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Determination of Optimal Dietary Level of Inclusion of Cooked Sword Bean Meal in Broiler Starter Diet

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Abstract: The optimal dietary level of inclusion of cooked sword bean meal was investigated. One hundred and twenty (120) day-old Anak broiler chicks were randomly allocated to 4 dietary treatments, each having 3 replicates of 10 chicks in a Completely Randomized Design (CRD). Diet 1 was soybean-based control. While the test feedstuff (cooked sword bean meal) quantitatively replaced 27.27%, 36.36% and 45.45% of soybean meal in diets 2, 3 and 4, respectively. Each diet was offered ad-libitum to the birds for a period of 28 days. There was a general decrease as the quantity of the test diets increased for final live weight, daily weight gain and feed-intake. For feed conversion ratio, diet 2 had the lowest value (1.65) as opposed to (1.87) control diet, (2.2) diet 3 and (2.70) diet 4. For gross margin, diet 2 had the highest value (N163.45) when compared with control diet (N130.05), diet 3 (N120.37) and diet 4 (N85.47), making diet 2 a choice. Values of cut-parts showed significant ($p<0.05$) differences for back-cut only, which followed no specific pattern that can be attributed the effect of diets. It follows then that any of the treatment could serve for cut-parts. Values of organs showed significant ($p<0.05$) difference with respect to proventriculus only in favour of diet 2. For blood constituents, the PCV, HB, RBC, WBC, MCV, fall within the normal range for all the diets while MCHC for control diet only, falls within the normal range established for broiler chickens. The MCH for control diet and diet 2 fell within the normal range. (33.2433, 34.18), as opposed to other diets (40.06, 23.51). For Serum chemistry, diet 4 (25.13) urea value was numerically higher than all other values (23.6, 24.00, 22.9). Creatinine values also follow similar trend (1.033, 1.100, 1.000, 1.166). Diet 2 had the highest numerical value for globulin and total protein (15.1, 38.9) while diet 4 (.536.00) had the highest value for alkaline phosphatase. For histopathological changes, the only organ affected was liver starting at 10% dietary level of inclusion. Diet 2 (7.5%) compared favourably with control diet and hence recommended.

Key words: Determination, optimal, cooked sword bean meal, broiler diet

INTRODUCTION

The demand for protein of animal origin in a developing country like Nigeria has far outstripped supplies. An average Nigerian for instance, consumes only about 10 gram per day of the minimum daily intake of 35 grams recommended by Food and Agricultural Organization FAO[1]. This could be attributed to low level of animal protein production[2]. A solution to the problem is to increase the level of animal production by intensifying the production of highly reproductive animals with short generation interval such as poultry, pigs and rabbits[3]. However, intensive poultry and livestock farming in Nigeria have been greatly affected by the high cost of feeds and feed ingredients, especially the conventional protein ingredients like soy bean cake and groundnut cake. Consequently, the prices of animal product have escalated, thereby making them out of the reach of common man. A possible solution to this problem is to explore the nutritive protein source, which is cheap and locally available[2]. The alternative vegetable protein source being considered in this study is sword bean (*Canavalia gladiata*). A leguminous seed, that belongs to family Papillionidae, resistant to pest and diseases. It yields about 4600kg of seeds per hectare. The crude protein content of about 22-29% with fairly good amino acid profile[4-6]. It is known that raw sword bean seeds contain anti-nutritional/toxic factors such as canavanin, con-canavanin-A, Gibberellins, phytin, tannin, hydrocyanide etc[7-9]. This underscores the importance of detoxification before usage. Akinmutimi[9] reported 17.84, 52.56, 28.83 and 41.8% reduction in phytic acid, tannin, trypsin inhibitors and cyanogenic glycosides when raw sword bean was cooked for 90minutes. Also, heat treatment especially cooking is a common, acceptable and affordable means of detoxification among rural dwellers[6,10]. This highlights the reason for its use as a method of detoxification in this very study. This study

was carried out to investigate the response of broiler birds fed diets containing graded levels of cooked sword bean meal in place of soybean meal.

MATERIALS AND METHODS

The experiment was conducted at the livestock unit of Micheal Okpara University of Agriculture, Umudike, Abia state, Nigeria. Umudike bears a co-ordinate of 5°28[l] north and 7°31[1] east and lies at an altitude of 122 m above sea level. It is located within the tropical rainforest zone and the environment is characterized by an annual rainfall of about 1277mm. The relative humidity during the raining season is well above 72%, monthly ambient temperature ranges from 170 to 36[0]C. March is the warmest month with an average temperature range of 22-30°C.

The raw sword beans were purchased from Agwantashi in Nassarawa State of Nigeria, while other feedstuffs and materials were purchased from Umuahia and Aba, all in Abia State. The raw seeds were cooked for 90 minutes at about 100°C. The cooked seeds were sun dried and then oven dried at 60°C. They were later milled using a harmer mill and then used for analysis and animal trials.

Experimental diets and composition: Four diets were formulated (Table 1). Diet1 was soybean based and served as control. Cooked sword bean meal replaced soybean meal (weight to weight) in diets 2, 3 and 4, at 27.27 (7.5%), 36.36 (10%) 45.45 (12.5%), respectively.

Experimental birds and their managements: One hundred and twenty (120) day old Anak broiler birds of average weight of 35 g per bird were randomly assigned to four (4) treatment diets, given 30 birds per treatment group in a Completely Randomized Design (CRD). Each treatment group was subdivided into three replicates of 10 birds each. Chicks were brooded in a deep litter pen measuring 2.6×3 m. The litter material used was wood shaving. Heat was provided with kerosene stove under galvanized metal hovers. Feed and water were provided to the birds *ad- libitum*, while additional light was supplied at night using kerosene lanterns to enable the birds to feed at night. Black tarpaulin cloth was used to cover the wire netting part of the building to prevent cold during brooding that lasted for 2 weeks. The birds were vaccinated against new castle disease at 'day old' (1\0) and 3rd week lasota. Gumboro vaccine was administered at the 10th day (1\0). Medication such as sugar solution for the first 2 to 3 days and later biovite for the purpose of relieving stress and E. S. B_3 to prevent coccidiosis were carried out.

Table 1: Composition of the treatment diets containing various graded levels of cooked sword bean meal in place of soybean meal

	Levels of cooked sword bean seeds			
Ingredients	0%	7.5%	10%	12.5%
Maize	49.8	49.8	49.8	49.8
Cooked Soybean	27.5	20	17	15
Sword beans	-	7.5	10.5	12.5
Blood meal	5	5	5	5
Palm Kernel Cake	9	9	9	9
Fish meal	3	3	3	3
Bone meal	3	3	3	3
Oyster shell	2	2	2	2
Vitamin-premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Methionine	0.1	0.1	0.1	0.1
Lysine	0.1	0.1	0.1	0.1
Total	100	100	100	100
Calculated composition				
Crude protein (%)	23.85	22.5765	22.067	21.7275
Metabolisable energy (kcal Kg^{-1})	2848.414	2843.69	2841.8	2840.54

Data collection: Initial average weight of the birds was taken on the first day of the experiment. Average weight and weight gains were subsequently taken on weekly basis. Feed conversion ratio (FCR) was calculated by dividing the average feed intake by the average weight gain. Percentage mortality was calculated using:

$$\frac{\text{Number of dead birds}}{\text{Overall number of birds 1}} \times 100$$

Gross margin/profitability lest was calculated according to Sonaiya[11]. Evaluation of carcass quality was carried out as described by Ojewola[12]. For blood constituents' evaluation, one bird per replicate was randomly selected and bled at the end of the trial by severing the jugular vein. A set of blood samples were collected into bottles containing EDTA for haema to logical evaluation while another set of blood samples were collected without any anticoagulant, for blood chemistry evaluation. Haematological parameters and blood chemistry were determined as described by Dacie[13].

Histopathological examination was carried out as described by Durry[14]. It involves collection of samples from various organs such as the liver, kidney, heart, spleen etc. The samples were fixed with 10% normal saline for a minimum of 20 h after which, they were processed and embedded in paraffin wax. Thin section of 5 cm thick were cut, stained with haematoxylin and Eosin (H and E) and examined using the light microscope to observe the presence of necrosis, hyperplasia etc.

Chemical and data analysis: Cooked sword bean meal and the experimental diets were analyzed for proximate composition according to methods of A.O.A.C[15]. All data were subjected to Analysis of Variance (ANOVA) while means with significant differences were separated using Duncan Multiple Range Test (DMRT)[16].

RESULTS

Table 2 shows the proximate composition of the test ingredient and the experimental diets. The cooked sword bean meal had 25.02% crude protein, 2.94% ether extract, 6.49% crude fiber, 3.74% ash, 52.67% Nitrogen free extract and 4.52kcal/g gross energy. The composition of the experimental diets varied slightly. The growth performance of broiler chickens fed graded levels of cooked sword bean meal is as shown in Table 3. There was a significant difference for all treatment means for all the parameters measured, with the exception of percent mortality. The mean final weight, weight gain and feed intake decreased as the quantity of dietary level of inclusion of cooked sword bean meal in the diet increased and became significant ($p<0.05$) at 10 and 12.5% for final weight and weight gain, respectively but at 7.5% and above for feed intake. Diet containing 7.5% cooked sword bean meal has the lowest feed to gain ratio, followed by control diet (diet 1) (0%), Diet 3 (10%) and lastly 12.5% (diet 4) zero percent mortality was observed. The gross margin favored diet 2 (N163.43), followed by control diet (133.05), diet 3 (N 120.37) and diet 4 (N 185.47). The mean weight of cut parts of broiler chicken fed cooked sword bean meal is as shown in Table 4. There was no significant ($p>0.05$) difference among the treatment means with the exception of back-cut and the back-cut result does not follow a specific pattern that can be attributed to the effect of diet. Table 5 shows the result of organ weight. There was no significant ($p>0.05$) difference for weight of organ except for proventriculus. The value of proventriculus increased as the dietary levels of inclusion of the test ingredient increased. Table 6 reveals the haematological values of the broiler chickens fed graded levels of dietary inclusion of cooked sword bean meal. All the haematological parameters measured fall within the established standard range, with the exception of the MCHC and MCH for diet 3 (10% cooked sword bean meal) and diet 4 (12.5% cooked sword bean meal). Table 7 shows the blood chemistry of broiler chickens fed graded levels of cooked sword bean meal.

Table 2: Proximate composition of experimental diets and the test feed stuff

Determined composition	Diet 1 (0%)	Diet 2 (7.5%)	Diet 3 (10%)	Diet 4 (12.5%)	Test feed stuff
Crude protein	23.85	22.58	22.07	21.73	25.02
Ether extract	4.26	4.775	5.315	4.64	2.89
Crude fibre	3.805	4.085	3.775	4.065	6.49
Ash	11.89	13.385	12.815	13.1	3.72
Nitrogen free Extract	47.01	63.56	46.6	44.95	52.67
Dry matter	90.285	90.025	91.47	89.975	90.79
GE (Kcal g^{-1})	3.193	3.074	3.044	2.966	4.52

Table 3: Growth performance of broiler chickens fed graded Levels of Cooked Sword Bean Meal (%)

	Graded levels of cooked sword bean meal (%)				
	0%	7.5%	10%	12.5%	+SEM
Initial weight (g)	35.00	35.00	35.00	35.00	0.00
Mean final weight (g)	682.78^{a}	591.51^{ab}	432.78^{bc}	310.55^{c}	49.41
Mean daily weight gain (g)	23.13^{a}	19.88^{ab}	14.21^{bc}	9.84^{c}	1.794
Avg feed intake/ bird /day (g)	42.33^{a}	32.77^{b}	31.22^{b}	26.50^{c}	0.961
Feed conversion ratio (g feed/g gain)	1.87^{bc}	1.65^{C}	2.20^{ab}	2.70^{a}	0.17
% Mortality	0	0	0	0	0
Gross margin (N)	133.05	163.46	120.37	85.47	

a-c treatment means in the same row with different superscript are significantly different ($p<0.05$)

Table 4: Cut parts expressed as percent (%) dressed weight of graded levels of cooked sword beans meal in broiler chicken diet

	Graded levels of cooked sword bean meal (%)				
	0	7.5	10	12.5	+SEM
Live weight (g)	466.67^{a}	350.00^{ab}	308.33^{b}	275.00^{b}	43.700
Dressing percentage	75.99000	74.96000	71.92667	73.49667	1.56
Breast cut	20.19000	18.07000	21.38500	20.88000	1.103
Drum stick	12.40000	11.58000	12.66000	11.71500	0.675
Wing	11.42500	11.23000	11.99500	12.02500	0.544
Back cut	14.02000^{c}	17.14000^{ab}	17.93500^{a}	16.695^{b}	0.212
Thigh	13.27500	10.99000	12.61500	12.57500	1.187

a-b treatment means in the same row with different superscript are significantly different ($p<0.05$)

Table 5: Organ weight expressed as percent (%) dressed weight of graded levels of dietary inclusion of cooked sword bean meal

	Graded levels of cooked sword bean meal (%)				
	0	7.5	10	12.5	+SEM
Kidney	1.32667	1.49500	1.39500	1.61500	0.126
Liver	3.38500	4.24000	4.60500	4.35500	0.446
Spleen	0.060	0.100	0.100	0.075	0.018
Heart	0.870	0.860	0.970	1.00	0.043
Gizzard	6.40500	6.34000	6.30000	6.45500	0.552
Proventriculus	1.01000^{b}	1.31000^{b}	1.53500^{ab}	2.06000^{a}	0.170
Intestine	10.85000	10.86833	13.21500	10.74500	1.187

a-b treatment means in the same row with different superscript are significantly different ($p<0.05$)

There were significant ($p<0.05$) differences for all the parameters except for globulin and total protein. However, the significant values of urea, creatnine, albumin and alkaline phosphatase did not follow any specific pattern that could be attributed to the effect of

Table 6: Haematological values of the broiler chickens fed graded levels of dietary inclusion of cooked sword bean meal

	Graded levels of cooked sword bean meal (%)				
	0	7.5	10	12.5	+SEM
PCV (%)	28.67^{c}	34.00^{b}	34.33^{ab}	36.00^{a}	0.553
HB (g 100 mL^{-1})	9.6333	10.2533	10.1133	10.1133	0.567
RBC (×106/3cm^{3})	2.9000	3.0000	2.9667	3.0333	0.137
WBC (×106/3cm^{3})	1.8000	1.8000	2.0000	2.0000	0.472
MCV (m^{-3})	98.9300^{b}	113.3300^{ab}	117.2867^{a}	118.7800^{a}	5.020
MCHC (Pg)	33.6100	30.1600	29.4467	28.1933	1.786
MCH (%)	33.2433	34.1800	40.0600	23.5100	5.041

a-c treatment means in the same row with different superscripts are significantly different ($p<0.05$)

Table 7: Blood chemistry of broiler chickens fed graded levels of cooked sword bean meal

	Graded levels of cooked sword bean meal (%)				
	0	7.5	10	12.5	+SEM
Urea (mg dL^{-1})	23.6000^{b}	24.0000^{ab}	22.9000^{b}	25.1300^{a}	0.360
Creatinine (mg dL^{-1})	1.0333^{b}	1.1000^{ab}	1.0000^{b}	1.1667^{a}	0.037
Albumin (g L^{-1})	22.900^{a}	23.800^{a}	19.900^{b}	23.800^{a}	0.397
Globulin (g L^{-1})	14.967	15.100	15.067	14.267	1.263
Total protein (g L^{-1})	37.867	38.900	34.967	38.000	1.138
Alkaline phosphatase (µ L^{-1})	458.667^{b}	468.000^{b}	536.000^{a}	488.000^{a}	15.830

a-b treatment means in the same row with different superscript are significantly different ($p<0.05$)

the diets. Histopathological examination reveals that liver is the most affected organ. The liver showed histopathological changes characterized by mild to moderate hyperaemia and necrosis of hepatocytes that manifested at 10% dietary level of inclusion of cooked sword bean meal.

DISCUSSION

The proximate composition and energy level obtained for cooked sword bean confirms the potentiality of the legume as an alternative protein source for livestock and poultry[7,9]. The slight variation in the composition of experimental diets is not surprising since the replacement of soybean meal with cooked sword bean meal was weight to weight replacement resulting in diets that are neither iso-nitrogernous nor iso-caloric.

The gradual decline in the feed intake value observed could be attributed to the effect of increase in the quantity of residual anti-nutritional factors as the dietary level of inclusion of cooked sword bean meal increases.

High tannin for example has been reported to cause poor feed intake by its ability to bind with the protein of saliva and mucosa membrane, resulting in poor palatability of such diets[17,18]. Saponin also causes decrease in feed intake through its irritating effect on the linings of the gut[19].

Other anti-nutrients such as con-canavanin-A and Canavanin have been reported to cause poor feed intake by moderating endocrine activity, leading to reduced appetite and inhibition of nitric oxide formation from arginine resulting in reduced appetite, respectively[20,18].

The observed final weight and weight gain could be attributed to the poor feed intake as well as the effect of poor nutrient utilization due to high level of residual anti-nutritional factors such as phytin, trypsin as reported by Akinmutimi[9] and canavanine Udedibie[21]. Phytin for example chelates protein forming complex compounds that are not readily broken down; hence loss of protein as well as its component amino acids, leading to poor performance of the birds, since deficiency of a single amino acid has been reported to cause poor performance[22].

The chelating capacity of phytin with minerals also results in poor availability of minerals for nutrient metabolism. Aletor and Fasuy[23] Trypsin inhibitors also inhibit digestive enzymes by irreversibly binding themselves to the enzymes thus, making the enzymes unavailable for the breaking down of protein[24] leading to poor protein digestibility with the resultant effect of growth depression[25]. Akanji [26] reported that any processing method that could not completely remove trypsin inhibitors could not lead to complete removal of haemaglutinin (Con-canavanin-A) a heat stable anti-nutrient and of course, canavanin another related heat stable anti-nutrient[27]. Earlier on Akinmutimi [9] reported that cooking of raw sword seed for 90minutes did not completely remove trypsin inhibitors. Hence, possibility of residual canavanin. Canavanin has been reported to hinder the metabolism of arginine because of their related structure[28]. This may result to poor ratio of arginine to lysine metabolism resulting in high arginine to lysine ratio in favor of lysine. This has been reported to cause poor weight gain[22]. The feed-to- gain ratio of diet 2 (7.5% cooked sword bean meal) that was better than other diets could be due to moderate feed intake and weight gain of the diet. The significantly ($p<0.05$) higher values of diet 3 (10%) and diet 4 (12.5%) suggest poor nutrient utilization, hence nutritionally inferior protein due to increase in anti-nutrient as the quantity of the test ingredient increased. The zero percent mortality shows that the chickens could tolerate the level of residual anti-nutrients.

The observed gross margin result being in favour of diet 2 (Cooked sword bean) could be attributed to the product of moderate feed cost, feed intake, favourable weight gain and growth resulting in better market price of the birds placed on it as opposed to others. The observed mean weight of cut-parts suggests that any of the diets could be chosen. More so, when significantly different ($p<0.05$) values for back-cut did not follow a specific pattern that could be attributed to the effect of

the test diets. This was confirmed by the good dressing percentage for all the diets, signifying good edible portion of live weight as opposed to inedible offals[29]. The increase in the value of proventriculus as the quantity of test ingredient increased could be due to the increase in the crude fibre content and/or increase in the quantity of anti-nutrients, resulting in increased activity of proventriculus[30]. Numerical values of heart, liver, proventriculus intestine and percent dressed weight of diet 2 (7. 5% cooked sword bean) compared favourably with the control diet, making it a choice diet.

The values of MCHC and MCH for diet 3 (10% cooked sword bean meal) and diet 4 (12.5% cooked sword bean meal) that were out of established standard range shows the poor quality protein of the said diets[31] and hence the broiler chickens placed on the diets may be prone to anaemia. This probably explains the poor performance of broiler chicks placed on diets 3 and 4. Based on the above, diet 2 (75% cooked sword bean) compared favourably with control diet and therefore stands as a preferred diet.

Despite the non-specific pattern of the result observed for the values of urea creatinine, albumin and alkaline phosphatase,

The highest values of urea creatinine and appreciably high alkaline phosphatase could probably explain the poor performance of birds placed on diet 4 (cooked sword bean). It is known that high values of urea, creatinine and alkaline phosphatase are indications of poor quality protein of the test diet[31,32]. Creatinine for example makes broiler chickens prone to muscular wastage[32] while high urea values suggest poor metabolism of protein[31]. Judging from absolute values of albumin globulin total protein and alkaline phosphatase, diet 2 (7.5% cooked sword bean meal) gave a better result and hence confirms its recommendation. The histopathological changes observed may explain the lower MCHC for diet 4 and slightly lower values of MCHC and MCH for diet 3 (10% cooked sword bean meal) Oyawoye[27]. It also explains the high values of alkaline phosphatase in diets 3 (536.00) and 4 (488.00) since liver damage has been associated with high alkaline phosphatase[33-35]

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