

Effects of varying levels of cooked kidney bean meal (*Phaseolus vulgaris*) as replacement of soyabean meal or groundnut cake on the performance of broiler chicken

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Abstract

The experiment was conducted to assess the effects of different inclusion levels of cooked kidney bean meal as non - conventional feedstuff on the growth performance of broilers chicks. The test diets were formulated such that, diet T1 (control diet) contained no kidney bean meal, diet T2 contained 20% cooked kidney bean meal, diet T3 contained 40% cooked kidney bean meal and diet T4 contained 60% cooked kidney bean meal. The trial lasted for eight weeks and the following parameters were measured weekly during the course of the experiment. Feed intake, body weight, weight gain, feed conversion ratio, nutrient digestibility, length of body parts and carcass proportion. The result showed that there were significant differences ($p < 0.05$) in the Final body weights and average mean body weights. The birds fed 20% cooked kidney bean meal diets had the highest mean body weight (1220g) while birds fed 60% cooked kidney bean meal had the lowest mean body weight (941.20g). There was no significant difference ($p > 0.05$) in the feed intake of birds fed cooked kidney bean meal diets. There were no significant difference ($p > 0.05$) in the length of body parts and carcass proportion except thigh and wing, crop of birds fed cooked kidney bean meal diets respectively. Significant difference ($P > 0.05$) were not observed in the dry matter, ether extract, crude fibre and ash digestibility except in crude protein and NFE (Nitrogen Free Extract). There were no significant differences ($P > 0.05$) among birds fed the four experimental diets in parameters considered in the carcass proportion except the wing and the crop. It was however concluded that the addition of cooked kidney bean meal had a positive effect on the performance as well as CP digestibility of the birds when their inclusion in the diet is within the range of 20-40% replacement of conventional plant protein sources.

Keywords: Kidney bean meal, broiler, replacement, performance, carcass

Effets de différents niveaux de tourteau de haricot rouge cuit (*Phaseolus vulgaris*) en remplacement du tourteau de soja ou du tourteau d'arachide sur la performance du poulet à griller



Résumé

L'expérience a été menée pour évaluer les effets de différents niveaux d'inclusion de tourteau de haricots rouges cuits comme aliment non conventionnel sur les performances de croissance des poussins de chair. Les régimes testés ont été formulés de telle sorte que le régime T1 (régime témoin) ne contenait pas de farine de haricots rouges, le régime T2 contenait 20 % de farine de haricots rouges cuits, le régime T3 contenait 40 % de farine de haricots rouges cuits et le régime T4 contenait 60 % de farine de haricots rouges cuits. L'essai a duré huit semaines et les paramètres suivants ont été mesurés chaque semaine au cours de l'expérience. Consommation alimentaire, poids corporel, gain de poids, taux de conversion alimentaire, digestibilité des nutriments, longueur des parties du corps et

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proportion de la carcasse. Le résultat a montré qu'il y avait des différences significatives ($p < 0,05$) entre les poids corporels finaux et les poids corporels moyens moyens. Les oiseaux nourris avec 20 % de farine de haricots rouges cuits avaient le poids corporel moyen le plus élevé (1220 g), tandis que les oiseaux nourris avec 60 % de farine de haricots rouges cuits avaient le poids corporel moyen le plus bas (941,20 g). Il n'y avait pas de différence significative ($p > 0,05$) dans la consommation alimentaire des oiseaux nourris avec des régimes à base de farine de haricots rouges cuits. Il n'y avait pas de différence significative ($p > 0,05$) dans la longueur des parties du corps et la proportion de carcasses, à l'exception de la cuisse et de l'aile, culture d'oiseaux nourris respectivement avec des régimes à base de farine de haricots rouges cuits. Aucune différence significative ($P > 0,05$) n'a été observée dans la matière sèche, l'extrait d'éther, la fibre brute et la digestibilité des cendres, sauf dans la protéine brute et le NFE (Nitrogen Free Extract). Il n'y avait pas de différences significatives ($P > 0,05$) entre les oiseaux nourris avec les quatre régimes expérimentaux dans les paramètres pris en compte dans la proportion de carcasse, à l'exception de l'aile et du jabot. Il a cependant été conclu que l'ajout de farine de haricots rouges cuits avait un effet positif sur les performances ainsi que sur la digestibilité des CP des oiseaux lorsque leur inclusion dans l'alimentation se situe dans la fourchette de remplacement de 20 à 40 % des sources de protéines végétales conventionnelles.

Mots-clés : Farine de haricot rouge, poulet de chair, remplacement, performance, carcasse

Introduction

The over dependence on soyabean and groundnut cake in most developing countries as the key conventional protein concentrates for feeding livestock is currently threatening the development of the industry. The heavy demands for these feed items has resulted in an increase in their prices and consequently cost of livestock feeds and its products (Emiola *et al.*, 2002). There is the need to source for alternative protein sources of feed for monogastric animals, hence the use of kidney bean whose consumption is limited to man and has no industrial use and could meet the nutritional requirements of livestock. Kidney bean (*Phaseolus vulgaris*) is a productive tropical legume that is little known and utilized as human and livestock feeds (Emiola *et al.*, 2002). Kidney bean is an annual leguminous food crop, twinning and climbing bushy plant of about 20-60cm tall. It thrives well in a warm climate at a temperature of 18-40°C. It requires a minimum rainfall of 400 to 500mm during the growing season and soil pH of 5.8 to 6.5 (Liebenberg *et al.*, 2006).

Arija *et al.*, (2006) reported that the seeds from genus phaseolus have long been known to be a rich source of protein, minerals, vitamins and energy in diet of human and monogastric animal. Encyclopedia of medicinal plants (2006) reported that kidney beans have a high nutritional value but when raw, they are toxic since they contain phaseolin, a toxalbumin which disappear when the beans are cooked. It is therefore intended in this work to examine the effect of cooked kidney bean meal on the performance of broilers.

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plant protein source for livestock feed. There is the need to source for alternative protein sources of feed for monogastric animals, hence the use of kidney bean whose consumption is limited to man and has no industrial use and could meet the nutritional requirements of livestock

The objectives of this research work is to evaluate the response of broilers fed graded levels of cooked kidney bean meal, carcass characteristics of broilers and to determine the degree of nutrient digestibility by broilers fed cooked kidney bean meal.

Materials and methods

The experimental site and location

The experiment was conducted at the poultry unit of the Teaching and Research Farm of the Department of Animal Production, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger State, Nigeria. Minna is situated in Guinea Savannah and lies at latitude 9° 37' North and longitude 6° 33' East. The town has a mean annual precipitation of 1300mm. with temperature that rarely falls below 22°C. The peaks are 40°C (February March) and 35°C (November December). Students hand book FUT Minna (2007).

Experimental animal

A total number of one hundred and forty four (144) day old (Anak Strain) broiler birds were used for this experiment. White kidney beans were purchased from Agaie market in Agaie Local Government Area of Niger State, other ingredients were purchased in Minna, Niger state.

Experimental design

Complete Randomized Design (CRD) was used in this experiment. The birds were randomly allocated to four (4) treatments. Each treatment was replicated thrice with each replicate having 12 birds. The birds were fed with the diet that contained inclusion of different levels of cooked white kidney bean meals. Treatment one (T1)

which was the control experiment was supplemented with 0% cooked kidney bean meal (CKBM). Treatment two (T2) 20% cooked kidney bean meal. Treatment three (T3) 40% cooked kidney bean meal and Treatment four (T4) 60% cooked kidney bean meal in the diet.

Proximate analysis of the feeds

Samples of the feed were collected from each treatment for proximate analysis to determine their nutrient composition of the diets. Routine vaccination, anti – stress and vitamin/ mineral premix were given to the birds from the first week of the experiment. Feed and water were provided *ad-libitum*.

Digestibility trial

Two birds were removed from each of the replicate and placed in metabolic cages. The birds were allowed to acclimatized in the metabolic cage for a period of 3 days before the collection of the faeces started. A 4 day collection trial was carried out, the weight of the birds were recorded at the end of the trial. The feed intake of the birds was determined by finding the differences between the leftover and the initial feed given. The faeces collected were weighed on the wet basis and wrapped in the aluminum foil and taken to the laboratory for analysis. Samples of the faeces were collected at 3 weeks of age and also at 8 weeks from each replicates.

Carcass proportion

At the end of the experiment, one bird per replicate (three per treatment) were randomly selected and slaughtered, weights of carcass, body parts were measured and recorded, using an Avery weighing scale and a flexible measuring tape.

Statistical analysis

The data collected were statistically analyzed for interpretation and to draw inference. One way (ANOVA) and Duncan Multiple Range test was used to separate the means at 5% level of probability.

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Results and discussion

No significant differences were observed in the feed intake, carcass proportion and body length of chickens. Significant differences

were observed in the body weights, body weight gain, feed conversion efficiency and nutrient digestibility in birds.

Table 1: Antinutritional factors analysis of kidney beans (*Phaseolus vulgaris*) seeds

Antinutritional factors	Raw kidney bean	Cooked kidney bean	Soaked kidney bean
Oxalate(mg/100g)	115.59	93.93	109.95
Saponin(%)	1.65	0.39	1.83
Tannins(mg/100g)	112.59	58.76	112.29
Cyanide (mg/100g)	0.61	0.48	0.77
Phytate (mg/100g)	341.80	374.80	291.44
Trypsininhibitors (mg/100g)	15.53	5.88	29.82

Table 2: Composition of the experimental diets (%) fed to the broiler bird

Ingredients	Diets			
	T1	T2	T3	T4
Maize	54	40	32	22
Kidneybean meal	-	20	40	60
Soya bean meal	10	8	6	2
Groundnut cake	14	11	8	3
Fish meal	5	6	3	2
Rice bran	10	7.5	4	3
Bone meal	3	3	3	3
Lime stone	3	3	3	2
Palm oil	-	0.5	0.5	2
Premix	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total	100	100	100	100
%CP	20.13	22.26	21.80	20.50
ME/Kcal/kg	3266.01	3173.99	3169.30	3222.11

Table 3: Chemical composition of raw and cooked kidney bean (%)

Parameters	%Moisture	%CF	%CP	%Ash	%EE	%NFE	M.E.Kcal/kg
Raw Kidney Beans	11.00	8.37	23.80	7.5	10.50	49.83	3508.97
Cooked Kidney Beans	15.33	9.38	23.43	9.3	11.04	43.85	3326.66
Soaked kidney beans	16.09	8.28	23.31	9.48	9.16	49.77	3378.60

KEY; CF-Crude fibre, CP-Crude protein, EE-Ether extract, NFE- Nitrogen free extract
M.E.Kcal/kg- Metabolizable Energy Kcal/kg

The result of the proximate composition of raw, cooked and soaked kidney beans shows a reduction in the percentages of moisture content, crude protein and ash in cooked soaked kidney beans. This is in line with the report of Emiola *et al.* (2002) who observed that cooking and soaking kidney bean tend to reduce the crude protein content possibly due to solubilization, leaching and vapourization of some

nitrogenous compound during processing. The crude protein value of 23.43% for the cooked kidney bean in this study is in agreement with the (23.70%) reported by (Emiola *et al.*, 2002) and slightly higher than the 22.40% crude protein reported by Apata (1990). The moisture content is lower in cooked kidney bean, compared to the raw kidney bean. This is in line with Arijia *et al.* (2006) who observed lower moisture

content of extruded kidney bean compared to raw kidney beans. The authors also reported similar concentration of crude fibre in both raw and extruded kidney bean seeds as recorded in the present study. Akinmutimi (2004) observed crude protein contents of other legume such as cooked lima bean, boiled jacked bean and boiled sword bean to be 21.5%, 25.88% and 25.63% respectively, therefore the crude protein value of 23.43% for the cooked kidney bean seeds fell within the range of alternative protein sources for monogastric animals.

The proximate composition of the experimental diets on table 4.3 shows that the crude protein of the diets were slightly higher than the 24.70% and 23.70% as reported by Emiola and Ologhobo (2006)

and Emiola *et al.* (2002) respectively. Okon *et al* (2007) reported that a higher protein feed enhance feed consumption and utilization, resulting in higher weight gain. The experimental diets have moderate crude fiber content. This is in agreement with the findings of (Emiola and Ologhobo (2006) who observed that low crude fibre content in the feed makes it ideal for poultry. Ani (2006) noted that the higher the fibre content level in the feed, the more quickly it passes through monogastric (rabbit) digestive system and the lower the digestibility. The ether extract of the feed maintained higher values, T4 had a higher value (9.00%) T3 (8.5%), T2 and T1 (7.5%) respectively and therefore the metabolizable energy was equally higher among all treatments diets.

Table 4: Proximate composition of the experimental feeds (%)

Variables	Feeds			
	T ₁	T ₂	T ₃	T ₄
Moisture content	7.00	6.8	7.8	8.6
Crude protein	26.25	26.30	26.25	24.85
Ether extract	7.5	7.5	8.5	9.00
Crude fibre	7.33	8.67	10.00	12.00
ASH	10.00	10.00	10.50	12.50
NFE	47.65	45.58	45.50	45.42
Energy ME Kcal/kg	3410.0	3331.8	3275.0	31782.2

Table 5: Performance of birds fed varying levels of cooked kidney beans diets

Parameters	T1	T2	T3	T4	SEM
Initial weight	81.17	82.04	81.96	82.17	1.77
Final body weight	1150.93	1220	1075.92	941.2	33.47
Body weight gain	1069.76	1137.96	994.02	859.03	33.16
Avg daily weight gain	19.1	20.32	17.75	15.34	0.77
Average feed intake	1780.36	1708.68	1709.68	1712.19	69.99
Avg daily feed intake	31.79	30.51	30.53	30.57	1.22
Feed conversion ratio	1.66	1.50	1.72	1.99	0.33

Key; T1 (Control), T2(20%CKBM), T3(40%CKBM) , T4(60%CKBM)

The result shows no significant difference ($P > 0.05$) in their feed intake. At the end of the experiment, birds fed diet T1 recorded the highest mean value of feed intake (1780.36g) followed by T4 with a value of 1712.19g. T3 had a value of 1709.65g while T2 recorded the lowest mean value of feed intake (1708.68g). The result obtained

shows no significant difference ($P > 0.05$) in the feed intake of 0% CKBM (control diet), 20%CKBM, 40% CKBM and 60% CKBM inclusion in the diets. This shows that the feeds were generally acceptable to the birds. This confirms the potential of kidney bean as a feed stuff which is in line with the findings of Ofongo and Ologhobo (2007)

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who observed that cooking was a better processing method for kidney bean. The insignificant difference in the feed intake between treatments (control diet and CKBM diets) could be connected to the heat treatment that virtually denatured ANFs in the CKBM. This is in agreement with Emiola and Ologhobo (2006) who observed that cooking and dry heating (toasting) increases the digestibility of nutrients available to young non ruminant animals, especially young chicks resulting in improved growth. Significant differences ($P < 0.05$) were observed in the body weights of birds fed CKBM diets with the birds fed 60% CKBM having the least body weight. This is in line with Arija *et al.* (2006) who observed that as the amount of kidney bean is increased in the diet, body weight decreases or reduces compared to those fed control diet. The authors reported that as the inclusion level of cooked kidney bean meal increases in the diet, residual trypsin inhibitors and heamagglutinin (ANFs) increases. This could partly have accounted for the relatively poor performance of broilers fed 60% CKBM (T4). Emiola *et al.* (2002) also noted that the significant differences ($P < 0.05$) in growth rate between birds fed control and cooked meals might be due to high level of tannin (ANFs) in the cooked kidney bean seeds. It can therefore be posited that the poor performance of the birds (T4) observed in this trial is probably due to residual anti-nutritional factors (ANFs) intake in the experimental diet since their diet contain up to 60% CKBM. Significant differences ($P < 0.05$) were observed among treatments in the average body weight gain. Progressive improvements in the weight gain observed among treatments was in agreement with Emiola and Ologhobo, (2006) who observed that improvement in average daily gain (ADG) in growth recorded in groups fed cooked and toasted kidney bean could be attributed to the inactivation or reduction

in ANFs in the meals. Arija *et al.* (2006) also reported that a significant improvement was observed for weight gain with birds fed extruded kidney bean diet compared to birds fed raw kidney bean diet. This would have been as a result of higher heat processing through extrusion of kidney bean. There were significant differences ($P < 0.05$) in the efficiency of feed utilization. Improvement was noticed in the efficiency of feed utilization among all treatments which is reflected in the weight gain. This observation was in agreement with Emiola and Ologhobo (2006) who reported that there are improved values obtained in the group fed cooked kidney bean diet compared to birds fed decorticated and raw kidney bean diet and that the residual ANFs in the cooked and toasted meal could have accounted for the observed difference in the feed conversion efficiency of birds. The average mean value depicted T2 (20% CKBM) as treatment that performed better in feed utilization. T4 (60% CKBM) had poor performance in feed conversion efficiency, this was evidenced in the body weights and body weight gain. So as the level of inclusion of CKBM increases, the feed utilization decreases. This is in agreement with Arija *et al.* (2006) findings in which the level of weight gain and feed efficiency increases as the level of extrusion kidney bean decreases in its inclusion in the diets of broiler chicks. Table 6 shows the result of length of parts of birds fed cooked kidney bean meal diets. There were no significant differences ($P > 0.05$) in the length of cut-up parts like the head, neck, breast, back, thigh, wings shank, gizzard and intestine. There were no significant differences ($P > 0.05$) observed among birds on the four experimental diets in length of body parts. The head, neck, breast, back, drumstick, wing, shank, gizzard and intestine of birds fed diets recorded no significant difference ($P > 0.05$). This lack of significant difference ($P > 0.05$)

could be attributed to higher nutrient digestibility of the experimental diets. The thigh length which recorded a significant

difference ($P < 0.05$) had T1 with the highest value of 9.67cm and T4 recorded the lowest value of 8.33cm.

Table 6: Body length of the parts of birds fed cooked kidney bean meal diets (cm)

Body parts	Treatments				SEM
	T1	T2	T3	T4	
Head	8.5 ^a	9.3 ^a	8.8 ^a	8.8 ^a	0.21
Neck	14.17 ^a	14.5 ^a	14.77 ^a	14.77 ^a	0.21
Breast	17.17 ^a	13.3 ^a	16.3 ^a	16.17 ^a	0.77
Back	17.5 ^a	17.0 ^a	17.0 ^a	16.8 ^a	0.21
Thigh	9.67 ^a	9.17 ^b	9.0 ^b	8.33 ^c	0.16
Drumstick	10.17 ^a	10.33 ^a	10.33 ^a	10.33 ^a	0.17
Wings	18.67 ^a	19.33 ^a	19.33 ^a	18.67 ^a	0.17
Shank	14.02 ^a	14.17 ^a	13.33 ^a	13.0 ^a	0.21
Gizzard	7.07 ^a	6.50 ^a	5.83 ^a	6.00 ^a	0.18
Intestine	217.67 ^a	232.83 ^a	216.50 ^a	214.33 ^a	3.35

Means followed by the same letter indicated in columns are not significant at 5% level

Key;

T₁– 0% inclusion of cooked kidney bean meal

T₂– 20% inclusion of cooked kidney bean meal

T₃– 40% inclusion of cooked kidney bean meal

T₄– 60% inclusion of cooked kidney bean meal

S.E.M – Standard error of means

Table 7: The digestibility of nutrient in birds fed cooked kidney bean meal diets (%)

Variables	Feeds			
	T ₁	T ₂	T ₃	T ₄
Dry matter	95.13 ^a	94.67 ^{ab}	94.27 ^a	95.00 ^a
Crude protein	79.87 ^a	78.54 ^a	77.12 ^a	74.92 ^b
Ether extract	94.17 ^a	94.67 ^{ab}	95.33 ^a	95.83 ^a
Crude fibre	74.00 ^{ab}	74.11 ^{ab}	74.34 ^a	74.44 ^a
ASH	81.17 ^{ab}	81.50 ^{ab}	83.00 ^a	83.17 ^a
NFE	67.63 ^b	71.64 ^{ab}	69.54 ^{ab}	73.46 ^a

Means followed by the same letter indicated in columns are not significant at 5% level

KEY

T₁ – 0% inclusion of cooked kidney bean meal

T₂ – 20% inclusion of cooked kidney bean meal

T₃ – 40% inclusion of cooked kidney bean meal

T₄ – 60% inclusion of cooked kidney bean meal

Table 7. shows the degree of nutrient digestibility by broiler birds fed CKBM diets. Significant difference ($P > 0.05$) were not observed in the dry matter, ether extract, crude fibre and ash digestibilities except, crude protein and NFE. There were no significant differences ($P < 0.05$) among treatments in dry matter, crude fibre and ash digestibilities. Their digestibilities decreased ($P < 0.05$) with increasing level of CKBM. The observed decrease could be either due to the anti-nutritional factors. Ani

(2006) reported that ANFs have depressive effect on digestion and utilization of nutrients. Fielding (1991) also reported that the higher the fibre level in the feed, the more quickly it passes through the monogastric digestive system and the lower the digestibility. Moreover, fibre contains lignins, celluloses and hemicelluloses. Lignin is not only largely indigestible itself, but it also lowers the digestibility of other complex carbohydrates and nutrient (Jokthan *et al.*, 2006). Significant

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differences ($P < 0.05$) were observed in ash and ether extract digestibilities. These nutrient digestibilities (ash and ether extract) were higher in diets having increasing levels of CKBM. The higher

percentages recorded in ether extract digestibility in T4 and T3 could be as a result of inclusion of palm oil in these diets, this could also have accounted for higher value of ash in nutrient digestibility trial.

Table 8: Carcass proportion of birds fed cooked kidney bean meal diets

Body parts	Treatments				SEM
	T1	T2	T3	T4	
Live wt/kg	1.47	1.42	1.40	1.37	0.03
Slaughter wt/kg	1.30	1.27	1.30	1.22	0.02
Plucked wt/kg	1.18	1.22	1.20	1.13	0.02
Dressed wt/kg	0.92	0.92	0.90	0.87	0.02
Slaughter wt % lw	88.5	89.4	92.8	89.1	0.75
Plucked wt % lw	87.3	86.0	85.80	82.9	1.41
Dressed wt % lw	62.45	64.5	65.60	63.2	0.95
Head wt % lw	2.51	2.66	2.67	2.57	1.54
Neck wt % lw	5.17	4.84	5.17	5.45	0.39
Breast wt % lw	12.39	16.45	13.60	11.78	0.70
Back wt % lw	8.91	9.50	10.23	10.31	0.26
Thigh wt % lw	8.40	8.77	8.81	8.02	0.20
Drumstick	9.83	9.94	10.86	9.64	0.26
Wings wt % lw	7.07	7.63	8.37	8.79	0.25
Shank wt % lw	3.45	3.63	3.95	4.29	0.17
Viscerals					
Kidney wt % lw	0.74	0.78	0.69	0.66	0.04
Lungs wt % lw	0.70	0.74	0.72	0.44	0.05
Gizzard wt % lw	3.47	4.45	3.53	3.55	0.20
Crop wt % lw	2.90	5.06	3.27	3.33	0.35
Intestine wt % lw	7.02	7.13	6.68	6.76	0.20
Heart wt % lw	0.60	0.66	0.65	0.61	0.02
Fats wt % lw	0.81	0.79	0.93	0.55	0.08
Bile wt % lw	0.29	0.26	0.12	0.22	0.03
Spleen wt % lw	0.21	0.19	0.21	0.22	0.01
Liver wt % lw	2.65	3.02	2.93	2.65	0.07

Table 8 Shows the carcass proportion of birds fed cooked kidney bean meal diets. There were no significant differences ($P > 0.05$) among birds fed the four experimental diets in parameters considered in the carcass proportion. The live weight, slaughter weight, plucked weight and dressed weight recorded no significant differences ($P > 0.05$), so also their weight reflected as percent of live weights (WT% LW). No significant differences ($p > 0.05$) were observed in the head, neck breast, back, thigh, drumstick, shank and other visceral organs. These insignificant differences was as a result of the acceptance of the feed and nutrient

utilization. This shows that cooked kidney bean meal was well tolerated and handled by the birds.

Conclusion

The addition of cooked kidney bean meal had a positive effect on the performance on the birds as well as crude protein digestibility of the birds when their inclusion in the diet is within the range of 20-40%. This positive impact is in terms of feed intake, body weights, body weight gain, feed conversion efficiency and improvement in their carcass proportion. However, up to 60% inclusion of CKBM in the diets of broilers will counteract this

positive impact.

Recommendation

From the result of this experiment, the study indicated 40% protein replacement of cooked kidney bean meal for Soyabean meal and Groundnut cake as a plant protein source of feed. I also recommend that other processing method of kidney bean could be employed in order to adequately remove the anti-nutritional factors to the barest minimum.

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