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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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Assessment of Partial Equi-Protein Replacement of Soyabean Meal with Cassava and Leucaena Leaf Meals in the Diets of Broiler Chicken Finishers

G.E. Onibi[1], O.R. Folorunso[2] and C. Elumelu[1]
[1]Department of Animal Production and Health, School of Agriculture and Agricultural Technology, Federal University of Technology, P.M.B. 704, Akure, Ondo State, Nigeria
[2]Department of Animal Production, Federal College of Agriculture, Akure, Ondo State, Nigeria

Abstract: Three hundred and fifty broiler chickens (Anak, 2000) were used to study the effect of partial replacement of soya bean meal (SBM) protein with cassava and or leucaena leaf meals. Diet 1 was the control diet with soyabean meal but no leaf meal. Diets 2 and 3 had 30% and 60% SBM protein respectively replaced with cassava leaf meal (CLM) protein. In diets 4 and 5, 30% and 60% of the SBM protein respectively, were replaced with leucaena leaf meal (LLM) protein. The SBM protein in diets 6 and 7 was substituted at 30% and 60% respectively with 50:50 CLM and LLM protein. The birds were assigned to the experimental diets at 10 birds per replicate and 5 replicates per treatment. The energy to protein ratios of the diets were similar. The response criteria measured were feed intake, weight gain, nitrogen retention, shank and skin pigmentation, selected carcass, organ and muscle characteristics and economics of production. The results showed that weight gain (WG, 52.1±1.00 g/day) and feed intake (134±4.37 g/day) were higher ($P<0.05$) in birds fed the control diets. On other diets, WG were 44.4±4.18 g (Diet 2), 43.7±2.10 g (Diet 6), 40.2±4.32 g (Diet 4), 37.2±4.13 g (Diet 3), 34.9±1.04 g (Diet 7) and 26.0±4.86 g (Diet 5) per day. Nitrogen retention was apparently highest ($P>0.05$) for birds on the control diet. Shanks of birds on leaf meal diets were more pigmented ($P<0.05$) than the control. Carcass, organ and muscle characteristics were not affected ($P<0.05$) by dietary treatments. Cost of feed per kilogram weight gain were similar for broiler on Diets 1, 2 and 6 (₦110, ₦108 and ₦109 respectively) and highest for Diet 5 (₦150). It was concluded that 30% replacement of soyabean meal protein in a 14% soyabean meal ration with cassava (10.50% of diet) or 50:50 cassava and leucaena (9.55% of diet) leaf meal protein would optimize growth performance and economic returns from broiler production especially during periods of high cost and scarcity of soyabean meal.

Key words: Chickens, protein replacement, leaf meals

Introduction

It is well recognized that malnutrition is a common problem for impoverished people in the developing countries. For example, per capita animal protein consumption in 1990 was 17.7 kg/year in the developing countries compared with 81.6 kg/year in the developed countries, showing considerable potential for increasing consumption (Sansoucy, 1995). This author also reported that while in 1970 ruminant and monogastric meat production rates were approximately equal, it is expected that by 2010, monogastrics would produce 2.4 times more meat than ruminants, providing that feed is available and affordable. Thus, the high cost of livestock production (especially feed) is mainly responsible for the high unit cost of animal products. The cost of feeding has been put at 60-80% of the total cost of production for intensively reared livestock especially poultry (Fajimi *et al*., 1993; Tewe, 1997). The bulk of the feed cost arises from protein concentrates such as groundnut cake, soyabean meal and fish meal. Prices of these conventional protein sources continue to soar and is becoming uneconomical to use them in poultry feed (Esonu *et al*., 2001). There is constant need to look for locally available and cheap sources of feed ingredients particularly those that do not attract competition between humans and livestock. Soyabean for example, is a staple food, used in a variety of ways by many penurious people in African countries.

The recognition of protein from leaf sources has gained prominence because of its ready availability and perhaps because it is the cheapest and the most abundant potential source of protein (Fasuyi, 2000). Leaf meals do not only serve as protein source but also provide necessary vitamins, minerals and also oxy-carotenoids, which causes yellow colour of broiler skin, shank and egg yolks (D'mellow *et al.,* 1987). *Manihot esculenta* (cassava) and *Leucaena leucocephala* (leucaena) are very popular tropical plants predominant in Southern Nigeria. In spite of the nutritive and agronomic advantages of these plants, leucaena contains a tyrosine analogue non-protein amino acid (mimosine) and cassava contains cyanogenic glucosides, phytin and tannin which may be harmful to animals, including poultry (Tewe, 1991). Cassava and

Table 1: Gross and proximate composition of experimental diets (%)

	Diets						
	1	2	3	4	5	6	7
	% of SBM protein replaced with leaf meal protein						
Ingredients	0	30-CLM	60-CLM	30-LLM	60-LLM	15-CLM+ 15 LLM	30-CLM+ 30 LLM
Maize	46.00	46.00	46.00	46.00	46.00	46.00	46.00
Maize offal	14.50	12.50	4.50	14.70	8.40	13.60	6.40
Groundnut cake	14.00	14.00	14.00	14.00	14.00	14.00	14.00
Soyabean meal	14.00	9.70	5.60	9.70	5.60	9.70	5.60
Cassava leaf meal[1]	-	10.50	21.00	-	-	5.25	10.50
Leucaena leaf meal[2]	-	-	-	8.60	17.20	4.30	8.60
Brewers dried grain	5.00	-	-	-	-	-	-
Palm oil	1.00	1.80	3.40	1.50	3.30	1.65	3.40
Others*	5.50	5.50	5.50	5.50	5.50	5.50	5.50
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated nutrient composition							
Crude protein, %	20.30	19.20	18.30	19.50	18.90	19.20	18.50
ME, MJ/kg	12.30	11.80	11.20	11.90	11.50	11.80	11.40
Lysine, %	0.97	0.93	0.85	0.94	0.86	0.94	0.86
Methionine, %	0.61	0.57	0.53	0.58	0.54	0.57	0.54
Crude fibre, %	4.28	4.53	5.45	5.35	7.19	4.94	6.30
Ether extract, %	6.28	6.44	7.05	6.96	8.46	6.71	7.78
Calcium, %	1.09	1.06	1.08	1.18	1.29	1.13	1.18
Phosphorus, %	0.59	0.52	0.54	0.60	0.58	0.59	0.56
ME : CP	0.61	0.61	0.61	0.61	0.61	0.61	0.61
Proximate composition							
Moisture, %	6.60	6.62	6.83	7.02	6.42	5.93	7.14
Crude protein, %	19.70	18.60	18.10	18.50	19.00	19.10	18.90
Crude fibre, %	3.10	4.50	5.47	4.75	5.43	4.72	5.75
Ether extract, %	5.51	5.33	6.19	6.40	5.89	6.22	6.01
Ash, %	6.11	6.18	6.41	6.13	6.56	6.53	6.30
Nitrogen free extract, %	58.90	58.80	56.10	57.20	56.70	56.60	55.90

ME = Metabolisable energy; CP = Crude protein; SBM = Soyabean meal. [1]Cassava leaf meal (CLM) contained 8.95% moisture, 21.1% CP, 9.59% crude fibre, 5.60% ether extract, 5.90% ash and 48.9% nitrogen free extract. [2]Leucaena leaf meal (LLM) contained 9.53% moisture, 23.0% CP, 11.2% crude fibre, 4.81% ether extract, 5.30% ash and 46.2% nitrogen free extract. *Others: Fish meal = 1.50%, Bone meal = 2.50%, Lysine = 0.20%, Methionine = 0.30%, Premix = 0.50%, Salt = 0.50%.

leucaena leaf protein concentrates have been shown to contain a high level of crude protein (Aletor and Adeogun, 1995). However, the process of extraction of leaf protein concentrate is difficult and cumbersome for rural populace in Africa. Therefore, if rural poultry is to develop which could translate to rural development, poverty alleviation and increased animal protein intake, easily adaptable use of protein-rich leaves in form of leave meals needs more research emphasis.

Thus, this study was conducted to determine the effect of replacing up to 60% of soyabean meal in finisher diet, with cassava and leucaena leaf meals, on growth performance, economically valuable carcass characteristics and production cost of broiler chickens.

Materials and Methods

Experimental site and materials: The study was conducted at the Teaching and Research Farm of the Federal University of Technology, Akure, South-western Nigeria. Leucaena and cassava leaves were collected within and around the University farm where they were abound. The leaves were sun-dried for 5 days and ground before incorporation into the diets. Other feed ingredients and day-old chicks (Anak, 2000) were purchased from reputable feedmill and hatchery respectively.

Experimental diets: Seven experimental finisher broiler diets with similar metabolisable energy to crude protein ratio were formulated. The gross, calculated nutrient and proximate compositions are shown in Table 1. Diet 1 was the control with soyabean meal (SBM) but no leaf meal. Diets 2 and 3 had 30% and 60% SBM protein respectively replaced with cassava leaf meal (CLM) protein. In diets 4 and 5, 30% and 60% of the SBM protein respectively were replaced with leucaena leaf meal (LLM) protein. The SBM protein in diets 6 and 7 was substituted at 30% and 60% respectively with 50:50 CLM and LLM protein.

Experimental layout and management of birds: The completely randomized experimental design was adopted. After a pre-experimental brooding and rearing period of 4 weeks on deep litter and *ad libitum* feeding

Table 2: Performance of broiler chicken finishers on partial equi-protein replacement of soyabean with cassava and/or leucaena leaf meals

	Parameters					
Diet	Initial live weight, g	Final live weight, g	Average weight gain, g/bird/day	Average feed intake, g/bird/day	Feed conversion ratio	Nitrogen retention, g/bird/day
1	806±45.9	2265±66.7[a]	52.1±1.00[a]	134±4.37[a]	2.58±0.12[a]	2.91±0.41
2	805±48.8	2049±63.1[b]	44.4±4.18[b]	123±7.24[b]	2.79±0.43[a]	2.72±0.25
3	809±26.8	1850±67.4[c]	37.2±4.13[c]	127±2.78[ab]	3.44±0.43[b]	2.33±0.50
4	807±34.7	1932±83.1[bc]	40.2±4.32[bc]	125±2.86[b]	3.12±0.31[b]	2.56±0.63
5	805±44.1	1532±75.3[d]	26.0±4.86[d]	109±6.01[c]	4.26±0.61[c]	2.24±0.42
6	804±44.1	2026±44.1[b]	43.7±2.10[b]	121±2.10[b]	2.78±0.17[a]	2.74±0.41
7	806±41.9	1783±41.9[c]	34.9±1.04[c]	119±7.45[b]	3.42±0.21[b]	2.07±0.51

Means are for 5 replicates of 10 birds/replicate (Mean ± SD). Means with different superscripts within the same column are significant (P<0.05).

Table 3: Shank and skin pigmentation of broiler chicken finishers on partial equi-protein replacement of soyabean with cassava and/or leucaena leaf meals

Diets	Shanks	Skin
1	2.00±0.29[c]	2.63±1.30
2	2.61±0.40[bc]	3.10±1.21
3	3.11±0.52[b]	2.93±0.83
4	2.27±0.36[bc]	2.37±1.27
5	2.90±0.61[b]	2.67±0.88
6	3.03±0.44[b]	3.23±1.48
7	3.73±0.32[a]	2.83±1.23

Means are for 5 replicates of 4 birds/replicate using a 10-member panel (Mean ± SD). Means with different superscripts within the same column are significant (P<0.05).

of a commercial broiler starter mash (23% crude protein), a total of 350 starter chicks were selected. Fifty chicks at 10 chicks/replicate (5 males + 5 females) and 5 replicates/dietary treatments were placed on each of the 7 experimental diets in metabolism cages that were housed in an open chicken wire meshed poultry house. Starter chicks on the replicates were balanced for initial weights such that group mean weights were identical (Table 2). The birds were fed their respective experimental diets *ad libitum* for 28 days during which the weekly feed consumption and group live weights were taken. Faeces voided during the last five days were collected, weighed, dried in air-circulating oven for 72 hours, cooled and weighed and then preserved in a freezer at -20°C. Weight of feed consumed during this period was also taken.

Slaughtering for carcass, organ and muscle characteristics: At conclusion of the feeding trial, the birds were starved overnight in order to empty their crops and 4 female birds/replicate (20 birds/dietary treatment) were selected and weighed. The birds were hung using chicken shackles, stunned and sacrificed by severing the jugular vein. The carcasses were allowed to bleed freely for 10 minutes, scalded in 65°C water for 15 seconds, manually defeathered, eviscerated and washed in chilled (4°C) potable water for 3 minutes. The carcasses were then presented to a 10-member trained panel to score for intensity of shank and skin yellowish pigmentation (1 = no, 2 = slight, 3 = moderate, 4 = high and 5 = extremely high). Thereafter, the carcasses were dissected into parts as described for Turkey by Hahn and Spindler (2002). Carcass, organs and muscle weights taken were: Dressed, eviscerated, thigh, drumstick, chest, back, belly fat, heart, liver, gizzard, inner chest muscle (*Supra coracoideus*) and outer chest muscle (*Pectoralis thoracicus*). Dressed and eviscerated weights were expressed as percentage of live weight while the others were expressed in g per kilogram live weight.

Cost evaluation: The costs of feeding the broilers were calculated using the prevailing market prices of feedstuff at the time the experimental diets were formulated.

Chemical and statistical analyses: The proximate composition of the leaf meals and diets and nitrogen content of faecal samples were determined by the method of AOAC (1995). Nitrogen retained by the birds calculated as the difference between feed nitrogen and faecal nitrogen (on dry matter basis). Data collected were subjected to one-way analysis of variance. Where significant differences were found, the means were compared using the Duncan's Multiple Range Test. The Minitab Statistical Package (v. 10.5, Minitab Inc., USA) was used for statistical analysis.

Results and Discussion

Diets: The experimental diets were formulated to be on-farm adaptable as much as possible (Table 1). Thus, the calculated CP were between 18.3 and 20.3% while the ME ranged between 11.2 and 12.3 MJ/kg. However, the ME to CP ratios for all diets were similar and was 0.61. The proximate composition of the cassava and leucaena leaf meals and the experimental diets are also shown presented in Table 1. The CLM and LLM contained 21.1% and 23.0% crude protein contents respectively. The analyzed and calculated nutrient composition of the diets did not vary widely.

General observation and performance of broiler chickens: The boiler chickens were apparently healthy throughout the experimental period and only one of the birds on the control diet died on the third day to the conclusion of the feeding trial. Post mortem examination revealed no dietary effect but heat stress. The performance of the broiler chicken finishers fed the experimental diets is presented in Table 2. The final live weight, average weight gain, feed consumption and feed conversion ratio were significantly influenced (P<0.05) by dietary treatments. The highest final live weight (2265±66.7 g), average weight gain (52.1±1.00 g/day), average feed intake (134±4.37 g/day) and lowest feed conversion ratio (FCR, 2.58±0.12) was observed for birds on Diet 1 (Control). Birds fed diets with 30% SBM protein replaced with leaf meal protein had higher final live weight, average weight gain, average feed intake and lower feed conversion ratio than those on their respective 60% SBM replacement (Diets 2 vs. 3; 4 vs. 5; 6 vs. 7). Birds fed diets in which the SBM protein was replaced with CLM had higher final live weight, average weight gain, average feed intake and lower feed conversion ratio than those in which the SBM protein was replaced with LLM at the same percent level of replacement (Diets 2 vs. 4; 3 vs. 5). Nitrogen retention (NR) of birds on the control diet (Diet 1) was apparently highest (2.91±0.41 g/day, P>0.05) than those fed the leaf meal diets which ranged between 2.24±0.42 and 2.74±0.41 g/day). Nitrogen retained by birds was apparently higher at 30% than 60% SBM protein replacement and for birds fed CLM than LLM.

The highest final live weight and average weight gain by birds fed the control diet suggests that this diet promoted better growth than the leaf meal based diets. This may be partly attributed to an adverse effect of amino acid imbalance in the leaf meal based diets compared with the control diet as SBM has a better amino acid profile than leaf meals (Agbede and Aletor, 2003). Aletor *et al.* (2000) reported that diets with balanced amino acids are palatable and consumed in large amounts with attendant improvement in the performance of broilers. The reduced live weights and weight gains and higher FCR due to feeding leaf meals compared to feeding the control diet and 60% SBM protein replacement compared with 30% SBM protein replacement with leaf meals may also in part be attributed to the increased level of dietary fibres which could impair dietary nutrient utilization (Nwokolo *et al.*, 1985). Similarly, the leaf meals contained residual anti-nutrients and the concentration would be higher at higher levels of dietary inclusion of the meals, hence the higher depressing effect on broiler performance. The depressed growth performance, feed intake and feed efficiency was more obvious with LLM than CLM which could be adduced to higher level and/or more potent anti-nutritive components of leucaena than cassava leaves. The apparent differences (P>0.05) in nitrogen retention by birds on the different diets may be attributed to factors such as amino acid imbalances, increased dietary fibre and possible adverse of residual anti-nutrients earlier proffered for differences in weight gain and feed intake of birds. In a similar vein and attributable to similar reasons, SBM protein replacement by 50:50 CLM and LLM protein generally led to better performance of the birds than LLM alone (Diets 6 vs. 4; 7 vs. 5) but not as good as CLM alone.

Shank and skin pigmentation: Table 3 shows the results of the shank and skin pigmentation of broiler chicken finishers fed the experimental diets. At 30% replacement of SBM protein with CLM and LLM, yellow shank pigmentation scores were numerically higher (P>0.05) than for the control chickens. Substitution of SBM protein with CLM and LLM at 60% compared with 30% was observed to lead to higher shank pigmentation scores (P>0.05). Higher numerical shank pigmentation scores were recorded for birds fed CLM compared with LLM. The substitution of SBM protein with 50:50 combinations of CLM and LLM protein was observed to produce chickens with higher shank pigmentation scores compared with feeding either of the two leaf meals. Skin pigmentation was not significantly influenced (P>0.05) by dietary treatments but was higher chickens fed leaf meals. There was no trend shown by level of incorporation or type of leaf meals in relation to intensity of skin pigmentation.

The observed differences in yellow skin pigmentation could be attributed to the levels of carotenoids in the leaf meals. Agbede and Aletor (2003) reported increased yellow pigmentation (due to β-carotene, precursor of vitamin A) of shanks of broiler chicks by dietary incorporation of leaf meal protein concentrates. Better utilization of CLM than LLM for reasons earlier deduced could be responsible for higher shank pigmentation of birds fed CLM. The lack of trend in skin pigmentation in relation to dietary treatments is a pointer to the fact that shank pigmentation is a better indicator of intensity of pigmentation in chickens. It is likely that meat from chickens fed the leaf meals would contain more vitamin A since chickens are able to incorporate dietary components into their muscles (Onibi, 1999).

Selected carcass, organ and muscle characteristics: All the carcass, organ and muscle characteristics measured (Table 4), except the liver and gizzard were not significantly influenced (P>0.05) by dietary treatments. Relative weights of the liver of birds were significantly higher (P<0.05) at 30% (23.4 ± 2.32 g/kg LW) and 60% (24.9 ± 2.43 g/kg LW) SBM protein replacement with LLM than those of the control and CLM based diets. Relative weights of the liver were higher at

Table 4: Selected carcass, organ and muscle characteristics of broiler chicken finishers on partial equi-protein replacement of soyabean with cassava and/or leucaena leaf meals

	Diets						
Parameters	1	2	3	4	5	6	7
Dressed carcass, % LW	85.6±3.55	83.4±2.80	84.3±5.65	83.6±4.77	83.5±4.08	85.6±3.17	84.2±2.29
Eviscerated carcass, % LW	76.1±1.27	73.1±4.75	77.4±3.71	75.1±4.92	73.3±3.05	76.0±2.64	74.2±2.50
Thigh, g/kg LW	89.9±2.34	90.3±7.13	96.5±13.9	89.8±9.16	86.6±9.29	100.1±11.3	91.2±11.8
Drumstick, g/kg LW	86.1±12.7	86.1±9.25	87.0±10.4	83.4±11.8	83.6±6.22	86.6±8.58	90.1±8.82
Chest, g/kg LW	147±7.28	144±10.2	153±14.3	139±9.69	144±7.35	152±11.2	142±10.2
Back, g/kg LW	147±17.1	136±13.4	139±10.9	129±7.91	136±12.8	142±9.42	139±11.7
Belly fat, g/kg LW	15.3±5.22	17.3±6.79	21.1±5.14	13.5±2.72	17.8±2.80	18.0±3.21	13.1±2.65
Heart, g/kg LW	5.76±0.35	5.20±0.13	4.99±0.29	4.83±0.44	5.17±0.95	5.72±1.49	4.56±0.43
Liver, g/kg LW	17.8±0.74^{c}	16.8±0.63^{c}	19.7±1.81^{bc}	23.4±2.32^{a}	24.9±2.43^{a}	19.8±1.11^{bc}	20.6±2.02^{ab}
Gizzard, g/kg LW	19.5±0.60^{c}	22.2±1.24^{b}	24.2±1.81^{ab}	22.3±0.80b	26.4±1.07^{a}	23.4±1.42^{ab}	25.9±1.33^{a}
Supra coracoideus, g/kg LW	8.51±0.33	9.25±3.12	10.5±2.99	9.11±1.44	8.78±1.81	10.3±1.60	11.3±2.11
Pectoralis thoracicus, g/kg LW	30.9±2.64	31.7±1.92	33.9±2.34	33.8±3.62	29.8±2.43	30.4±3.91	33.4±2.44

Means are for 5 replicates of 4 birds/replicate (Mean±SD). LW = Live weight of birds. Means with different superscripts within the same row are significant (P<0.05).

Table 5: Cost evaluation of broiler chicken finishers on partial equi-protein replacement of soyabean with cassava and/or Leucaena leaf meals

Diets	No. of birds	Av.weight gain(kg)	Av. feed intake(kg)	Cost of feed (N/kg)	Cost of feed consumed (N/bird)	Cost of feed per kg weight gain (N)
1	50	1.09	2.82	42.5	120.0	110
2	50	0.93	2.58	38.9	100.0	108
3	50	0.78	2.66	35.8	95.2	122
4	50	0.84	2.62	39.0	102.0	122
5	50	0.55	2.28	36.2	82.6	150
6	50	0.91	2.54	39.0	99.0	109
7	50	0.73	2.51	36.0	90.5	124

N = Naira; unit of currency in Nigeria. Calculations were based on the prices of feedstuff as at October, 2007 and excluded the cost of harvesting and processing of leaf meals.

higher levels of dietary leaf meal substitution. The relative weight of gizzard from broilers fed the control diets was lowest (19.5 ± 0.60 g/kg LW, P<0.05), followed by those fed CLM and highest for LLM based diets. Similar to that of the liver, relative weights of the gizzard increased with increasing dietary levels of leaf meals.

The relative weights of the carcass cuts (thigh, drumstick, chest and back) that were similar suggest that the control and the test diets (leaf meal based diets) promoted similar carcass characteristics. Even, the most economically important chicken inner breast muscle (*Supra coracoideus*) and outer breast muscle (*Pectoralis thoracicus*) were not significantly influenced by dietary treatments. Thus, identical carcass and muscle developments are attainable by feeding the diets. The higher relative weights of the liver and gizzard at higher level of inclusion of leaf meals and the higher weights of these two organs in LLM based diets than CLM based diets are attributable to a combination of increased levels of dietary crude fibre and anti-nutritive factors earlier proffered for differences in growth performance. These two organs are possible sites for detoxification hence increased weight with increasing muscular activities due to increased levels of dietary anti-nutrients. The gizzard breaks down ingested feed by muscular action and higher dietary fibre would promote higher thickening of the muscles (Onibi *et al*., 1999).

Cost evaluation: Cost assessment of the effect of partial equi-protein replacement of SBM with CLM and/or LLM is presented in Table 5. The cost of feed and cost of feed consumed were highest for the control diet (₦42.5/kg and ₦120/bird respectively). Cost of feed consumed decreased at higher inclusion of leaf meals. However, costs of feed per kilogram weight gain were similar for birds fed the control diet, Diet 2 and Diet 6 (₦110, ₦108 and ₦109 respectively). Diets 3, 4 and 7 were observed to produce similar cost of feed per kilogram weight gain of ₦122, ₦122 and ₦124 respectively while the highest cost of ₦150/kg weight gain was found for birds fed Diet 5 (60% SBM protein replaced with LLM protein).

It was apparent from the result of cost evaluation that 30% SBM protein replacement with CLM and 50:50 CLM and LLM (Diets 2 and 6) would produce economically profitable broiler chicken finishers as the control diet. Despite the low cost of feed consumed by broilers on Diets 3, 4 and 7, the depressed weight gain was responsible for the high cost of feed per kilogram weight gain. High LLM in Diet 5 adversely affected weight gain by birds resulting in highest cost of feed per kilogram weight gain.

Conclusions: This study revealed some information as to the benefits and limitations of using leaf meals from cassava and leucaena in the development of the poultry sector especially in area of village poultry nutrition. Soyabean meal (SBM) which might not be readily available at the rural levels due to an array of use of soyabean for human consumption as well as high cost of SBM could be substituted with leaf meals bearing in mind the following:

1: Growth performance characteristics would be marginally depressed at 30% equi-protein replacement of 14% SBM with CLM or 50:50 (protein for protein) CLM and LLM. Carcass characteristics were not adversely affected and cost of feed per kilogram weight gain by birds was similar to feeding diets without leaf meal. At this level, a saving of 4.30 kg SBM per 100 kg of feed would be made.
2: 60% equi-protein replacement of SBM in broiler finisher diet with CLM showed similar promise as 30% equi-protein replacement with LLM in terms of performance and carcass characteristics, though not as good as in (1) above and at a higher cost of feed per kilogram weight gain by birds compared with feeding diets without leaf meal.
3: While 60% equi-protein replacement of SBM in broiler finisher diet with 50:50 (protein for protein) CLM and LLM could be considered under unforeseen conditions where SBM and CLM are scarce, a total substitution at 60% equi-protein replacement of SBM with LLM should not be adopted due to marked depressive effect on growth performance and high cost of feed per kilogram weight gain by birds.

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