	217.13^{c}	246.60^{ab}	5.1814*
Price/kg of bird weight (N)	287.48^{b}	344.54^{a}	306.63^{b}	311.88^{b}	295.92^{b}	5.2326*
Final wt of birds (kg)	2.44^{a}	2.033^{b}	2.283^{a}	2.233^{ab}	2.373^{a}	0.0405*
Marginal Revenue per bird in (N)	425.37^{c}	443.43^{bc}	465.96^{ab}	482.87^{a}	453.40^{bc}	5.1815*
Net gain/bird (N)	275.37^{b}	293.43^{ab}	285.96^{b}	332.87^{a}	303.40^{ab}	8.1750*

a-c values in same with different superscripts are significantly different (P<0.05)
NS=Non – Significant. SEM=Standard error of mean. *=Significant

The result of organ proportion expressed as percent of dressed weight is as shown in Table 7. There were significant differences (P<0.05) among the treatment means for heart and kidney, while liver, gizzard and spleen were only numerically different. The high value (7.27%) observed for the intestine of birds fed D2 is in agreement with Ologhobo *et al.* (1993) who reported same when raw lima bean was fed to chicks. This, they attributed to the effect of high but less digestible fibre content of raw lima bean. The value for D4 (6.55) could be attributed to slow passage of fatty diet that must take some longer time to digest. The quality and high fat content of the cashew kernel meal (15.54%) could have elicited increased activity in the heart of the chickens fed diet 4, thus leading to the increase observed in the weight of the heart in birds fed D4 (0.73) which is numerically and respectively above those of D5 (0.71), D2 (0.65) and D1 (0.62) and significantly (P<0.05) above D3 (0.58). Differences in values for kidney among treatments were significant (P<0.05). The higher value observed for birds fed D3 (0.84) can be attributed to the increase in activity of the kidney enzymes to detoxify the available anti-nutritional factors present in the test ingredients. The lowest value (0.62) of kidney weight in D4 is understandable knowing that cashewnut meal has not been known to be high in toxic substances like some other oil seeds (Odunsi, 1999). Thus, the kidney based enzymes may exhibit reduced activities, thus making cashewnut meal a probable plant protein source for broiler.

The economics of production of broiler birds fed the five different plant proteins is shown in Table 8. Birds fed D4 had the highest net gain/bird (N332.87) which was significantly (P<0.05) different from D1 (N275.37) and D3 (N285.96), while all the other diets are comparable. At the time this trial was carried out, a kilograme of D5 gave the least value (N45.11) followed closely by D4 (N49.61), D3 (N52.31), D1 (N52.51) and D2 (N59.61). Having considered the amount of feed consumed by birds throughout the period of experiment, it was observed that birds fed D4 gave the least mean total feed intake/bird, an indication that inclusion of cashewnut meal in broiler diet is more economically advantageous than the other four test ingredients.

In conclusion, inclusion of cashewnut meal, an unconventional protein source, with a great potential as plant sources in broiler ration enhanced biological performance, quality carcass yield, efficient nutrient utilization and economics of production. It compared favourably with conventional plant protein sources such as soyabean meal and groundnut cake, while pigeonpea meal can also be used where soyabean meal, groundnut and other established oil seeds are scarce and costlier. Therefore, cashewnut meal is recommended as an alternative protein source to conventional plant protein sources.

References

Abiola, S.S., 1999. Comparative utilization of toasted and cooked soyabean in broilers ration. Proc. Of 24th NSAP Conference, University of Ilorin Kwara State, Nigeria, P: 84-86.

Aduku, A.O., 1993. Tropical feedstuff and analysis table. Ahmadu Bello University Samaru, Zaria Nigeria, p:1.

Akinmutimi A.H., 2004. Evaluation of sword bean (C. gladiata) as an alternative feed resource for broiler chicken. Ph.D. thesis. Michael Okpara University of Agriculture, Umudike. Abia State Nigeria (unpublished).

Akpodiete, O.J. and E.O. Inoni, 2000. Economics of broiler chickens fed maggot meal as replacement for fish meal. Nig. J. Anim. Prod., 27: 56-63.

Aletor, V.A and A.O. Fasuyi, 1997. Nutrient composition and processing effect on cassava leaf (Manihot esculenta, cranzi) anti-nutrient. A paper presented at the 2nd annual conference of Anim. Sci. Ass of Nigeria. Lagos, p: 231-242.

Amaefule, K.U. and F.C. Obioha, 1998. The substitution of pigeon pea seed (Cajanus cajan) for groundnut cake and maize in broiler finisher rations. Nig. J. Anim. Prod., 25: 9-12.

Amaefule, K.U. and F.C. Obioha, 2001. Performance and Nutrient utilization of broiler starters fed diets containing raw, boiled on dehulled pigeonopea seeds (Cajanus cajan) Nig. J. Anim. Prod., 28: 31-39.

Amaefule, K.U., C.N. Odukwe and E.C. Ndubuisi, 2003. Pigeonpea seed meal as protein source for broilers. J. Sustain Agri. Environ., 5: 1-11.

Ali-Balogun, J.K., C.A.M. Lakpini, J.P. Alawa, A. Mohammed and J.A. Nwata, 2003. Evaluation of cassava foliage as a protein supplement for sheep, Nig. J. Anim. Prod., 30: 37-46.

Atteh, J.O., 2002. Principles and practice of livestock feed Manufacturing. Adlek printers Ilorin. Nigeria, P:13-67.

Association of Official Analytical Chemist (A.O.A.C), 1995. Official Methods of Analysis. 18th edition. Washington. D.C.

Babajide, T.E., 1998. The effect of graded level of cashew kernel meal on performance and carcass characteristics of broiler finishers. B. Technology (degree) project. Dept. Anim. Prod. And Health. Ladoke Akintola University of Technology, Ogbomoso. Nigeria.

Bamgbose, A.M., E.O. Oyawoye, O.H.O. Apata, A.S. Mohammed and A.M. Musa 1998. Utilization of roasted full-fat soyabean in diets for broiler chickens. Proc. Of the NSAP Anniversary Conference, University of Agriculture, Abeokuta Ogun State, Nigeria.

Duckworth, J., J.M. Naftalin and A.C. Dalgana, 1950. The digestibility of linseed oil and mutton fat by chicks. J. Agri. Sci. Camb., 40: 39-49.

Emenalom, O.O. and A.B.I. Udedibie, 1998. Effect of dietary raw, cooked and toasted Mucuna prients seeds (Velvet bean) on the performance of finisher broilers. Nig. J. Anim. Prod., 25-199.

Etuk, E.B., A.B.I. Udedibie and H.O. Obikaonu, 2002. Replacement value of pigeonpea (Cajanus cajan) seed meal for soyabean meal and maize in broiler finisher diets. Proc. 7th Annual Conference Anim. Sci. Ass. of Nigeria (ASAN). Abeokuta Nigeria, p: 157-160.

Ewa, U.E., 1999. Evaluation of the metabolized energy and true digestible protein of jackbean (*Canavalia ensiformis)* using Muscovy Ducks (carina moschata). B.S Thesis, Michael Okpara University of Agriculture, Umudike, pp: 25-33.

Foley, R.C., D.L. Bath, F.N. Dickinson and H.A. Tucker, 1972. Diary cattle principles, practices, problems and profits lea and Febiger, Philadephia, U.S.A.

Hankanson, J., 1974. Factors affecting the digestibility of fats and fatty acids in chicks and hens Swedish J. Agri. Res., 4: 33-47.

Hayse, P.L. and W.W. Marison, 1973. Eviscerated yield, component part and meat, skin and bone ratios in chickens broiler. Poult. Sci., 57: 718-722.

Iwe, M.O. and O.O. Onadipe, 2001. Effect of addition of extruded full-fat soy flour into sweet potato flour on functional properties of the mixture, J. Sustain. Agri. Environ., 3: 109-117.

Izundu, R.O., 1999. Effect of Processing on Energy and Protein Digestibility of sword bean (*Canavalia gladiata)* using Muscovy Duck (*Carina moshata)* B. Agri. (degree) project. Michael Okpara University of Agriculture, Umudike. Abia State, Nigeria, pp: 1-25.

Keshavarz, K. and H.L. Fuller, 1980. The influence of widely fluctuating temperatures on heat production and energetic efficiency of broilers. Poult. Sci., 59: 2121-22128.

Liener, E.I. and L.M. Kakade, 1980. Protease inhibitors Toxic constituents of plant foodstuffs Academic Press 2nd Edn., P: 7-71.

Mba, A.V., M.C. Njike and V.A. Oyenuga, 1974. The proximate composition and the amino acid content of some Nigeria oil seeds. J. Sci. Food Agri, 25: 1547-1553.

Munro, J.M., 1987. Cotton Longman Publishing Co. Singapore. P: 1-5, 15-21.

Nworgu, F.C.H., J.U. Ogbonna, J.A. Olupona, A.O. Oredein and G.N. Ogbosuka, 1997. Effects of various protein sources on broiler performance and livestock products, 104-113.

Nworgu, F.C., G.N. Egbunike, J.B. Faphohunda, F.O. Ogundola, A.J. Omela, G.E. Ogbosuka and C.N. Okpeze, 2000. Performance of broiler chicks fed full-fat extruded soyabean meal and full-fat soyabean Trop. Anim. Prod. Invest., 3: 47-54.

Obioha, F.C., 1992. A guide to Poultry Production in the Tropics. Acena Publ. Enugu Nigeria, P: 18.

Odunsi, A.A., 1999. Feeding values of cashew kernel meal in the diet of finishing broiler chickens.

Odunsi, A.A., 2002. Effect of feeding reject cashew kernel meal on pre and early laying performance of pullet. Arch. Zootec., 51: 423-429.

Ologhobo, A.D., A. Apata, A. Oyejide and R.O. Akinpelu, 1993. A comparison of protein fraction prepared from lima beans (*Phaseolus lunatus)* in starter diets. Animal Resources, 4: 13-30.

Olomu, J.M., 1995. Monogastrics Animal Nutrition – Principles and Practice. JACHEM Publ. P: 111-148.

Olunloyo, O.A., 1996. Marketing outlet for cashewnuts. Proc. Of the National Workshop on Cashew Production Technology. Cocoa Research Institute Ibadan. Nigeria.

Oluyemi, J.A. and F.A. Roberts, 2000. Poultry production in warm wet climates, Macmillan Press, Ltd, London, pp: 195-199.

Ojewola, G.S., 1993. Productive performance and body composition of broiler as influenced by dietary energy and protein in the Humid tropics. Ph.D thesis. Dept. of Animal Science. University of Ibadan. Nigeria.

Ojewola, G.S., S.F. Abasiekong and C.S. Nwachukwu 2001. Methionine supplementation in the productive efficiency, carcass characteristics and Economics of growing Indigenous turkey. Trop. J. Anim. Sci., 4: 161- 170.

Philips, T.A., 1977. An Agricultural Note Book. New Edition. Longman Group London. P45.

Piva, G., E. Santi, and T.E. Ekpeyong, 1977. Nutritive value of cashewnut extraction meal. J. Sci. Food Agri., 22: 22-23.

Steel, R.G.D. and J.H. Torrie, 1984. Principle and Procedures of Statistics McGram Hill New York.