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Processed Kidney Bean (*Phaseolus vulgaris*) in Broiler Feeding: Performance Characteristics

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INTRODUCTION

Most legumes are consumed by man while also serving as plant protein source for monogastric animals. Although, reasons for under-utilization of indigenous pulses as feedstuffs for monogastric animals and as food for humans are varied, the presence of potent anti-nutritional substances in these seeds is a significant factor. The anti-nutritional factors include: protease inhibitors, haemagglutinins (lectins), tannins, glycosides and alkaloids.
An important aim of research in animal production is to enhance cost effective livestock production while providing adequate animal protein and livestock by-products for human consumption. The ever increasing human population necessitates the need to source for alternative feeds and feedstuffs for animals. If the common goal of the agricultural policy of developing countries which is self sufficiency in food production is to be realized, then means of increasing the feed supply base for livestock production becomes exigent.
This study investigated the replacement of soybean meal and groundnut cake with processed kidney beans in broiler diets and its effects on performance characteristics and nutrient digestibility.

MATERIALS AND METHODS

The kidney beans were purchased from Iseyin in southwest Nigeria. It was divided into two equal portions. One portion was cooked for 1hr without decortication, and sun dried for three days. The other portion was soaked in boiled water for 12hr, decorticated and sun dried for three days. The processed kidney beans were milled and used to replace soybean meal and groundnut cake at 50% protein for protein.

FEEDING AND MANAGEMENT OF BIRDS

A total of 120 one day-old Abor-Acre broiler chicks were obtained from Zartech farm in Ibadan Oyo state. The chicks were reared in electrically heated battery brooders maintained at 32°c from day 1 to 7 post hatch. During this time, chicks were provided free access to water and a standard broiler starter diet containing 234 g/kg DM crude protein and 3200 kcal/kg DM metabolisable energy.
Six experimental diets were formulated comprising of two basal diets (soybean meal and groundnut cake) as indicated in Table 1. On day 8, chicks were allotted to six dietary treatments in a completely randomised design such that each treatment had two replicates of ten birds per replicate. The trial lasted

for 42 days. Feed intake was determined weekly for the entire period of the trial. Protein efficiency was calculated as a ratio of weight gain to protein consumption over the period of the trial.

SAMPLE COLLECTION

On day 39, two birds per replicate whose body weights were closest to the mean of the group were selected and placed in metabolic cages with facilities for individual feeding, watering and collection of droppings. The droppings were collected for 3 days, and sprayed with 1% boric acid to reduce bacterial decomposition of protein. Samples for each bird were bulked, wrapped in aluminium foil and oven dried at 85°c for 24 hr. Representative faecal samples were used for dry matter determination. Total dry weight of faeces and feed consumed were recorded. Mortality was recorded during the study.

CHEMICAL ANALYSIS

Proximate analysis of test ingredients, feed and faecal samples were carried out according to the procedures of AOAC (1990). All data collected were subjected to analysis of variance and means separated using least significant difference (LSD) method using SAS (1985).

Table 1: Gross and Chemical Composition of Experimental Diets (g/kg DM)

ingredients	1	2	3	4	5	6
Maize	450	450	450	450	450	450
CKB	-	262.5	-	-	281.8	-
DKB	-	-	262.5	-	-	281.8
SBM	300	150	150	-	-	-
GNC	-	-	-	300	150	150
Fish meal	40	40	40	40	40	40
PKC	167	54.5	54.5	167	35.2	35.2
Constant Ingredients*	43	43	43	43	43	43
1000	1000	1000	1000	1000	1000	1000
Determined Composition						
Dry matter	894	901	894	896	901	901
Crude protein	225.5	224.8	224.7	226.3	225.7	225.5
Ether extract	44.6	38.9	38.6	73.1	52.0	49.8
Crude fibre	39.0	41.0	36.4	45.0	43.4	34.2
Ash	90.4	84.0	91.3	88.1	108	117
NFE	608.7	617.2	619.6	573.7	628.8	582.2
Calculated Composition						
M.E. (kcal/kg DM)	2830	2860	2860	2820	2860	2860

*(gm): bone meal (20), oyster shell (15), premix (2.5), DL-methionine (2.0) and lysine (1.0).

CKB: cooked kidney beans
DKB: decorticated kidney beans
SBM: soybean meal
GNC: groundnut cake
PKC: palm kernel cake
NFE: nitrogen free extract

1:SBM diet
2:SBM/CKB diet
3:SBM/DKB diet
4:GNC diet
5:GNC/CKB diet
6:GNC/DKB diet

RESULTS AND DISCUSSION

The proximate compositions of raw and processed kidney beans are shown in Table 2. The performance characteristics and nutrient utilization by experimental birds, expressed as means from duplicate pen observations are show in Table 3.

Raw kidney bean had the highest crude protein (276.8 g/kg DM) compared to cooked and decorticated kidney bean which had 237.0 g/kg DM and 247.3 g/kg DM respectively. Processing appeared to have reduced the non-protein nitrogen content of the processed beans with a corresponding denaturation and solubilisation of heat-labile anti-nutritional factors. Further more, cooking mature legumes in water causes a loss of protein, carbohydrate and other nutrients into the cooking water. Ether extract ranged between 8.8 g/kg DM-10.8 g/kg DM in raw and processed kidney beans. Ash content was least in cooked kidney beans (51.8 g/kg DM) while raw and decorticated kidney beans had 52.9 g/kg DM and 49.6 g/kg DM respectively. Crude fibre was least in decorticated kidney beans (41.5 g/kg DM) in contrast to values obtained in raw and cooked kidney beans (53.3 g/kg DM and 51.8 g/kg DM). Nitrogen free extract was high (654.5 g/kg DM) in cooked kidney beans while raw and decorticated kidney beans had 606.2 g/kg DM and 650.3 g/kg DM. Soaking, cooking and toasting (different processing methods) lower the amount of crude protein, ether extract, crude fibre and total ash. Results obtained in this study as indicated above are in agreement with observations made by other authors (Bressani and Sossa, 1990, Apata 1990, Emenalon and Udedibie 1998 and Emiola 2004).

Table 2: Proximate Composition of Raw and Processed Kidney Beans (g/kg DM)

Parameters	**Raw**	**Cooked**	**Decorticated**
Dry matter	901	915.6	910.7
Crude protein	276.8	237.0	247.3
Ether extract	10.8	8.8	10.8
Ash	52.9	47.9	49.6
Crude fibre	53.3	51.8	41.5
NFE	606.2	654.5	650.2

Inclusion of cooked kidney beans in the diets of broiler chicks caused a significant ($p<0.01$) increase in feed intake in diets 2 and 5 compared to diets 3 and 6. However, this increase was significantly ($p<0.01$) low in contrast to the basal diets (diet 1 and 4). Cooking tends to increase palatability, while increasing protein intake as observed in Protein Efficiency Ratio, (Wu et al.,1996) which was higher in diet 2 compared to 3 but not significantly ($p>0.05$) different. Body weight gain was also significantly ($p<0.05$) increased in diets 3 and 6 which contained decorticated kidney beans than diet 2 and 5 which contained cooked kidney bean.

Table 3: Performance Characteristics and Nutrient Digestibility of Broilers Fed Processed Kidney Beans Diets

Performance indices	1	2	3	4	5	6	SEM
Feed intake (Gm/bird/42days)	3312.12^{a}	3186.54^{b}	3020.22^{c}	3357.06^{a}	2752.26^{d}	2609.88e	0.19
Body weight gain. (Gm/bird/42days)	1573.86^{a}	1544.28^{a}	1552.90^{a}	1429.50^{ab}	1217.04^{b}	1282.76^{b}	1.59
Feed: Gain ratio	2.11	2.06	1.95	2.35	2.26	2.03	0.38
Protein Efficiency Ratio	0.643^{a}	0.515^{b}	0.463^{b}	0.455^{b}	0.432^{b}	0.430^{b}	0.03
Mortality %	25.0	10.0	-	20.0	-	2.0	
Dry matter	65.5	62.00	57.50	57.50	60.50	52.00	0.04
Crude protein	70.00^{a}	57.50^{abc}	57.00^{bc}	67.00^{ab}	65.00^{ab}	49.50^{c}	0.04
Ether extract	96.00^{a}	78.50^{ab}	83.50^{ab}	90.50^{ab}	80.50^{ab}	63.00^{b}	0.09
Ash	23.50	12.50	16.00	12.50	26.00	12.50	0.07
Crude fibre	15.5^{b}	15.5^{b}	17.00^{b}	32.5^{a}	24.5^{ab}	35.00^{a}	0.04
NFE	71.00	73.00	65.00	56.50	65.00	59.00	0.05

Means along the same row with different superscripts are significantly different ($p<0.05$).
1:SBM diet.
2:SBM/CKB diet.
3:SBM/DKB diet.
4:GNC diet.
5:GNC/CKB diet.
6:GNC/DKB diet.
NFE: Nitrogen free extract.

Feed: Gain ratio was not significantly different ($p>0.05$) across dietary treatments but was lowest in diets 3 and 6. The high weight gain in diet 3 and 6 suggested a better feed utilization. Cooking has been reported to be effective in reducing haemagglutinin and trypsin inhibitor content of kidney beans (Emiola 2004), while reducing the tannin content marginally. Tannins form insoluble or inactive complexes with dietary proteins thereby reducing their biological value, while forming complexes with digestive enzymes. Other negative effects are reduced palatability, reduced weight gain and feed efficiency (Griffits 1991) which was evident in values obtained for weight gain and Feed: Gain ratio in diets 2 and 5. Cooking might have appeared to reduce trypsin inhibitor and haemagglutinin to the barest minimum (Emiola 2004). However, Feed: Gain ratio indicate the anti-nutritive effect of residual tannin present in the cooked beans. According to the author, cooking reduces tannin content to about 35%. The presence of tannins in diets results in reduced weight gain and poor feed efficiency (Ahmed 1991, Mariscal-Landin 1992). Residual tannin in processed kidney beans had effect on feed intake, growth and general performance of birds fed processed kidney bean as indicated in feed intake and weight gain values of birds fed the processed kidney bean diets.

Protein Efficiency Ratio (PER) was significantly ($p<0.05$) decreased across dietary treatments with the lowest value obtained in diet 6 (0.430). This suggested improved protein utilization attributable to heat processing, as observed in birds fed diets 3 and 6. As earlier discussed, cooking is more effective in removing trypsin inhibitor and haemagglutinin than decortication after soaking (Cheftel et al.,1993, Wu et al.,1996 and Emiola 2004).

Udedibie and Carlini (2000) asserted that any treatment that cannot destroy trypsin inhibitor completely will have little effect on haemagglutinin. Protein Efficiency Ratio obtained in this study suggested a probable retention of over 70% of the original activity of trypsin inhibitor in decorticated than cooked kidney beans with the presence of a level of residual tannin in the cotyledon of decorticated kidney beans. Crude protein digestibility was significantly ($p<0.05$) decreased across the dietary treatments with the lowest value in diet 6. Earlier reports indicate that tannin complexes formed initially in the grain or in the digestive tract of the animal reduces the digestibility of dietary components mainly protein (Apata 1990, Hu et al.,1997). Inhibition of enzymatic digestion of dietary proteins in the digestive tract could also result in poor total tract and ileal digestibility, digestive disturbances and reduced animal performance (Butler et al., 1984). Ether extract digestibility was significantly ($p<0.0$) reduced across dietary treatments. This suggested the probable effects of tannins on activities of lipase, α-amylase and digestion of lipids (Longstaff and McNab 1991b). Crude fibre digestibility was also significantly ($p<0.05$) reduced in diets 2 and 5 but significantly ($p<0.05$) increased in diets 3 and 6. The structure and amount of residual tannins likely present in the processed kidney beans probably determined their nutritional effects (Makkar 1995). These effects include; reduction of voluntary intake reduced apparent digestibility of dry matter, crude protein and crude fibre (Waghorn et al., 1990; Muhammed et al., 1994).

CONCLUSION

Although several studies with kidney beans show that the anti-nutritional factors present in the beans exert their deleterious effect via reduced nutrient absorption, following extensive structural and functional disruption of the intestinal microvilli. However, results from this study indicated that a 50% protein for protein replacement of SBM with cooked kidney beans gave performance that was equally as good as feeding either SBM or GNC as protein source. Cooking was a better processing method for kidney bean compared to decortication or better still decortication prior to cooking to enable adequate removal of the anti-nutritional factors to the barest minimum.

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