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The Substitution Effect of Noug Seed (Guizotia Abyssinica) Cake with Cassava Leaf (Manihot Escutulata C.) Meal on Feed Intake, Growth Performance, and Carcass Traits in Broiler Chickens

Aberra Melesse[1], Mengistu Masebo[2], Aster Abebe[1]

[1]*School of Animal and Range Sciences, Hawassa University, Hawassa, Ethiopia*
[2]*Departement of Animal and Range Sciences, Bule-Hora University, Bule-Hora, Ethiopia*

***Corresponding Author:** Aberra Melesse, School of Animal and Range Sciences, Hawassa University, P.O. Box 05, Hawassa, Ethiopia.*

ABSTRACT

Insufficient supply, high prices and competition with the human food means there is a continuous demand for alternative protein sources for poultry. As a result, leaves of multipurpose trees have been reported to be alternative feed ingredients. Among them, cassava leaves is becoming an increasingly important ingredient in poultry diets, largely due to its high availability. This study was thus designed to assess the effect of dietary inclusion of cassava leaf meal (CLM) on feed intake, growth performance, and carcass characteristics of Ross 308 broiler chickens. Five treatment diets were formulated to contain 0% (Treatment 1, T1), 2% (Treatment 2, T2), 4% (Treatment 3, T3), 6% (Treatment 4, T4) and 8% (Treatment 5, T5) of CLM by substituting the Noug seed (Guizotia abyssinica) cake. After two weeks of brooding, 240 unsexed Ross 308 broiler chicks were weighed and randomly allocated to the five treatment diets with four replicates of 12 chickens each. The experiment lasted for 6 weeks, during which feed intake and body weight were assessed on daily and weekly basis, respectively. At the end of the experiment, two chickens (male and female) per replicate of each treatment were randomly selected, fastened overnight, weighed and slaughtered for the determination of carcass parameters. The results indicated that the feed intake (g/chicken/day) was 80.9, 80.4, 80.9, 77.0 and 74.0 for chickens fed with T1, T2, T3, T4 and T5 diets, respectively being higher ($p<0.05$) for those of T1, T2 and T3 than T4 and T5. Chickens reared in T1, T2 and T3 diets had higher ($p<0.05$) body weight and total weight gain values than those of T4 and T5. No significance difference was observed in body weight between chickens reared in T1, T2 and T3 diets. The body weight and weight gain parameters were higher ($p<0.05$) for those chickens reared in T4 than those of T5. The feed conversion ratio did not vary between treatment diets. Chickens reared in T1 had higher ($p< 0.001$) pre-slaughter weight and dressed carcass than those of other treatments. The values for dressing percentage, and drumsticks were higher ($p< 0.001$) in chickens reared in T1 and T2 diets than those of T4 and T5. Chickens fed with T1, T2 and T3 diets had higher ($p<0.05$) values for thighs and wings as compared with those reared in other treatments. The interaction effect of sex by treatment was significant for breast, drumstick, back, gizzard and skin. Male chickens had higher ($p<0.05$) carcass values than females. It can be concluded that sun-dried cassava leaf can be included up to 4% of the broiler diets by replacing Noug seed cake without any adverse effects on feed intake, growth traits, feed conversion ratio and carcass components.

Keywords: *broiler chicken; carcass components; cassava leaf; growth performance; noug seed cake.*

INTRODUCTION

Shortage of protein supplements has recently been a serious issue in several regions of the world; in many of these, the use of cereal products as livestock feeds is increasingly unjustified in economic terms. Monogastric animals like poultry are markedly affected by such a trend.

Feed cost for poultry accounts about 70 of the total production cost. The bulk of the feed cost arises from protein concentrates such as Noug seed cake, groundnut cake, fish meal and soybean meal. Prices of these conventional protein sources have soared so high in recent times that it is becoming uneconomical to use them in poultry feeds under smallholder production systems (Melesse *et al.*, 2013).

Moreover, the majority of livestock production in tropical countries comes from small-scale mixed farming systems in which there is a close association between local animal breeds and local feed resources.

There is thus a need to search for locally available and cheap sources of protein feed ingredients, particularly those that do not attract competition in consumption between humans and livestock. Hence, evaluation of potentially useful unconventional feed resources is important in order to increase the feed resource base for livestock production in general and for chicken rearing in particular. One possible source of cheap protein is the leaf of some tropical multipurpose tree species. These leaf meals not only provide protein base but also offer some vitamins such as vitamin A and C, minerals and also oxycarotenoids, which cause yellow color of broiler skin, shank and egg yolk (Melesse *et al.*, 2011, 2013, 2017).

Cassava leaves are highly nutritious with high protein, ranging from 16.6% to 39.9% (Khieu *et al.*, 2005), and mineral levels, as well as being a valuable source of vitamin B1, B2 and C and carotenes (Adewusi and Bradbury, 1993). Additionally, the amino acid concentration of cassava leaves is very similar to that of alfalfa (Ravindran, 1991; Phuc and Lindberg, 2000) and the ME ranges from approximately 1590 kcal/kg (Khajarern and Khajarern, 1991) to 1,800 kcal/ kg (Ravindran, 1991). Dry cassava leaves can therefore be ground into meal to be fed to poultry as a source of protein and carotene (Khajarern and Khajarern, 1991; Ravindran, 1993). The leaves can be harvested within 4 to 5 months of planting, without having any adverse effect on the root. Recent studies have revealed that cassava leaves are an excellent and easily available source of protein as well as minerals. The CP, EE, crude fiber and NFE contents of cassava leaves cultivated in Ethiopia was 28.3, 67.4, 16.0 and 331g/kg DM (Melesse *et al.*; unpublished data). The cassava leaves were also found to be rich in Calcium (14 g/kg DM), Phosphorous (3.17 g/kg DM) and Magnesium (4.19 g/kg DM; Melesse *et al.*, unpublished data).

Previous limited studies indicated that cassava leaf might be used as partial substitutes for the conventional protein sources in poultry rations. Some reports indicated that cassava leaf could be included at up to 20% in broiler rations (Khajarern and Khajarern, 1991). For replacement pullets, the maximum possible inclusion level was 16.5% of pelleted rations, whereas with layers, where it was used as carotenoids source, a maximum level of 5% is recommended (Khajarern and Khajarern, 1991). The limiting anti-nutritional factors to use cassava leaf as source of protein for poultry are the hydrocyanic acid (HCN) contents, its low energy, bulkiness and possibly their tannin content. However, previous studies have demonstrated that it is possible to produce cassava leaf with low cyanide levels (Ravindran *et al.*, 1986; Ravindran and Ravindran 1988).

Both Noug seed (*Guizotia abyssinica*) cake and cassava leaves contain similar levels of crude protein (approx. 28%) on dry matter basis but differ in their crude fiber content considerably. In Ethiopia, Noug seed cake is considered as one of the most common protein sources in poultry nutrition. However, it contains high level of crude fiber (24.5% on DM basis) making it unsuitable for poultry feeding. Moreover, the cost of Noug seed cake has been consistently rising over the last many years. Thus, substituting the Noug seed cake with other suitable cheap protein sources becomes justifiable in monogastric nutrition such as poultry. This study was thus conducted to assess the effects of dried cassava leaf meal on feed intake, growth performances, and carcass traits of broiler chickens by replacing the Noug seed cake of the control diet.

MATERIALS AND METHODS

Description of the Study Area

The experiment was carried out at poultry farm of School of Animal and Range Sciences, College of Agriculture, Hawassa University, which is situated 275 km south of Addis Ababa. Geographically it is situated at 7°4’N latitude and 38°31’E longitude at an altitude of 1650 m above sea level. Rainfall is bi-modal and ranges between 674 and 1365 mm. The mean temperature ranges between 12 ^{0}C and 27 ^{0}C.

Preparation of Leaf Meal Material

The leaf part of the cassava (*Manihot escutulata* Crantz) was used in this experiment as protein source by replacing the protein content of Noug seed cake. Fresh cassava leaf was collected from Hawassa Research Center of Southern Agricultural Research Institute. The collected leaves were chopped and spread on a plastic sheet and sun-dried for two and half days to reduce the hydrocyanic acid content. During the process of drying, leaves were turned regularly to prevent uneven drying and possible decay of the leaves. The dried leaves were then milled using hammer mill to produce cassava leaf meal (CLM). The feed was prepared fresh and stored in a way to avoid any contamination. Finally, the cassava leaf meal was mixed with other feed ingredients to prepare the experimental diet.

Experimental Design

Two hundred forty day-old broiler chicks were divided in to five treatment groups consisting of 48 birds per group. Each treatment group was further replicated 4 times with 12 birds per replicate in a completely randomized design. Based on the result of the chemical analysis, five treatment diets were formulated to contain cassava leaf meal at 0% (T1), 2% (T2), 4% (T3), 6% (T4) and 8% (T5) by replacing the Noug seed cake in the control diet.

Management of the Experimental Chickens

Three hundred fifty day old unsexed ROSS 308 broiler chicks were bought from Debre Zeit Agricultural Research Center (Ethiopia). All chicks were reared under the brooder house for two weeks at the experimental site during which they were provided with starter ration. At the end of the brooding period, two hundred forty chickens were individually weighed on a digital sensitive balance and blocked into three categories according to their body weight to avoid carryover effects in the later experiment. Each chick from each block was then randomly assigned to each treatment diet to have uniform body weight distributions across treatments.

Each pen had a dimension of 3 x 4 m, which was designed to accommodate 12 chickens along with feeders and drinkers. Chicks were reared in a deep litter housing system with concrete floors, which was covered with wood shavings at a depth of 5 cm. Experimental pens, watering and feeding troughs were cleaned and disinfected with appropriate disinfectants. Chicks were vaccinated against Newcastle and Infectious Bursal Diseases (Gumboro). The vaccines were obtained from National Veterinary Institute (Debre Zeit, Ethiopia). Moreover, anti coccidiostat and oxytetracycline was given with drinking water. Mortality and any abnormality were recorded throughout the entire experimental period. The experimental period lasted 42 days exclusive of the brooding period.

Formulating the Starter and Finisher Diets

As shown in Tables 1 and 2, both the starter and finisher diets were composed of maize, soybean seed, wheat bran, Noug seed (*Guizotia abyssinica*) cake, CLM, limestone, bone and meat meal and salt. All ingredients (except the limestone and CLM) were purchased from local market. Wheat bran was purchased from the Hawassa Flour Mill Factory. The soybean seed was roasted for 5 minutes until the beans were brown to deactivate trypsin inhibitor (Negesse and Tera, 2010) and milled in sieve size of 5 mm separately. All other feed ingredients were also milled with similar sieve size and mixed at the feed processing plant located at the College of Agriculture.

Table1. *Proportion of feed ingredients used in the formulation of the starter diet*

Feed ingredients	**Mixture %**
Maize	51.5
Soybean	31.5
Wheat bran	7
Noug seed cake	8
Limestone	2
Salt	0.5
Total	100 kg
Nutrient requirement for the broilers (%)	Supplied by the ration
Crude protein 19-20%	19%
Crude fiber 4-5%	5.6%
ME (kcal/g) 2900-3000	2913

ME = metabolizable energy; limestone contains about 35% of Ca

Table2. *Proportion of feed ingredients used in the formulation of the grower diet*

Feed ingredients	T1	T2	T3	T4	T5
Maize	50.5	50.5	50.5	50.5	50.5
Soybean	33.5	33.5	33.5	33.5	33.5
Noug cake	8	6	4	2	0
Wheat bran	3	3	3	3	3
Cassava leaf meal	0	2	4	6	8
Limestone	2	2	2	2	2
Meat and bone meal	2.5	2.5	2.5	2.5	2.5
Salt	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100

Supplied by the ration (%)					
Crude protein	20.5	20.5	20.6	20.6	20.6
Ether extract	4.12	4.22	4.33	4.43	4.54
Crude fiber	6.28	6.11	5.94	5.77	5.6
Calcium	1.02	1.04	1.06	1.07	1.09
Phosphorous	0.59	0.58	0.57	0.56	0.56
ME (Kcal	2954	2967	2980	2993	3006

ME = metabolizable energy

Data Collection Procedures

Feed Intake and Body Weight

During the experimental period, chickens were fed on replicate basis *ad libitum* and each day a measured amount of feed was offered between 08.00 and 16.00 hours. The leftover feed was always collected in the next morning before feed is offered and weighed. The amount of feed was increased keeping in mind that at the end at least 10% refusal is left. Feed intake was then determined by subtracting the leftover from the offered feed. Body weight was taken at the beginning of the experiment (considered as initial weight) and then on weekly basis between 7:00 and 8:00 am before feeding. The body weight taken at the end of the experiment was considered as final body weight. Total body weight gain was then computed by subtracting the initial body weight from the final. Feed conversion ratio (FCR) was calculated by dividing the total feed intake by total weight gain.

Carcass components

At the end of the experimental period, two chickens (1 male and 1 female) per replicate (in total of 40 chickens) were picked and kept in a separate pen without feed. After overnight fasting, each bird was weighed (considered as pre-slaughter weight) and manually eviscerated. The dressed carcass weight was taken after defeathering and removal of feet, head and the viscera while the skin is included. The dressed carcass, breast, thighs and drumsticks were weighed inclusive of bones. The wings were removed by a cut through the shoulder joint at the proximal end of humerus. The breast portion was obtained as described by Hudspeth *et al.* (1973). The thigh and drumstick portions were obtained by cutting through the joint between the femur and ilium bone of the pelvic girdle. The drumstick was separated from the thigh by a cut through the joint formed by the femur, fibula and tibia. The dressing percentage was calculated from dressed carcass weight as a percentage of the pre-slaughter weight. The carcass analysis in this study included only those edible components of the carcass as the chicks used in this experiments are the commercial broilers.

Chemical Analysis of Experimental Feeds

Cassava leaf meal and feeds offered were analyzed for dry matter (DM), crude fat (EE), crude fiber (CF) and total mineral (ash) by proximate analysis procedures of AOAC (1995). Total nitrogen content of the feed was determined by using micro-Kjeldahl method and the crude protein (CP) was then calculated as nitrogen (N) × 6.25. All samples were analyzed in duplicates at Animal Nutrition Laboratory of Hawassa University. The metabolizable energy (ME) of diets was estimated according to the equation proposed by Wiseman (1987). Nitrogen free extract (NFE) was calculated by difference of organic matter and the sum of CF, EE and CP.

Statistical Analysis

Data obtained on feed intake, body weight, weight gain, and feed conversion ratio were subjected to one-way ANOVA by fitting treatment diet effect as independent variable. Data on carcass components were subjected to two-way ANOVA by fitting the effects of treatment diets and sex as fixed factors. All data were analyzed using the General Linear Model (GLM) Procedures of SAS ver. 9.4 (SAS, 2012). Means were then separated using Duncan's multiple range tests. Treatment differences were considered significant at the $P<0.05$ level unless noted otherwise. The following statistical models were used to analyze the data:

ANOVA Model 1 (Feed Intake, Body Weight, Weight Gain and FCR)

$Yij = \mu + Ti + eij$, where:

Yij = the observed j variable in the i^{th} treatment

μ = overall mean of the response variable

Ti = the effect due to the i^{th} cassava leaf meal level (i = 1, 2, 3, 4, 5)

eij = random residual error

ANOVA Model 2 (Carcass Components)

$Yijk = \mu + Ti + Sj + Ti*Sj + eijk$, where:

$Yijk$ = the observed k variable in the i^{th} treatment and j^{th} sex

μ = overall mean of the observed variable

Ti = effect due to i^{th} treatment levels (i = 1, 2, 3, 4, 5)

Sj = effect due to j^{th} sex of chickens (j = male and female)

$Ti*Sj$ = effect due to the interaction between i^{th} treatment and j^{th} sex

$eijk$ = random residual error

RESULTS

Nutrient Contents of Cassava Leaf and Treatment Diets

The analyzed chemical composition and calculated ME value of CLM and experimental diets are indicated in Tables 3 and 4, respectively. Accordingly, the CP and ash contents of cassava leaf are found to be relatively high. The EE and CF contents of cassava leaf are appeared to be high. The calculated ME value of CLM is also relatively high.

Table3. *Chemical composition of cassava leaf*

Nutrients	Composition (% DM)
Analyzed	
Dry matter	92.5
Ash	12.3
Crude protein	25.6
Crude fiber	12.5
Crude fat	11.0
Calculated	
Nitrogen free extract	31.1
Metabolizable energy (kcal/kg DM)	2857

As shown in the Table 4, the CP contents of the experimental diets were similar although it was slightly higher in the control diet. The crude fiber content is comparable across all treatment diets being slightly higher in T1 and T2. The ash content varied across treatment diets being higher in T5 but lower in T4. The calculated values of ME and NFE were similar across all treatment diets even though slightly lower in treatment five.

Table4. *Nutrient and energy contents of experimental diets (on % DM basis)*

Nutrients	T1	T2	T3	T4	T5
Analyzed					
Dry matter	94.5	94.5	94	93	92.5
Ash	14.6	14.6	14.5	13.6	17.2
Crude protein	22	21.9	22	21.7	21.7
Crude fat	12.7	12.5	12.6	10.5	10.6
Crude fiber	5.5	5.3	4.8	4.85	4.45
Calculated					
NFE	39.7	40.3	40.1	42.25	38.2
ME (Kcal/kg DM)	3093	3102	3099	3100	2956

NFE = nitrogen free extract; ME = metabolizable energy

Table5. *Average values of initial and final body weights, weight gain, feed intake and feed conversion ratio of Ross 308 chicken fed different levels of cassava leaf meal*

Parameters	T1	T2	T3	T4	T5	SEM	P-value
Initial weight (g/chick)	207	203	201	202	206	33.0	0.265
Final weight (g/chick)	1238^a	1233^a	1231^a	1190^b	1155^c	48.9	0.003
Total gain (g/chick)	1031^a	1030^a	1030^a	988^b	948^c	58.3	0.007
Weight gain (g/chick/d)	24.5^a	24.5^a	24.5^a	23.5^b	22.6^c	1.21	0.002
Feed intake (g/chick/d)	80.9^a	80.4^a	80.9^a	77.0^b	74.0^b	1.87	0.035
FCR (g feed/g gain)	3.30	3.28	3.30	3.28	3.27	0.09	0.472

$^{a-c}$ Means with different superscript letters in the same row are significantly different ($p<0.05$) FCR = feed conversion ratio; SEM = standard error of the mean

Feed Intake, Body Weight and Feed Conversion Ratio

As presented in Table 5, there were no significant differences in initial body weight of chickens among the treatment diets. However, the final body weight and total body weight gain was higher ($p<0.05$) among the chickens fed with T1, T2 and T3 diets than those of T4 and T5.

The average daily weight gain per hen also followed similar trend. The daily feed intake was higher ($p<0.05$) in chickens fed on T1, T2 and T3 diets than those of T4 and T5. Although not significant, chickens reared in T1, T2 and T3 had the numerically higher FCR value than those of T5 and T4.

Carcass Components

As presented in Table 6, male chickens had significantly higher carcass component weights than females. The pre-slaughter weight was significantly higher in chickens fed with T1 diets than those reared in other treatments. Chickens reared in T4 and T5 had the lowest values. Chickens reared in T1 had higher ($p<0.05$) dressed carcass weight than those of other treatments. Chickens fed with T3 had higher ($p<0.05$) dressed carcass weight than those of T4 and T5 while chickens reared in T2 had intermediate value. The values for dressing percentage, and drumsticks were higher ($p<0.05$) in chickens reared in T1 and T2 diets than those fed of T4 and T5. Chickens fed on T1, T2 and T3 had higher ($p<0.05$) values for thighs and wings as compared with those reared in other treatments. The gizzard weight was higher ($p<0.05$) in chickens reared in T1 and T2 than those fed on T4 and T5 diets. The interaction effects of sex by treatment was significant for breast, drumstick, back, gizzard and skin (Table 6).

Table6. *Least square means (g) of main carcass components as affected by treatment diets, sex and their interactions*

Carcass Components	Sex		Treatment diets					ANOVA		
	Male	Female	T1	T2	T3	T4	T5	Sex	Treatment (Trt)	Sex x Trt
Pre-slaughter weight	1212^{a}	1192^{b}	1256^{a}	1199^{b}	1201^{b}	1177^{c}	1178^{c}	<0.0001	<0.0001	NS
Dressed carcass	797^{a}	747^{b}	836^{a}	788^{b}	779^{b}	707^{d}	749^{c}	<0.0001	<0.0001	NS
Dressing percentage	65.7^{a}	62.6^{b}	66.5^{a}	65^{b}	66^{b}	60^{c}	64^{b}	0.0002	<0.0001	NS
Breast	271^{a}	240^{b}	257^{ab}	249^{b}	266^{a}	249^{b}	267^{a}	<0.0001	0.0002	***
Thigh	113^{a}	96^{b}	120^{a}	104^{a}	104^{a}	96.1^{b}	97.2^{b}	<0.0001	<0.0001	NS
Drumstick	111^{a}	98.4^{b}	118^{a}	110^{b}	106^{b}	93^{c}	97^{b}	<0.0001	<0.0001	**
Back	122^{a}	109^{b}	132^{a}	117^{b}	116^{c}	102^{d}	110^{c}	<0.0001	<0.0001	***
Wing	61.8^{a}	52.5^{b}	62^{a}	61^{a}	60^{a}	53^{b}	49^{b}	<0.0001	<0.0001	NS
Neck	51.3^{a}	38^{b}	44^{bc}	48^{a}	47^{ab}	44^{bc}	41c	<0.0001	0.0038	NS
Gizzard	42.3^{a}	34^{b}	42^{a}	40^{a}	39^{ab}	32^{c}	36^{b}	<0.0001	<0.0001	***
Skin	55.8^{a}	45^{b}	60^{a}	51^{b}	50^{b}	42^{d}	47^{c}	<0.0001	<0.0001	**

^{a,b} *Means with different superscript letters within the same row are significantly different ($p<0.05$); NS = not significant;*

Discussion

Nutrient Compositions of Cassava Leaf and Experimental Diets

The results of this study indicated that cassava leaf is relatively rich in protein (25.6%), which is in good agreement with those findings reported by Melesse *et al.* (unpublished data). Ravindran *et al.* (1986) reported 21.0% of CP, which is slightly lower than found in the current study. On the other hand, Phuc *et al.* (2000) and Régnier *et al.* (2013) reported higher CP levels ranging from 30.0 to 34.7 %. This high variability might be explained by differences in the plant varieties within each species, the collected fractions (leaves vs. leaves + stems), agricultural practices (time and method of planting, fertilization, age of harvesting), sampling procedure and environmental factors (climate, soil). According to the reports of Ravindran and Ravindran (1988), the CP content decreased from 38% in very young leaves to 19.7% in mature leaves. A lack of repeatability of analytical methods, especially for the dietary fibre fractions, may also explain these differences. Earlier studies have reported that almost 85% of CP fraction in cassava leaf is true protein (Eggum, 1970).

In the present study, the petioles were excluded and this may have been the reason for the higher CP content of the cassava leaf. The ash content of the cassava leaf is relatively high which might be due to the plentiful amount of calcium in it (Aletor and Adeogun, 1995; Melesse *et al.*, unpublished data). In addition, Gómez (1985) reported similar data in terms of the amount of calcium in cassava leaves. Since high Ca to P ratio (1-2:1) is desirable for poultry as compared to other livestock (Phillips, 1990), cassava leaf could be an alternative feed ingredient of mineral source in the poultry ration.

Since protein and Ca are important nutrients for growth of chickens and calcium is necessary for the normal development of skeletal system, the high protein and calcium levels in cassava leaf make it potentially good alternative feed to substitute the conventional feeds like Noug cake, which contain high amount of the crude fiber in the diets of broilers.

The nutrient compositions and calculated NFE and ME contents of all the treatment diets were comparable. Moreover, the calculated and analyzed content of all treatment diets for CP were comparable and are within the recommended levels of broiler chickens (Scanes and Ensminger, 2004). The T1 and T2 diets had higher CF content than the rest of other diets. This is due to the high levels of CF present in Noug seed cake. Recent studies conducted by Melesse *et al.* (unpublished data) indicated 24.5% of CF level in Noug seed cake, which is considerably higher than that of cassava leaf (12.5%).

Feed Intake, Body Weight and Feed Conversion Ratio

One of the most important factors that play essential roles on the performance of animal is the voluntary feed intake. The study indicates that inclusion of cassava leaf meal significantly affected the feed intake of the chickens being lower in chickens reared in the T4 and T5 diets with high level of cassava leaf inclusion. Thus, beyond that limit the inclusion of the cassava leaf might have a negative effect on feed intake and there by depressing growth performance of the broilers. This could be explained by the unpalatable taste and the dustiness of the cassava leaf meal, which might have inhibited the birds from consuming adequate quantities. Birds are known to consume more when diets are acceptable and coarse than when they are finely ground (Melesse *et al.*, 2013). However, new study is still required to come up with the appropriate inclusion levels of cassava leaf to dual purpose and layer breeds of chickens. The feed conversion ratio was similar across all treatment diets indicating that cassava leaf meal might be used to partially substitute Noug seed cake in broiler rations.

Body growth is determined by deposition of protein, fat and water in the animal's body. The deposition and percentage of these elements individually in each part of the body determine physiological age and stage of maturity of the birds. Chickens fed with T4 and T5 diets showed depressed performance compared with those fed on other treatment diets and are in good agreement with the results of Olugbemi *et al.* (2010) and Melesse *et al.* (2013) who reported a depressed growth in birds fed *M. oleifera* and *M. stenopetala* leaf meals at higher levels without affecting the feed intake. This might be attributed to the effects of nutrient imbalance and poor metabolism in monogastric animals fed with high levels of unconventional feed ingredients (Esonu *et al.*, 2006; Iheukwumere *et al.*, 2008). This nutrient imbalance in cassava leaf could probably occur due to the presence of various anti-nutritional factors like tannins and phenols (Régnier *et al.*, 2013; Melesse *et al.* unpublished data), which might impair the bioavailability of the nutrients like energy and protein. The concentration of anti-nutritional factors such as cyanide content can be affected by the maturity stage of leaf materials. Ravindran and Ravindran (1988) reported a reduction of the glucoside concentration in cassava leaves with increased age of the plant.

The observed lower body weight gain with increasing levels of cassava leaf (T4 and T5) might be further associated with lower feed intake at higher level of cassava leaf inclusion and possibly due to the deficiency of certain amino acid particularly those sulfur-containing amino acids (Ravindran and Ravindran,1988; Ravindran, 1991). Moreover, the presence of HCN might have affected the normal growth of broiler chickens. The HCN content is normally between 200 and 800 mg/kg DM in fresh cassava leaves (Ravindran, 1991). Sun-drying the leaves to produce cassava hay will result in a reduction in HCN (Ravindran, 1991). D'Mello *et al.* (1987) reported that a diet containing more than 6% leaf meal of leucocephala significantly depressed the body weight gain of birds.

Carcass Components

Among the treatments the chickens reared on the treatment one (T1) showed better pre-slaughter weight than the rest of the treatments. The depressed weights of the carcass components observed in T4 and T5 might be explained by the reduced feed intake of birds, which is in good agreement with the reports of Esonu *et al.* (2002) and Nwoche *et al.* (2006).

In the present study, non significant interactions between sex and the treatment diets were observed for pre-slaughter weight, dressed carcass weight, dressing percentages, thigh, wing and neck indicating that the experimental ration had similar effect on both sexes. These findings are in good agreement with those of Lopez *et al.* (2011) and Melesse *et al.* (2013) for broiler and Koekoek chickens, respectively. On the other hand, significant interactions between sex of the chickens and the treatment diets were observed for breast, drumstick, back and gizzard indicating that male birds responded better than females to diets containing various levels of cassava leaf.

In the present study, male birds had higher weights of dressed carcass, thighs and drumsticks than females and are consistent with the results of Negesse and Tera (2010) for Rhode Island Red chickens, Melesse *et al.* (2013) for Koekoek chickens and Nikolova and Pavlovski (2009) for commercial broiler chickens. The higher values in carcass traits observed in male chickens might be attributed to the presence of sex hormones (androgen) that enhanced muscle development more than the sex hormone (estrogen) in females which is mostly responsible for fat deposition rather than muscle tissue development (Scanes, 2003). The gizzard weight of the chickens decreased with increasing levels of the cassava leaf. Ayssiwede *et al.* (2011) reported that the increase in gizzard size is related to the volume of feed, increased time spent grinding the feed and increased frequency of gizzard contraction.

CONCLUSION

The substitution of Noug seed cake with cassava leaf meal has resulted in improvement of final body weight gain, total body weight gain and daily body weight gain among the broilers fed with the T3 diet (4% substitution levels). However, there was a detrimental effect on the feed intake and growth of the chickens at higher substitution levels (T4 and T5 diet). It is recommended that small-scale poultry producers can use sun-dried cassava leaves as a good protein substitute to the expensive Noug seed cake in the broiler diet.

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CONFLICT OF INTERESTS

There is no conflict of interests among the authors.

REFERENCES

[1] Adewusi S.R.A. and Bradbury J.H. (1993). Carotenoid in cassava: Comparison of open-column and HPLC methods of analysis. Journal of the Science of Food and Agriculture. 62, 375-383.

[2] Aletor V.A. and Adeogun O.A. (1995). Nutrients and anti-nutrient components of some tropical leafy vegetables. Food Chemistry. 53 (4), 375-379.

[3] AOAC. 1995. Official Method of Analysis, 6^{th} ed., Association of Official Analytical Chemists, Washington DC.

[4] Ayssiwede S.B., Dieng A., Bello, H., Chrysostome C.A.A.M., Hane M.B., Mankor A., *et al.* (2011). Effects of *Moringa oleifera* (Lam) leaves meal incorporation in diets on growth performances, carcass characteristics and economics results of growing indigenous Senegal chickens. Pakistan Journal of Nutrition. 10 (12), 1132-1145.

[5] D'Mello J.P.E., Acamovic T. and Walker A.G. (1987). Evaluation of Leucena leaf meal for broiler growth and pigmentation. Tropical Agriculture (Trinidad). 64, 33-35.

[6] Eggum O.L. (1970). The protein quality of cassava leaves. British Journal of Nutrition. 24, 761-769.

[7] Esonu B.O., Iheukwumere F.C., Emenalom O.O., Uchegbu M.C. and Etuk E.B. (2002). Performance, nutrient utilization, and organ characteristics of broilers Livestock Research for Rural Development. Volume 14, Article #52. Retrieved April 20, 2018, from http://www.lrrd.org/lrrd14/6/eson146.htm.

[8] Esonu B.O., Opara M.N., Okoli I.C., Obikaonu H.O., Udedibie C. and Iheshiulor O.O.M. (2006). Physiological response of laying birds to Neem (*Azadrachita indica*) leaf meal-based diets: Body weight, organ characteristics and hematology. The Online Journal of Health and Allied Sciences. 2, 4. (http://www.ojhas.org./isssue18/2006-2-4.htm).

[9] Gómez G. and Valdivieso M. (1985). Cassava foliage: chemical composition, cyanide content and effect of drying on cyanide elimination. Journal of the Science of Food and Agriculture. 36 (6), 433-441.

[10] Hudspeth J.P., Lyon C.E., Lyon B.G. and Mercuri A.J. (1973). Weights of broiler parts as related to

carcass weights and type of cut. Journal of Food Science. 38, 145-150.

[11] Iheukwumere F.C., Ndubuisi E.C., Mazi E.A. and Onyekwere M.U. (2008). Performance, nutrient utilization and organ characteristics of broiler fed cassava leaf meal (*Manihot escutulata* C.). Pakistan Journal of Nutrition. 7, 13-16.

[12] Khajarern S. and Khajarern J.M. (1991). Use of cassava products in poultry feeding. In: Edts.: Machin D.and Nyvold S., Roots, tubers, plantains and bananas in animal feeding. Proceedings of the FAO Expert Consultation held in CIAT, Cali, Colombia, 21-25 January.

[13] Khieu B., Chhay T., Ogle R.B. and Preston T.R. (2005) Research on the use of cassava leaves for livestock feeding in Cambodia. In: Proceeding of The Use of Cassava Roots and Leaves for On-Farm Animal Feeding, Hue, Vietnam; 20; pp. 17-19.

[14] Lopez K.P., Schilling M.W. and Corzo A. (2011). Broiler genetic strain and sex effects on meat characteristics. Poultry Science. 90, 1105-1111.

[15] Melesse A., Tiruneh W. and Negesse T. (2011). Effects of feeding *Moringa stenopetala* leaf meal on nutrient intake and growth performance of Rhode Island Red chicks under tropical climate. Tropical Subtropical Agroecosystems. 14, 485-492.

[16] Melesse A. Getye, Y. and Berihun K. (2013). Effect of feeding different levels of *Moringa stenopetala* leaf meal on growth performance, carcass traits and some serum biochemical parameters of koekoek chickens. Livestock Science. 157, 498-505.

[17] Melesse A., Steingass H., Schollenberger M., Holstein J. and Rodehutscord M. (2017). Nutrient compositions and *in vitro* methane production profiles of leaves and whole pods of twelve tropical multipurpose tree species cultivated in Ethiopia. Agroforestry Systems. 71 (3), DOI: 10.1007/s10457-017-0110-9.

[18] Nikolova N. and Pavlovski Z. (2009). Major carcass parts of broiler chicken from different genotype, sex, age and nutrition system. Biotechnology in Animal Husbandry. 25, 1045-1054.

[19] Nwoche G.N., Ndubuisi E.C. and Iheukwumere F.C. (2006). Performance of finisher broilers and cost implication of feeding palm oil as energy supplement. Nigeria Agricultural Journal. 37, 44-49.

[20] Olugbemi T.S., Mutayoba S.K. and Lekule F.P. (2010). Effect of Moringa (*Moringa oleifera*) inclusion in cassava based diet fed to broiler chickens. International Journal of Poultry Science. 9(4), 363-367.

[21] Phillips J. (1990). Types and roles of feedstuffs. In: M.E. Ensminger (edit.). Feeds and Nutrition. Clovis California, 2nd edition. pp. 250-264.

[22] Phuc B.H.N and Lindberg J.E. (2000). Ileal and total tract digestibility in growing pigs fed cassava root meal diets with inclusion of cassava leaves, leucaena leaves, and groundnut foliage. Animal Science. 71, 301-308.

[23] Phuc B.H.N., Ogle B. and Lindberg J.E. (2000). Effect of replacing soybean protein with cassava leaf meal in cassava root meal based diets for growing pigs on digestibility and N retention. Animal Feed Science and Technology. 83, 223-235.

[24] Ravindran V., Kornegay E.T., Rajaguru A.S.B., Potter L.M. and Cherry J.A. (1986). Cassava leaf meal as a replacement for coconut oil meal in broiler diets. Poultry Science. 65, 1720-1727.

[25] Ravindran G. and Ravindran V. (1988). Changes in the nutritional composition of cassava (*Manihot esculenta* C.) leaves during maturity. Food Chemistry. 27, 299-309.

[26] Ravindran V. (1991). Preparation of cassava leaf products and their use as animal feeds. In Edts.: Machin D.and Nyvold S., Roots, tubers, plantains and bananas in animal feeding, Proceedings of the FAO Expert Consultation held in CIAT, Cali, Colombia, 21-25 January.

[27] Ravindran V. (1993). Cassava leaves as animal feed: Potential and limitations. Journal of the Science of Food and Agriculture. 61: 141-150.

[28] Régnier C., Bocage B., Archimede H., Noblet J. and Renaudeau D. (2013). Digestive utilization of tropical foliages of cassava, sweet potatoes, wild cocoyam and erythrina in Creole growing pigs. Animal Feed Science and Technology. 180, 44-54.

[29] Scanes C.G. (2003). Growth performance enhancement. In: Scanes, C.G. (Ed.), Biology of Domestic Animals, Wiley-Blackwell, Iowa.

[30] Scanes C.G. and Ensminger, M.E. (2004). Poultry Science. Pearson education, Inc., Upper Saddopler, NJ. pp. 242-245.

[31] Negesse T. and Tera A. (2010). Effects of feeding different levels of cooked and sun dried fish offal on carcass trait of growing Rhode Island Red chicks. Tropical Animal Health and Production 42, 45-54.

[32] Wiseman J. (1987). Feeding of non-ruminant livestock. Butterworth and Co. Ltd., pp. 9-15.