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Performance Characteristics and Nutrient Utilization of Starter Broilers Fed Raw and Processed Pigeon Pea (*Cajanus cajan*) Seed Meal

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Abstract: A 28 - day feeding trial was conducted to evaluate the effect of processing of pigeon pea seeds on the performance and nutrient digestibility of finisher broilers. Four experimental diets were formulated such that each diet contained raw, boiled, boiled with potash and toasted pigeon pea seed meals at 26% dietary level respectively. One hundred and ninety two 5-week old Anak 2000 broiler chicks were randomly assigned to the four experimental diets in a completely randomized design (CRD). Each treatment group was replicated four times with 12 birds per replicate. At the end of the 4 weeks feeding trial, three birds were randomly selected from each replicate and transferred to metabolic cages for faecal collection and determination of apparent nutrient digestibility. Another set of 3 birds were randomly selected from each replicate, deprived of water but not feed for 24 hours, slaughtered and eviscerated for organ weight determination. Results showed significant ($P < 0.05$) differences in performance among the birds fed processed and raw pigeon pea seed meals. Birds fed processed pigeon pea seed meal performed significantly ($P < 0.05$) better than those on raw pigeon pea seed meal. There was no significant ($P > 0.05$) difference in performance among the groups fed differently processed pigeon pea seed meals. The results of the digestibility trial showed that significant ($P < 0.05$) differences existed among the groups in protein digestibility only. The results of the trial indicated that the three processing methods boiling, boiling with potash and toasting were effective in reducing the antinutritional factors in pigeon pea seeds. The result of the study also indicated improved nutritive value of pigeon pea boiled with potash.

Key words: Processed pigeon pea, nutritive value, finisher broilers, performance, nutrient digestibility

Introduction

Globally, domestic animals continue to make important contributions to food supply. Livestock products account for about 30 percent of the total global value of food and agriculture, and approximately 19 percent of the value of global food production (Heap, 1998). Products from food animals provide over 33 percent of protein consumed in human diets globally and about 16 percent of food energy (Martin, 2001). However, despite considerable progress in food production in the last 30 years, 800 million people in the world are still undernourished (FAO, 1982).

Unfortunately, two thirds of the undernourished people of the world are located in the developing countries such as Africa. In these countries, daily protein intake is far below the requirement. For instance, Africa is only meeting 32g of the daily protein requirement of 52g recommendation by FAO. FAO also recommended that one third of the daily protein intake should be of animal origin, but in Africa (especially Nigeria) only about 20% of the low protein intake is of animal origin compared to about 70% in the United States. According to Atteh (2003), the average African is meeting only 33% of his daily animal protein requirement while meeting 66% of his daily plant protein requirement.

The low animal protein consumption by Africans in

general and Nigerians specifically, is a reflection of the deteriorating state of the Nigerian livestock industry, which has continued to show a discouragingly slow rate of growth. A realistic step towards enhancing animal protein supply and intake in Nigeria is the development and expansion of the poultry industry. FMAWRRD (1988) had earlier reported that the poultry sub-sector has the greatest potential to bridge not only the supply – demand gap but also the supply-requirement gaps for animal protein in the country. Despite the privileged role accorded to poultry industry, its future development depends to a large extent on the supply of appropriate, safe and cost effective feeds.

The sources of protein for poultry feed are expensive and they constitute about 30-35% of their diet. The over dependence on the use of soyabean and groundnut cake as major sources of protein in poultry feed has led to both society and competition with man for these ingredients and consequently high-cost of poultry feeds (Abubakar *et al.*, 2004; Agbede and Aletor, 2004). This situation is not only unhealthy for the industry; it is also a challenge to animal nutritionists. This limitation imposed by scarcity and competition with human consumption have forced animal nutritionists to exploit alternative protein feed ingredients that are locally available, relatively cheaper and can meet the nutrient

requirements of poultry.

The utilization of unconvention feedstuffs will reduce the cost of feed and maximize the returns from poultry farming.

Pigeon pea (*Cajanus cajan*) is an important legume with very low human food preference because of the availability of other beans that are easier to cook. It is equally of no industrial use as now in Nigeria. It has been found a satisfactory protein ingredient up to 30% of the whole diet for broilers (Amaefule and Obioha, 2001). However, its use in monogastric animal diet may be encumbered by the presence of antinutritional factors like trypsin inhibitors and hemagglutinins (Udedibie and Carlini, 2002). These toxic components impede protein and energy utilization by monogastric animal like poultry. Hence, the need for processing before usage.

With the available information on the potentials of *Cajanus cajan* as an alternative protein source and its limitation in poultry diets, this study therefore, evaluated the performance characteristics and nutrient utilization of starter broilers fed raw and processed pigeon pea seed meals.

Materials and Methods

Sources and processing of pigeon pea seeds: The pigeon pea seeds used for the experiment were procured from Abakaliki local market in Abakaliki, Ebonyi State, Nigeria. The pigeon pea seeds were divided into four (4) batches. One batch was not subjected to any processing method. The second batch was boiled for 60 minutes at 100°C, while the third batch was boiled in water with potash at 2g / kg of pigeon pea seed for 60 minutes. The boiled samples were drained and sun-dried. The fourth batch was toasted on frying pan in fire supplied by firewood. The samples were milled separately to produce raw, boiled, boiled with potash and toasted pigeon pea seed meal respectively.

Samples of raw, boiled, boiled with potash and toasted pigeon pea seed meals were analyzed for their proximate composition (AOAC, 1980) (Table 1). A phytochemical test was equally carried out to determine the anti-nutritional factor present, their level of occurrence and the effect of processing on them according to the method of Kakade *et al.* (1974) with the modification described by Liu and Markakis (1989) (Table 2). The pigeon pea seed meal (PSM) so prepared were used to formulate four broiler starter diets. The diets contained 26% PSM by proportion raw, boiled with potash and toasted PSM respectively. The ingredient and chemical composition of the diets are shown in Table 3.

Experiment birds and design: One hundred and ninety - two (192), day old broiler procured from a commercial hatchery and used for the experiment, the birds were fed commercial broiler starter diet for one week

Table 1: Proximate composition of Pigeon pea seeds

Ingredients	Raw	Boiled	Boiled	Toasted
Crude protein	27.15	26.02	26.02	26.20
Crude fibre	7.45	7.20	7.18	7.19
Ether Extract	1.67	1.50	1.52	1.58
Total Ash	5.31	4.21	4.20	4.40
Nitrogen free extract	58.42	61.07	1.05	60.61
Dry matter	7.45	87.05	87.05	95.50
Moisture content	2.55	12.95	12.95	4.50

(acclimatization period). At the eight day, the chicks were randomly assigned to the four experimental diets, giving forty-eight birds per treatment group in a completely randomized design. Each treatment group was further subdivided into four replicates of 12 birds each and kept in a compartment measuring 4m x 4m. The experimental feed and clean water were supplied *ad libitum*. Before the commencement of the experiment, the birds were weighed to obtain their initial body weight and subsequently weighed weekly. Feed conversion ratio and protein efficiency ratio were also computed. All routine vaccination and poultry management practices were maintained. The feeding trial lasted 28 days.

Determination of daily feed intake was done by obtaining the difference between quantity of feed offered and the leftover the following morning. Data so obtained were used to calculate the body weight changes, daily body weight gain, daily feed intake, feed conversion ratio and protein ratio for each of the treatment groups.

Digestibility trial: At the end of the feeding trial, four (4) birds per replicate were randomly selected and transferred to metabolic cages for faecal collection and determination of apparent nutrient digestibility. The birds were allowed to adjust to the cages for three days. The digestibility trial lasted 4 days. The total collection procedure was employed for the faecal collection. Polythene sheet spread underneath the cages was used for the faecal collection. Feathers and other dirties were hand picked and discarded from the faeces before weighing.

The collection for each day were dried in a forced air-circulation oven at 60°C. The samples of each replicate were allowed to cool in a glass desiccator to prevent further absorption of moisture from the atmosphere. The 4 days samples were pooled, ground and then analyzed for crude protein, crude fibre, ether extract and total ash according to the method of AOAC (1980) (Table V).

Statistical analysis: Data collected were subjected to analysis of variance and the means were separated using Duncan's Multiple Range Test as described by Steel and Torrie (1980).

Results

Chemical composition of the differently processed pigeon pea (*Cajanus cajan*) are shown in Table 1. Data

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Table 2: Antinutritional factors in raw, boiled, boiled with potash and toasted pigeon pea seeds

Raw and processed forms of pigeon pea seeds	Hemagglutinins (Hu/mg protein)	% loss in Hg	Trypsin inhibitor (Tiu/mg protein)	% loss in TI
Raw	69.32		38.04	
Boiled	1.01	98.50	0.82	97.84
Boiled with potash	NH*	100	NI**	100
Toasted	5.82	91.60	3.87	89.82

*No hemagglutination. ** No inhibition

Table 3: Composition of the experimental diets

Ingredients	Diets			
	RPSM	BPSM	BPPSM	TPSM
Maize	50.0	50.0	50.0	50.0
PSM	2.0	2.0	2.0	2.0
BDG	10.0	10.0	10.0	10.0
PKC	5.0	5.0	5.0	5.0
Fish meal	10.0	10.0	10.0	10.0
Bone meal	3.0	3.0	3.0	3.0
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Chemical analysis				
Nutrients				
Crude Protein	21.06	20.82	20.83	20.86
Crude Fibre	3.74	3.69	3.69	3.69
Ether Extract	4.20	4.16	4.17	4.19
Ash	3.94	3.70	3.70	3.74
NFE	62.80	63.35	63.35	63.25
ME (Kcal)	3017.56	3018.82	3018.82	3018.40

PSM - Pigeon Pea Seed Meal

BDG - Brewers Dried Grain

PKC - Palm Kernel Cake

RPSM - Raw Pigeon Pea Seed Meal

BPSM - Boiled Pigeon Pea Seed Meal

BPPSM - Boiled with Potash Pigeon Pea Seed Meal

TPSM - Toasted Pigeon Pea Seed Meal

*Vit A - 10,000.00iu, D₃ - 2,000iu, B₁ - 0.75g, B₂ - 5g, Nicotinic acid - 25g, Calcium pantothenate - 12.5g, B₁₂ - 0.015g, K₃ - 2.5g, E - 25g, Biotin - 0.05g, Folic acid - 1g, Manganese 64g, Choline Chloride - 250g, Cobalt - 0.8g, Copper - 8g, Iron - 32g, Zn - 40g, Iodine - 0.8g, Flavoumycin - 100g, Spiramycin - 5g, Di - methionine - 50g, Selenium - 0.6g, Lysine - 120g, BAT-5g.

on antinutritional factors in raw, boiled, boiled with potash and Toasted pigeon pea (PSM) are shown in Table 2. The ingredient and chemical composition of the of the broiler start diets are shown in Table 3, while the performance of the broiler chicks fed the experimental diets is shown in Table 4. Data on apparent nutrient digestibility is shown in Table 5.

Processed PSM compared favourably with the raw PSM in relation to ether extract and crude fibre values. They were however, slightly lower than the raw PSM meal in crude protein and total ash but slightly higher in nitrogen free extract content. Boiling, boiling with potash and toasting resulted in 4.16%, 4.05% and 3.49% reduction in crude protein content respectively. The decrease in crude protein may be probably because processing enhances degradation. Cooking for example has been

associated with solubilization and leaching of some nitrogenous compounds into the processing water (Onu *et al.*, 2001; Udedibie and Carlini, 2000).

Data on Table 2 showed that pigeon pea seed (*Cajanus cajan*) contains in addition to other chemical substances antinutritional factors such as hemagglutinins and trypsin inhibitors, which limit its use as feed ingredients for monogastric animals. However, processing of the seeds reduced / eliminated the antinutritional factors in pigeon pea seeds resulting in the enhancement of the nutritive value. Hemagglutinins and trypsin inhibitor activities were completely eliminated in boiled with potash pigeon pea seeds. This is not surprising since potash is a strong protein denaturing agent. However, the exact mode of action of potash on the antinutritional factors in pigeon pea seeds not clear. Boiling gave a percentage reduction of 98.50% and 97.84% of Hemagglutinins and trypsin inhibitor in pigeon pea seeds. Toasting or dry heating gave a percentage reduction of 91.60% and 89.82% of Hemagglutinins and trypsin inhibitor in the seeds. The higher residual amount of these ant metabolites in toasted seeds strengthened the findings of Akanji *et al.* (2003), D'Mello *et al.* (1985), and Nagra *et al.* (1985) on the effect of dry heat on the nutritive value of leguminous seeds.

Processing of pigeon pea seed resulted in a significant improvement over the raw seeds in most of the measurements recorded as shown in 4. Birds fed processed PSM gained significantly ($P < 0.05$) higher weight than those fed raw PSM. The enhanced performance obtained when pigeon pea seeds were subjected to either moist or dry heat indicates the beneficial effect of heat treatment in improving the nutritional value of pigeon seeds. The fact that pigeon pea seeds protease inhibitors and other toxic substances are heat labile (Liener and Kakade, 1980), suggest that heating was responsible for their destruction and the enhancement of the nutritive value of the seed.

Boiled pigeon pea seed diets resulted in higher body weight gain and better feed conversion ratio than toasted pigeon pea seed diets. Boiling of legume seeds as a processing method has been reported to be better than toasting (Akanji *et al.*, 2003). The difference in performance could be due to greater reduction of antitryptic and hemagglutinating activities of pigeon pea seeds achieved by boiling (Udedibie and Carlini, 2000). Toasting (dry heat) appeared not to be as effective as

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Table 4: Performance of young broiler chicks fed on the experimental diets

Parameter	Diets			
	T ₁	T ₂	T ₃	T ₄
Average Initial body weight (g)	98.3 ± 1.68	100 ± 0.92	96.17	90 ± 1.16
Average final body weight (g)	580 ± 3.07 ^b	745 ± 2.50 ^a	760 ± 1.65 ^a	730 ± 2.68 ^a
Average body weight gain (g)	481.67 ± 3.01 ^b	645 ± 2.22 ^a	665 ± 2.02 ^a	640 ± 2.92 ^a
Average daily weight gain (g)	17.17 ± 0.58 ^b	23.04 ± 0.52 ^a	23.73 ± 0.37 ^a	22.83 ± 0.56 ^a
Average total feed intake (g)	1553.27 ± 2.84 ^b	1380.67 ± 3.54 ^a	1385.5 ± 3.32 ^a	1395.13 ± 4.49 ^a
Average daily feed intake (g)	55.48 ± 0.53 ^b	49.31 ± 0.62 ^a	49.48 ± 0.63 ^a	49.82 ± 0.85 ^a
Feed conversion ratio	3.25 ± 0.29 ^b	2.14 ± 0.08 ^b	2.08 ± 0.16 ^a	2.18 ± 0.13 ^a
Average daily protein intake	11.68 ± 0.25 ^b	10.26 ± 0.31 ^a	10.31 ± 0.28 ^a	10.39 ± 0.40 ^a
Protein efficiency ratio	0.90 ± 0.25 ^b	1.59 ± 0.25 ^a	1.65 ± 0.25 ^a	1.55 ± 0.25 ^a

^a and ^b Means within a row having different superscripts differ significantly (P < 0.05)

Table 5: Apparent Nutrient digestibility of broilers fed on the experimental finisher diets

Parameters	Diets				SEM
	1	2	3	4	
Apparent nutrient digestibility					
Crude protein	58.25 ^b	68.10 ^a	70.31 ^a	67.89 ^a	1.82
Crude fibre	59.09	61.18	62.30	61.00	3.47
Ether extract	73.38	74.94	76.01	75.91	1.05
Ash	59.93	62.29	62.29	62.81	2.93
Nitrogen free extract	61.24	63.82	63.88	63.75	1.39

^a and ^b Means within a row having different superscripts differ significantly (P < 0.05)

boiling in inactivating the toxic substances in the seeds. The toasted samples still retain greater amount of the antinutritional factors. This result agrees with the earlier observations by Udedibie *et al.* (1994) on the effect of dry heat treatment on the nutritive value of legume seeds.

The feed intake of broilers on diet containing raw PSM was significantly (p < 0.05) higher than those containing processed PSM, this however did not result in higher weight gain. The birds apparently increased their intake of the raw diet to meet their nutrient requirement from a diet that contained anti metabolites. This suggests that nutrients in the raw PSM were not as available as they were in the processed diets (Amaefule and Obioha, 2001). The presence of antinutritional factors in raw PSM diets may also have increased the rate of gastric evacuation in the birds. High rates of gastric evacuation is usually compensated for by increased feed intake (Aduku, 1993).

Feed conversion ratio and protein efficiency ratio were significantly (P>0.05) better for those on processed diets than those on raw PSM. The superior feed conversion ratio of birds on processed diets suggests that there enhanced availability, digestion, absorption and utilization of the nutrients in the processed seeds by broilers. Similar observations have been reported by Akinmutini *et al.* (2003) and Akpodiete *et al.* (2001). Results of the digestibility studies (Table 5) showed that except for crude protein, there was no significant (P>0.05) in the digestibility of other nutrients among the birds on processed and raw PSM. The reduction in crude protein utilization may be ascribed to the presence of the antinutritional substances contained in raw PSM.

Trypsin inhibitors have been implicated in reducing protein digestibility (Liener, 1976).

In spite of the non significant (P > 0.05) difference in the performance of the broilers in the three differently processed PSM, broilers fed diets containing pigeon pea seeds boiled with potash recorded higher values in the performance parameters measured. This improvement over diets containing boiled and toasted PSM could be associated with complete elimination of the antinutritional factors, which enhanced protein and energy digestibility and utilization. However the exact mode of action of potash on the antinutritional factors in the pigeon pea is not clear.

Conclusion: The results obtained from this study indicates that all the processing methods viz; boiling, boiling with potash and toasting are effective in reducing the antinutritional factors in pigeon pea seeds in broiler rations. It appears that boiling with potash will further improve the nutritional value of pigeon pea seeds.

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