EFFECT OF RAW, COOKED AND ROASTED PIGEON PEAS - BASED DIETS ON PERFORMANCE CHARACTERISTICS AND BLOOD CHEMISTRY OF BROILER CHICKENS

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ABSTRACT
An experiment was conducted to examine the effect of raw, whole-cooked, crushed-cooked, whole-roasted and crushed-roasted pigeon peas on performance characteristics, haematology and serum enzymes of broiler chickens. A total of 120 day-old unsexed broiler chicks of the Marshall strain were randomly allotted to six dietary treatments. The experiment ran for eight weeks. Feed intake was more significantly ($P<0.05$) reduced in birds fed raw pigeon peas. Body weight gain, feed conversion efficiency and protein efficiency ratio were significantly ($P<0.05$) reduced in birds fed raw, whole – roasted and crushed – roasted pigeon peas respectively. Haematological studies showed higher significant ($P<0.05$) reductions in haemoglobin, red blood cells, packed cell volume and white blood cells of birds fed raw pigeon peas than those fed whole – roasted and crushed – roasted pigeon peas respectively. Serum enzymes, glutamic pyruvic transaminase and glutamic oxaloacetic transaminase were significantly ($P<0.05$) increased in birds fed raw, whole – roasted and crushed – roasted pigeon peas respectively. Birds fed whole – cooked and crushed – cooked pigeon peas had better values of the response indices. Moreover, the best significant ($P<0.05$) improvements in the response indices were obtained in birds fed crushed – cooked pigeon peas.

Keywords: Pigeon peas, processing, broilers and response indices

INTRODUCTION
The utilization of conventional grain legumes as sources of proteins and energy for livestock animals has without doubt contributed extensively to the survival of livestock industry especially with respect to the production of meat, eggs and animal by-products on a commercial scale in the tropics. However, over the years in the sub- Sahara Africa, the increasing scarcity of the conventional grain legumes, soy beans and groundnut, as a result of dwindling local production and scarce foreign exchange for importation has necessitated for continued search for alternatives such as the lesser known grain legumes.

A prominent example in the category of the lesser known utilized grain legumes is the pigeon pea (*Cajanus cajan*). One major problem associated with many of these raw grain legumes is the presence of some toxic compounds such as the trypsin inhibitors, lectins, haemagglutinins, tannins, oxalates and phytate in the cotyledons and seed coat. The toxic compounds exert one deleterious effect or the other on livestock animals especially the monogastrics (Essien and Udedibie, 2008). Trypsin inhibitor in raw pigeon peas was reported to be responsible for endogenous loss of essential amino acids and pancreatic hypertrophy in rats (Apata, 1990). Haemagglutinin on the other hand was reported to cause a disruption of the intestinal microvilli in rats fed with raw lima beans (Aletor and Fetuga, 1988). Similarly, Emiola *et al.*, (2003) reported reduction in growth and feed conversion deficiency of broiler chickens fed with raw kidney beans.

Over the years, attempts have been made to reduce or eliminate toxicity of most of these underutilized legume seeds with respect to monogastric animals. Belmar and Morris (1994) reported the varying efficacies of methods such as autoclaving, extrusion, ensiling with urea and or ammonia, alcohol acid or alkali extraction and amino acid supplementation on removal of toxic effects of grain legumes. However, some of these processing methods were reported later to be cumbersome and consequently expensive (Udedibie and Carlini, 1998).

Hence, this study was aimed at looking at effects of modified cooking and roasting methods on nutrient composition of pigeon peas. The second objective of this study was to look at the effects of the raw, cooked and roasted pigeon peas on performance, hematology and enzymes of broiler chickens.

MATERIALS AND METHODS

Raw pigeon peas acquired from the Teaching and Research Farm of the College of Agricultural Sciences, Olabisi Onabanjo University, Ayetoro, Yewa North, South Western Nigeria, were air dried and processed using the cooking and roasting methods following Akanji (2002) with slight modifications.

Cooking

Two batches of the air – dried pigeon peas were subjected to aqueous heating respectively. In the first batch, air – dried pigeon peas were soaked intact in distilled water (250 g seed / litre of water) for 24h and then cooked in fresh distilled water (250 g seed / litre of water) for 1h. Both the soaking and cooking water extracts were discarded. The cooked seeds were oven dried at 40^0C, bagged and labeled whole – cooked pigeon peas (WCPP)

Another batch of air – dried pigeon peas was crushed into smaller sizes using a mortar and pestle. The crushed seeds were then soaked and cooked in distilled water as that of the whole – cooked pigeon peas in this study. The product obtained was named crushed – cooked pigeon peas (CCPP).

Roasting

Air – dried whole pigeon peas were roasted in an oven at 130^0C for 30 mins. The seeds were stirred at interval of 10mins in the oven to allow for uniform dry heating. The seeds were considered roasted when they became crispy to touch. Thereafter, the roasted seeds were air – dried, bagged and labeled whole – roasted pigeon peas (WRPP). Another batch of air – dried pigeon peas was crushed into smaller sizes using mortar and pestle prior to being roasted in an oven as that of the whole – roasted pigeon peas in this study. The product obtained from this procedure was named crushed – roasted pigeon peas (CRPP)

Birds and management

A total of 120 day – old unsexed broiler chicks of the Marshall strain were used in this study. They were randomly divided into 6 groups of 20 chicks in a completely randomized design. Each group was further sub – divided into 4 replicates of 5 birds. Feed and water were supplied ad - libitum, and uniform light was provided 24 h daily. Vaccines against New Castle disease were administered to the birds immediately after hatching and when they were 28 days old respectively. Gumboro vaccine was administered to the birds when they were 10 and 35 days old respectively. The birds were dewormed adequately, while antibiotics were also given. Average weekly feed intake, body weight gain, feed conversion efficiency and protein efficiency ratio were used as measures of bird performance.

Diet Formulation

Diets of equal energy and nitrogen contents were formulated in which raw, whole – cooked , crushed – cooked, whole – roasted and crushed – roasted pigeon peas were incorporated at 15% into broiler starter and finisher diets respectively (Tables 1 and 2). Maize – soybean meal served as control. Minor adjustments were made in the fish meal and palm kernel meal.

All diets were supplemented with 0.3% synthetic methionine to ensure the amino acid was not limiting for growth.

Proximate analyses

The crude protein, crude fibre, ether extract, ash, nitrogen free extract and dry matter of raw, whole – cooked, crushed – cooked , whole roasted and crushed – roasted pigeon peas were determined using the analytical procedures of AOAC (1984) respectively.

Analytical measurements

On the 56^{th} day of the experiment, blood samples were collected from eight (8) live birds per group (2 per replicate group) by cardiac puncture through the use of syringe with needle into tubes containing ethylene diamine tetra-acetic dipotassium salt (EDTA) for hematological examination, and in ice cooled centrifuge tubes for enzyme assay and metabolic analysis. Hematological indices such as red blood cells hemoglobin, packed cell volume and white blood cells were determined by procedures outlined by Dacie and Lewis, (1977). As regards the enzymes assays, serum glutamic pyruvic transaminase was determined by procedures of Reitman and Frakel (1957) and serum glutamic oxaloacetic transaminase by Szasz (1969).

Statistical Analysis

All data were analyzed using the analysis of variance. Where significant treatment effects were obtained, their means were compared using Duncan Multiple Range Test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The results obtained on the proximate composition of raw, whole – cooked, crushed – cooked, whole – roasted and crushed – roasted pigeon peas are presented in Table 3. Slight differences were obtained in the crude protein, fiber, ash and nitrogen free extracts of the raw and differently processed pigeon peas respectively. However, crude protein content was reduced in crushed – cooked pigeon peas, but elevated in the crushed – roasted pigeon peas.

The results obtained on the performance characteristics of the broiler chickens are shown in Table 4. Feed intake was significantly ($P<0.05$) reduced in birds fed raw, whole – roasted and crushed – roasted pigeon peas respectively. Moreover, the feed intake was insignificantly ($P>0.05$) different between birds fed whole – cooked , crushed – cooked pigeon peas and those fed control diet respectively. Higher significant ($P< 0.05$) body weight gain was obtainedin birds fed crushed – cooked and whole – cooked pigeon peas respectively. Followed in weight gain were birds fed crushed – roasted pigeon peas. Growth was markedly reduced ($P<0.05$) in birds fed raw pigeon peas. Feed conversion efficiency (FCE) and protein efficiency ratio (PER) followed a similar pattern to the weight gain of the birds. Mortality was higher in birds fed raw pigeon peas.

Data obtained on haematological indices (Table 5) show higher significant ($P<0.05$) values of hemoglobin (HB), red blood cells (RBC), white blood cells (WBC) and packed cell volume (PCV) in birds fed whole – cooked and crushed – cooked pigeon peas respectively. PCV obtained in birds fed crushed – cooked pigeon peas was not significantly ($P > 0.05$) different from the birds in the control group. Birds fed crushed – roasted and whole – roasted raw pigeon peas followed next with significant ($P < 0.05$) lower values of HB, RBC, WBC and PCV respectively. The least haematological values were obtained in birds fed raw pigeon peas.

Results obtained on the hepatic enzymes are shown in Table 6. Glutamic pyruvic transaminase (GOT) and glutamic oxaloacetic transaminase (GPT) were significantly ($P<0.05$) increased in birds fed raw, whole – roasted andcrushed - roasted pigeon peas

respectively. Birds fed whole – cooked and crushed - roasted however had lower GOT and GPT values that were not significantly ($P > 0.05$) different from the control group.

The proximate composition obtained in raw pigeon peas used in this study agrees with the findings of Amaefule *et al.,* (2004). Marginal reductions obtained in the proximate composition whole – cooked and crushed - cooked pigeon peas in this study support the findings of Bressani and Sosa (1990) that food nutrients composition can be soluble in cooking water. Moreover, the crude protein (CP) content obtained in the raw pigeon peas (26.28%) in this study is higher than that reported on bambara groundnut (20.30%), but closer to those of raw jack beans (27.67%) and raw benne seed (25.15%) respectively (Akanji, 2002). The crude fibre (CF) content obtained in the raw pigeon pea (5.03%) is much lower than those reported on some grain legumes on raw sweet lupines (11.30-16.80%) (Apata, 1990) and raw jack beans (9.87%)(Akanji, 2002). The CF content in the pigeon peas in this study seems not high enough to render it undesirable for monogastric animals. Lutz and Pryztulski (2008) reported that grain legumes are a source of soluble fibre which lowers plasma cholesterol and prevents proventriculus cancer.

The ether extract obtained in the raw pigeon peas in this study (2.18%) is much lower than those reported in soybeans (21.68%) and benne seed (52.75%) (Akanji and Ologhobo, 2007).Lutz and Pryztulski (2008) reported that oils from grain legumes are rich in unsaturated fatty acids such as Oleic, linoleic, linolenic and arachidonic acids. The ash content of 4.50% obtained in the raw pigeon peas in this study is in support of the report of Apata (1990) that most legumes have ash contents that hardly exceed 5%. Furthermore, ash values are indicative of sources of minerals in feed stuffs. In a study of mineral element status in different kinds of legumes, Apata (1990) reported that legumes were relatively high in calcium, iron, magnesium, phosphorus and potassium, but low in sodium .

The results obtained in the feed intake of birds fed raw pigeon peas is similar to the findings of Emiola *et al.,* (2005) on the reduction of feed intake of broiler chickens fed raw kidney beans. Two anti-nutritional factors prominent in raw grain legumes, haemagglutinins and trypsin inhibitors, have been reported to be responsible for lower feed intake of birds and rats (Akanji, 2002). According to Apata (1990), the intake of raw jack beans, lima beans, and African yam bean significantly reduced the feed intake of rats. The higher feed intake obtained in the birds fed crushed - cooked pigeon peas can be attributed to a likely complete removal of haemagglutinins and trypsin inhibitor in the grain legume as a result of the combinations of factors such as increase in surface area of the pigeon peas due to crushing into smaller sizes, soaking in water for 24hrs and cooking in fresh water for 1hr. Apata (1990) had earlier reported that breaking grain legumes into smaller sizes has a tendency to eliminateheat labile toxic factors when subjected to aqueous heating treatment. The relatively low values of feed intake of birds fed roasted pigeon peas diet in the study can be attributed to likely residual haemagglutinins and trypsin inhibitors. Akanji (2002) reported that roasting of grain legumes has a tendency to give room for residual haemagglutinin, and that the addition of 1% of this antinutritional factor to a diet containing autoclaved soybeans reduced the feed intake of rats.

The reduction in the weight gain especially in birds fed raw pigeon peas in this study corroborates the findings of Emiola *et al.,*(2003) on the effect of raw kidney beans on growth rate of broiler chickens. Earlier findings showed that haemagglutinins in raw jack bean and bambara groundnuts caused alterations in some enzyme systems and loss of weight in growing cockerels (Akanji, 2002). Cooking was reported to remove toxic factors

(haemagglutinins and trypsin inhibitors) responsible for poor growth of rabbits fed grain legumes (Essein and Udedibie, (2007). Udedibie *et al.,* (1996) had earlier reported significant improvement in weight gain of broiler chicks fed two-stage cooked jack beans.

The lower FCE values obtained in this study are consistent with reports of Emiola *et al.,* (2003) and Masero *et al.,(*2005) on the effects of toxic factors on efficiency of feed utilization. Akanji (2002) had earlier reported significant correlations between feed conversion efficiency and each of haemagglutinin and trypsin inhibitor in adult cockerels fed raw jack beans, bambara groundnut and benne seeds. In a study carried out by Apata (1990), raw pigeon peas when fed to rats led to lower feed conversion efficiency. In this study, the reduction in the feed conversion efficiency especially in birds fed raw pigeon peas and whole – roasted pigeon peas can be attributed to effects of the combined effects of the anti-nutritional factors (total or residual) on reduction of protein metabolism and absorption and utilization of minerals. In his findings, D'Mello (1991) reported that trypsin inhibitor adversely influenced the utilization of proteins in rats by increasing the amount of cystine and methionine requirements. Also, Udedibie and Carlini (1998) were of the views that even minute amounts of residual haemagglutinin in processed jack bean could constitute a problem to birds on ad-libitum feeding system, and that the antinutritional factor is resistant to proteolytic digestion and therefore tends to accumulate in the animals by binding to the intestinal wall, thereby reducing the efficiency of feed utilization.

The significant improvement in PER value of birds fed crushed - cooked pigeon peas in this study suggest better protein metabolism and utilization. The lower PER values in the birds fed whole – roasted , crushed – roasted and raw pigeon peas are consistent with the findings of Akanji (2002) on the effects of haemagglutinin and trypsin inhibitor on the reduction of utilization of proteins in chickens fed either raw or dry – heated jack beans and bambara groundnuts. Roasted jack beans were reported to contain residual amounts of haemagglutinin and trypsin inhibitor (Ologhobo *et al.,* 1993), and which according to Udedibie and Carlini (1998) could reduce the efficiency of the dietary protein. This is because haemagglutinin is known to be resistant to proteolytic digestion and therefore tends to accumulate in the animals by binding to the intestinal studies. Another reason deducible to the lower PER values in this study is the likely effect of high temperature on the protein quality of the roasted pigeon peas. McDonald *et al.,* (1998) reported that high heat treatment during toasting/roasting and denature proteins in plants making them unavailable for birds.

Results obtained in the hematological parameters showed lower values of HB, RBC, WBC and PCV for birds fed whole – roasted , crushed – roasted and raw pigeon peas , but better improved in those fed whole – cooked and crushed – cooked pigeon peas respectively. The blood is known to be of high physiological importance to the animal body; hence, abnormal variations in cellular constituents would affect its primary functions (Lutz and Pryztulski, 2008). Akanji (2002) reported a progressive degradation of the erythrocytes of rats during intoxication of lectins from edible legumes. The haemagglutinin contents in the raw pigeon peas and roasted pigeon peas in this study could be attributed to the significant reduction in hemoglobin, red blood cells, white blood cells and packed cell volume of the birds. Apata (1990) was of the opinion that haemagglutinins have the ability to agglutinate the erythrocytes of numerous animal species, thus leading to dysfunction of red cell haematopoesis and a toxic induced red blood cell hemolysis and increase in the plasma volume. The high reduction in white blood cells in the birds fed raw pigeon peas reflects a decline in the production of blood cells for defensive mechanisms against infections thus

making the birds more susceptible to various physiological stress resulting in disease and greater mortality.

The results obtained on serum enzymes in this study are similar to the findings of Akanji and Ogungbesan (2008) that high residual canavanine, haemagglutinin and trypsin inhibitor activities in roasted jack beans contributed to increases in GOT and GPT of the birds respectively. Aletor and Fetuga (1984b) had earlier linked increased activities of hepatic transaminases in rats fed some raw legumes to increased catabolism of amino acids and liver cell damage as a result of the effects of the inherent anti- nutritional factors. Aletor and Fetuga (1988) suggested further that haemagglutinin could impart strong stimulus on liver cells, thereby allowing the enzymes to infiltrate into the extra hepatic fluids.

CONCLUSION

In this study, the poor response indices of birds fed either raw, whole- roasted or crushed - roasted pigeon peas are indication of metabolic disorders in the birds upon long time feeding. Moreover, the significant improvement in the response indices of birds fed crushed – cooked pigeon peas show that breaking the grain legume into smaller sizes prior to soaking in distilled water and cooking in fresh distilled water is a better method of processing. The anti-nutritional factors associated with most grain legumes such as haemagglutinin, trypsin inhibitor, tannin, oxalate, saponins and phytate seemed to be adequately removed in the crushed - cooked pigeon peas. However, the problem associated with crushing prior to soaking and cooking of pigeon peas lies in the leaching of nitrogen. Nevertheless, this shortfall in nitrogen content is believed to be taken care of through the inclusion of high nitrogenous feed ingredient such as fish meal in the diet. It is therefore concluded in this study that pigeon peas when crushed prior to aqueous heating can be incorporated in broiler diets up to 15%. Moreover, in view of the problem associated with the leaching of nitrogen into the soaking and cooking water, more studies still need to be done especially in the genetic improvement of pigeon peas. Also, on other simpler processing methods need to be investigated that could destroy the anti-nutritional factors without affecting the nutritional composition of pigeon peas.

Table 1: Percentage Composition of Starter Diets

	CONTROL	RPP	WCPP	CCPP	WRPP	CCPP
Maize	53.00	50.00	49.71	49.50	49.70	49.75
Soybean meal	30.00	18.55	18.70	18.81	18.60	18.55
Pigeon Peas	-	15.00	15.00	15.00	15.00	15.00
Fish meal	8.50	9.00	9.15	9.26	9.26	9.25
Palm Kernel meal	1. 50	0.15	0.14	0.13	0.14	0.15
Palm Oil	3.0	3.0	3.0	3.0	3.0	3.0
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50
Oyster Shell	0.50	0.50	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Premix	0.50	0.50	0.50	0.50	0.50	0.50
Methionine	0.30	0.30	0.30	0.30	0.30	0.30
Calculated crude protein(%)	23.4	23.10	23.21	23.17	23.34	23.52
Calculated metabolizable energy(MJ)	12.22	12.13	12.04	12.09	12.11	12.08

Table 2: Percentage Composition Of Finisher Diets

	CONTROL	RPP	WCPP	CCPP	WRPP	CCPP
Maize	54.70	53.00	52.00	51.75	52.70	52.50
Soybean meal	30.00	16.00	16.50	16.75	16.20	16.40
Pigeon Peas	-	15.00	15.00	15.00	15.00	15.00
Fish meal	3.00	3.00	3.50	3.45	3.30	3.40
Palm Kernel meal	5. 00	5.70	5.70	5.75	5.50	5.40
Palm oil	3.00	3.00	3.00	3.00	3.00	3.00
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50
Oyster Shell	0.50	0.50	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Premix	0.50	0.50	0.50	0.50	0.50	0.50
Methionine	0.30	0.30	0.30	0.30	0.30	0.30
Calculated crude protein(%)	20.63	20.51	20.43	20.38	20.37	20.75
Calculated metabolizable energy(MJ)	11.85	11.52	11.29	11.39	11.36	11.39

RPP - Raw Pigeon Peas ; WCPP - Whole Cooked Pigeon Peas,
CCPP - Crushed - Cooked Pigeon Peas; WRPP -Whole Roasted Pigeon Peas
CRPP- Crushed - Roasted Pigeon Peas

Table 3: Proximate Composition of Raw, Cooked and Roasted Pigeon Peas (expressed as Percentage of Dry Matter)

Pigeon peas	% CP	% CF	E.E %	Ash %	NFE %	DM%
RPP	26.28	5.03	2.18	4.50	52.65	90.64
WCPP	24.93	4.71	2.05	3.96	51.77	87.42
CCPP	23.91	4.56	2.01	3.94	51.71	86.13
WRPP	27.34	5.45	2.22	5.08	53.75	93.84
CRPP	27.58	5.49	2.27	5.13	53.80	94.27

CP – Crude protein; CF – Crude fibre; EE - Ether extract; NFE – Nitrogen free extracts; DM – Dry matter

Table 4: Performance Characteristics Of Broiler Chickens Fed Raw Cooked and Roasted Pigeon Peas

Groups	feed intake (kg/week)	weight gain (kg/week)	Feed Conversion Efficiency /week	Protein Efficiency Ratio/week	Mortality %
Control	0.51^{a}	0.30^{a}	0.59^{a}	2.63^{a}	0.00
RPP	0.40^{c}	0.16^{d}	0.41^{d}	1.80^{d}	20.00^{a}
WCPP	0.49^{a}	0.26^{b}	0.54^{b}	2.54^{b}	5.00^{c}
CCPP	0.50^{a}	0.28^{ab}	0.55^{ab}	2.58^{ab}	0.00
WRPP	0.44^{b}	0.20^{c}	0.45^{c}	2.09^{c}	10.00^{b}
CRPP	0.44^{b}	0.21^{c}	0.45^{c}	2.11^{c}	10.00^{b}
SEM	0.09	0.06	0.07	0.26	0.34

Means: with different Superscripts along columns are significantly different ($P<0.05$)

Table 5: Haematological Indices of Broiler Chickens Fed Raw Cooked and Roasted Pigeon Peas

	HB((g/dl)	RBC ($X10^{12}$/l	WBC ($X\ 10^{9}$/l)	PCV (%)
Control	9.42^{a}	3.95^{a}	2.24^{a}	31.46^{a}
RPP	7.43^{e}	2.70^{e}	1.16^{d}	24.00^{c}
WCPP	8.91^{bc}	3.82^{bc}	1.94^{b}	30.76^{b}
CCPP	8.94^{b}	3.88^{b}	1.97^{b}	31.29^{a}
WRPP	8.80^{d}	3.70^{d}	1.66^{c}	28.93^{c}
CRPP	8.86^{cd}	3.79^{cd}	1.68^{c}	28.55^{c}
SEM	0.26	0.17	0.18	0.34

Means with different superscripts along columns are significantly different ($P<0.05$).
HB - Haemoglobin; RBC- Red blood cells.; WBC-White blood cells.; PCV- Packed cell volume.

Table 6:Serum Enzymes Of Birds Fed Raw, Cooked And Roasted Pigeon Peas

	GPT (nmol/mg/Protein)	GOT (nmol/mg/Protein)
Control	68.9[c]	80.3[c]
Raw	124.3[a]	137.9[a]
WCPP	70.1[c]	83.1[c]
CCPP	69.3[c]	80.9[c]
WRPP	83.9[b]	91.7[b]
CRPP	79.3[b]	89.3[b]
SEM	1.24	1.36

GPT – Glutamic Pyruvic Transaminase ; GOT – Glutamic Oxalate Transaminase.

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