THE EFFECT OF PARTIAL SUBSTITUTION OF NOUG SEED CAKE WITH CASSAVA (*Manihot escutulata C*.) LEAF MEAL ON FEED INTAKE, GROWTH PERFORMANCE AND CARCASS TRAITS OF ROSS 308 BROILER CHICKENS

MSc THESIS

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APPROVAL SHEET-I

This is to certify that the thesis entitled **" Effect of partial substitution of Noug seed cake with cassava (Manihot Escutulata Crantz) leaf meal on feed intake, growth performance and carcass characteristics of broiler chickens"**, submitted in partial fulfillment of the requirements for the degree of **Master's** with specialization in Animal production, to the Graduate Program of the School of **Animal and Range Sciences, Hawassa University College of Agriculture,** has been carried out by Mengistu Masebo**,** under our supervision. Therefore, we recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the school.

Aberra Melesse (Prof.)	__________________	______________
Name of major advisor	Signature	Date

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DEDICATION

I dedicate this thesis manuscript to my mother Tadelech Wolde for her strong prayer, endless love and moral support and to my father Masebo Lambebo for his holistic support during the study at Hawassa University of college of agriculture.

STATEMENT OF THE AUTHOR

I declare that the thesis hereby submitted for the MSc degree at the Hawassa University College of Agriculture is my own work and has not been previously submitted at any other university or institution for any degree or diploma. I concede copyright of the thesis in favor of the Hawassa University, College of Agriculture.

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Signature___________________________

Place: Hawassa University, Hawassa

Date of Submission___________________

LIST OF ACRONYMS (ABBREVIATIONS)

ANOVA	Analysis of Variance
AOAC	Association of Official Analytical Chemists
CF	Crude Fiber
CLM	Cassava Leaf Meal
CP	Crude Protein
DBWG	Daily Body Weight Gain
DM	Dry Matter
DMI	Dry Matter intake
EE	Ether Extract
FAO	Food and Agricultural Organization
FBW	Final Body Weight
FCR	Feed Conversion Ratio
FI	Feed Intake
HCN	Hydro cyanic acid
Kcal	Kilo calorie
ME	Metabolizable Energy
MJ	Mega Joule
NFE	Nitrogen Free Extract
P	Probability
SEM	Standard Error of Mean
WBWG	Weekly Body Weight Gain

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Abstract

The effect of dietary inclusion of cassava leaf meal (CLM) on feed intake, growth performance and carcass characteristics of growing Ross 308 chickens was investigated at the poultry farm of the School of Animal and Range Sciences, Hawassa University. The leaves were collected from Hawassa Research center and were sundried and ground to make leaf meal. 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, which was incorporated in the diet as partial substitution of Noug seed cake. After two weeks of brooding, 240 unsexed broiler chicks were weighed and randomly allocated to the dietary treatments with four replicates of 12 chickens each totaling 48 chickens per treatment. 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) chick per replicate of each treatment whose body weight was nearly similar to those of average of 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, respectively being significantly higher for those of T1, T2 and T3 than T4 and T5. The crude fiber intake was ($p<0.05$) higher for those chickens reared in T1 and T2 diets. Chickens reared in T1, T2 and T3 diets had significantly higher 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. The body weight and weight gain parameters were significantly higher for those chickens reared in T4 than those of T5. There was no significance difference in feed conversion ratio between treatment diets. Chickens reared in T1 had significantly higher ($p< 0.0001$) slaughter weight and dressed carcass than those of other treatments. The values for dressing percentage, and drumsticks were ($p< 0.0001$) higher in chickens reared in T1 and T2 diets than those fed of T4 and T5. Chickens fed on T1, T2 and T3 had significantly higher values for thigh and wing as compared with those reared in other treatments. The interaction effects of sex by treatment was significant for breast, drumstick, back, gizzard and skin while it was insignificant for other carcass components. Male chickens had significantly higher carcass component values than females. The results of the current study revealed that the inclusion of cassava leaf meal up to 4% in broiler diet could be an alternative feeding strategy by partially substituting Noug seed cake.

Key words*: Cassava leaf, broiler chickens, feed intake, growth performance, carcass components*

1. INTRODUCTION

1.1. Background

The term “poultry” includes avian species like fowl, turkey, duck, goose, ostrich, guinea fowl, etc. which render not only economic service but contribute significantly to the human food as primarily supplier of meat, egg, raw material to industries (feathers, waste products), source of income and employment to people compared to other domestic animals (Avila,1985; Demeke, 2004).

Poultry convert feed into food products quickly, efficiently, and with relatively low environmental impact compared with other livestock. The high rate of productivity of poultry results in relatively high nutrient needs. Poultry require the presence of at least 38 dietary nutrients in appropriate concentrations and balance.

Poultry plays a crucial role in nutritional, economic and socio-cultural livelihood of rural households in many developing countries, including Ethiopia. Many scholars agreed that developing the poultry industry in the developing nations can be the better ways of reducing the observable gap in protein deficiency (Amos, 2006; Aberra, 2014). Studies by Van Eekeren (2006) indicated that people rear chickens under broadly varying circumstances, while their main objective is generally the same: maximum production from minimum cost and risk.

In Ethiopia, chicken are reared by almost every family in the countryside and the total chicken population in the country is estimated to be around 60 million (CSA, 2015/16). However, technical, organizational and institutional constraints make the economic contribution of the sector far below the expectations (Fisseha et al., 2010). The major constraints amounting to the poor performance of this important sector are inadequate supply and poor quality of poultry feeds (Nigussie and Alemu, 2005).

Among the feed constituents of livestock sector including poultry is the price of protein feed supplement that are the costliest of all. Studies by Aberra et al., (2011) indicated that the productivity of poultry sector in tropics has been grossly limited by the scarcity and consequent high price of the conventional protein and energy sources.

Noug seed cake has been widely used as protein source for livestock (and poultry being no exception). The price of this source have been escalading over times, which tells that the price of conventional source of feed are increasing beyond the reach of small scale farmers in recent times. This problem has been further widened due to the increasing competition between human and livestock.

If we are to save the poultry industries from total collapse is to provide food especially animal protein for the ever increasing human population, there is urgent need to look critically for other locally available sources of protein and energy, particularly those that attract no competition in consumption between man and livestock.

A good protein source is the leaf meal of some tropical legume plants. 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 (Opara, 1996; D'Mello et al., 1987).

Its efficient production of food energy, year-round availability, tolerance to extreme stress condition and suitability to present farming condition and food system in developing country including Ethiopia have contributed in choice of cassava as a potent source of extracting leaf protein for the purpose of replacing other protein sources of animal origin that are very expensive and thus economically unviable (Aletor and Adeogun, 1995). Apart from the highly balanced amino acid profile, cassava leaf protein has also been shown to contain a high level of crude protein, vitamin and nutritionally valuable minerals (Phuc et al., 2000).

1.2. Statement of problem and justifications

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 70-85% of the total production cost (Opara, 1996). 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 (Esonu et al., 2001). There is a need therefore to look 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 meal of some tropical legume and plants.

Both Noug seed cake and Cassava leaves contain similar levels of crude protein (approx. 28%) on dry matter basis but differ in their crude fiber content considerably. Noug seed cake is considered in Ethiopia 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, particularly in the broiler diet.

1.3. Objectives

The objective of the present experiment is to assess the effects of dried cassava leaf meal supplementation on feed intake, growth performances and carcass traits of broiler chickens by partially replacing the Noug seed cake of the control diet.

2. REVIEW OF LITERATURE

2.1. Description of Cassava

M. esculenta Crantz (also known as cassava, *manioc*, *tapioca*, Brazilian *arrowroot or yucca*) originated from tropical America and was first introduced to the Congo basin, Africa, by the Portuguese around 1558 (Akoroda and Ikpi, 1992). It is herbaceous shrub, 2–4 m tall, with palmate 3–7 lobed leaves. Cassava is extensively cultivated as an annual crop in tropical and subtropical regions for its edible underground tuberous root, recognized as one of the highest yielders of starch and the third largest source of food carbohydrates in the tropics, following rice and maize. Cassava is a major staple food in the developing world, providing a basic diet for over 800 million people (Lebot, 2009; Ecocrop, 2011), important as a drought tolerant crop capable of growing on marginal soils. Over the past 5 years (2008–2012 inclusive), cassava production on the African continent (~54% of global production) as a whole has been growing at a faster rate (~4%) compared with other major regions (worldwide average growth rate, +1.2%). African cassava production surpassed 145 million tons in 2011, approximately 57% of the global crop that year (256 million tone; FAO, 2013).

2.1. 1. Cassava and Its Product in Poultry Feeding

Cassava is traditionally grown for the production of roots. It yields about 10 – 30 t ha-1 of leaves that is usually wasted or used as manure (Bokanga, 1994). However, the leaves have become increasingly important as a source of protein for monogastric (Wanapat, 2002). Cassava leaves are rich in protein (Gomez and valvieso., 1985). Cassava leaf meal (CLM) is expected to give a good protein concentrates with a good balance of amino acids.

2.2. Nutritional Aspects of Cassava Leaf For Poultry

Cassava (*Manihot escutulanta* Crantz) foliage can be fed fresh, after drying it (cassava leaf meal) or ensile it as the leaves contain hydrogen cyanide that can be toxic to livestock. The high fiber content of cassava leaves makes them unsuitable for poultry if fed at high levels. However, their high protein and availability as a by-product make them valuable (Phengvilaysouk et al., 2008).

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 (Aberra 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; Aberra et al., unpublished data). Most of essential amino acids are also available in considerable amounts (Aberra et al.; unpublished data). Moreover, it contains 8.5 MJ/kg DM metabolizable energy and negligible amounts total phenols and soluble condensed tannins (= brownish or yellowish chemical compound which found in the plants). (Less than 4.5 % and 2.3%, respectively) as well as below 16% crude fiber(Aberra et al., unpublished data). The concentration of tannin levels is well below those toxic to animals. This makes the cassava leaves as alternative suitable feed resources for feeding monogastric animals such as chickens.

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, 2007). 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, 2007). 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, several studies have demonstrated that it is possible to produce cassava leaf with low cyanide levels (Gomez and Valdivieso, 1985).

Simple sun-drying alone eliminates almost 90% of the initial cyanide content from leaf. When combined with chopping and wilting, cyanide in the dried meal was reduced to levels which are safer for monogastric animals (Ravindran et al., 1987). Moreover, results from Enriquez and Ross (1972) indicated that supplementation of methionine at 0.15 to 0.20% of diets could help overcome the HCN toxicity and restore chick performances to normal levels.

2.3. Potential and Limitations of Cassava Leaves As Poultry Feed

The nutritional limitations of cassava leave include the HCN content, low digestible energy, bulkiness and possibly the high tannin content. The cyanogenetic glycosides, which on hydrolysis yield toxic HCN, may limit its use as a monogastric animal feed. However, the HCN concentration and the bitterness associated with high cyanogenetic glycoside contents in leaves (Sundaresan et al., 1987) decreases with the maturity of the leaves.

Ravindran et al. (1987) reported that HCN contents of cassava leaf blades in the stage of the expanding (1-4 leaves), fully expanded (5-7 leaves) and mature (8-11 leaves) were 3,161, 1,962 and 774 mg kg-1 DM respectively. However, the HCN content was also found to be reduced after fertilization with N, P and K (Cadavid et al., 1998). Gómez (1991) suggested that 100 mg HCN kg-1 feed on dry matter basis, as indicated by the Council of the European Community, could be the permissible maximum level. However, in poultry it was reported that broilers could tolerate diets containing 141 mg total cyanide kg-1 without any negative effects on growth performance (Panigrahi et al., 1992).

2.4. Nutrient Composition of Cassava Leaf

Cassava leaves contain an average of 21% crude protein, but values ranging from 16.7 to 39.9% Allen (1984). This wide variability is related to differences in cultivars, stage of maturity, sampling procedure, soil fertility and climate. Although cassava leaves are rich in protein, factors such as high crude fibre may limit its nutritive value for monogastric animals. Stage of maturity is the major factor contributing to the variability in fiber content, but environmental and cultivar effects are also implicated (Gómez 1991).

Table 1. Chemical composition (%) and metabolizable energy values of cassava leaf meal

Nutrients	Allen (1984)	Adeyemi et al. (2012)	Aberra et al. (unpublished data)
Dry matter	93	91.25	-
Ash	8.5 (5.7–12.5)	14.5	9.34
Crude protein	21 (16.7–39.9)	22.15	28.3
Crude fiber	20 (4.8–29.0)	12	16.0
Ether extract	-	-	6.74
ME (MJ/kg)	-	-	8.48

ME=metabolizable energy

Table 2. Mineral contents of cassava leaf meal

Minerals	Ravindran (1988)	Aberra et al. (unpublished data)
Macro minerals	%	g/kg DM
Potassium	1.28	13.8
Calcium	1.45	14
Magnesium	0.42	4.19
Posphorus	0.45	3.17
Sodium	0.02	0.07
Micro minerals	%	mg/kg DM
Zink	149	112
Manganese	52	71.5
Iron	249	239
Copper	12	6.33

Cassava leaves are good sources of minerals. They are particularly rich in Ca, Mg,P and Fe (Table 2). Cassava leaves are also rich in ascorbic acid and vitamin A, and contain significant amounts of riboflavin. But considerable losses of vitamins, particularly of ascorbic acid, occur during processing.

2.5. Amino Acid Composition of Cassava Leaf

Cassava leaf is rich in lysine. Some variation in the amino acid content of leaves has been reported and may be attributed to differences in stage of leaf maturity, sampling procedures, analytical methods and ecological conditions. As the leaves matures, the general trend for the amino acid concentrations decrease. Of the essential amino acids, lysine and histidine showed the greatest decrease at the time of growth (Ravindran 1988).

Table 3. Essential amino acid profile of cassava leaf meal (g/16g N)

Amino acids	Eggum (1970)	Aberra et al. (unpublished data)

Arginine	5.3 (4.0–5.7)	5.19
Lysine	5.9 (3.8–7.5)	4.22
Methionine	1.9(1.3–2.0)	1.54
Cystine	1.4 (0.7–1.4)	1.17
Total sulphur amino acids	3.3 (2.0–3.3)	-
Tryptophan	2.0	-
Histidine	2.3 (1.1–2.5)	2.65
Isoleucine	4.5 (3.9–5.0)	4.13
Leucine	8.2 (7.2–8.9)	7.95
Phenylalanine	5.4 (5.3–5.4)	5.37
Threonine	4.4 (3.2–5.0)	4.28
Valine	5.6 (5.1–5.7)	5.27
Aspartic acid	-	10.4
Serine	-	5.23
Glutamic acid	-	13.5
Proline	-	5.19
Glycine	-	4.88
Alanine	-	5.62
Tyrosine	-	3.67

2.6. Cyanogenic Glycosides of Cassava Leaf

The normal range of cyanide content is from 20 to 80 mg HCN per 100 g fresh leaf weight, but samples containing as low as 8 mg/100 g or over 400 mg/100 g have also been reported. On a dry basis (assuming 25% DM in fresh leaves), the normal range of HCN content would correspond to 800 to 3200 mg/kg. These levels are substantially higher than the normal range of HCN reported for fresh cassava roots.

The wide variations observed in leaf cyanide levels may be attributed to genetic, physiological, edaphic and climatic differences. Stage of leaf maturity is perhaps a major factor causing variations in the cyanide content. As in other cyanogenic plants, the glycoside concentration in cassava leaves decrease with age. Cyanide levels in the leaves are also influenced by the nutritional status of the plant.

2.7. Processing of Cassava Leaf

The existence of cyanogenic glycosides has made some form of processing a pre-requisitive for the use of cassava leaves in animal feeding. Several studies have demonstrated that it is possible to produce cassava leaf meal with low cyanide levels (Gomez and Valdivieso, 1985; Ravindran et al., 1987). Straightforward sun-drying only reduce nearly 90% of the firstly available cyanide amount. If combined with chopping and wilting, cyanide in the dried meal was diminished to levels, which are comfortable for non ruminant animals. This reduction is due to the action of endogenous linamarase on glucosides following loss of cell integrity (wilting) or tissue damage (chopping). The free tannin contents of cassava leaves are also considerably lowered during drying.

From a practical point of view, sun-drying would be the method of choice in the developing countries of the tropics. Since sun-drying is entirely dependent on the weather, the duration of drying will vary considerably. In general, cassava leaves dry easily and drying is completed, to about 10–12% moisture content, in two days during dry, sunny weather. Leaves can be also chopped manually or by means of a mechanical chopper. Leaves may also be bruised instead of chopping. Chopping not only increases cyanide elimination, but also shortens the drying time.

2.8. Nutritive Value of Cassava Leaf Meal (CLM)

Progressive depression in performance was observed with increasing levels of CLM. However, supplementation of diets containing 5-7% CLM with methionine and energy resulted in performance comparable to the control. Montilla et al. (1976) reported depression in gains and feed efficiency when CLM was included at 10, 20 or 30% levels in broiler rations. The depressing effects were largely overcome by pelleting.

The unfavorable effects of high dietary levels of CLM are due to bulkiness, reduced energy intake and methionine deficiency. At high levels of inclusion, bulkiness is probably the major limiting factor and, in this context, pelleting may prove beneficial.

2.9. Cassava Leaf Meal for Broilers

Most authors' report a decrease in growth performance when CLM is introduced in diets and feed intake can also be affected (Onibi et al., 2008). Performance is generally maintained at low levels of CLM (Iheukwumere et al., 2007) though adverse effects are sometimes observed with levels above 5%.

Some authors report acceptable performance with higher rates of CLM (10 to 20%) when methionine and energy are added or if pelleting is applied (Sankaravinayagam et al., 1999). In typical diets, the introduction of more than 5% CLM is not recommended, and the energy and amino acid (particularly methionine) levels have to be adequate.

3. MATERIALS AND METHODS

3.1. 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.

3.2. Preparation of Leaf Meal Material

The leaf part of the cassava (*Manihot Escutulata Crantz*) was used in the experiment as protein source by partially replacing the protein content of Noug seed cake. Cassava leaf used for the experiment was collected from Hawassa research center of Southern Agricultural Research Institute (SARI). The collected leaves were chopped and spread on a plastic sheet and sun-dried for two and half days to eliminate 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.

3.3. Experimental Design

Two hundred forty day-old broiler chickens were used in this experiment. The birds were divided in to five groups or treatments consisting of 48 birds per group. Each treatment group was further replicated 4 times with 12 birds per replicate in a completely randomized design experiment (Table 4). Based on the result of the chemical analysis=???, five grower diets was formulated to contain cassava leaf meal at 0% (T_1), 2% (T_2), 4% (T_3), 6% (T_4) and 8% (T_5) by partially replacing the CP of the Noug seed cake in the control diet. The diets were formulated to be iso-caloric and iso-nitrogenous.

Table 4. Experimental design of the feeding trial with broiler chicks

Dietary Treatments	Inclusion rate of CLM (%)	Inclusion rate of NSC (%)	Replicates	Chicks per replicate	Total chicks per treatment
1	0	8	4	12	48
2	2	6	4	12	48
3	4	4	4	12	48
4	6	2	4	12	48
5	8	0	4	12	48
Total					240

CLM = cassava leaf meal

3.4. Experimental Diets

As shown in Tables 5 and 6, the diet ingredients were composed of maize, soybean seed, wheat bran, Noug seed cake (*Guizotia abyssinica*), cassava leaf meal (CLM), limestone, bone and meat meal and salt. All ingredients (except the limestone and CLM) were purchased from local market at Hawassa city. 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 (Tegene and Asrat, 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 (Hawassa University).

Table 5. Proportion of feed ingredients (% dry matter) of the starter diets

Feed ingredients	Mixture % (kg/1000g)
Maize	51.5
Soybean	31.5
Wheat bran	7
Noug cake	8
Limestone	2

Salt		0.5
Total		100kg
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 35% of Ca

Table 6. Proportion of feed ingredients (% dry matter) of the grower diets

Feed ingredients	Treatment diets				
	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

3.5. Procurement and management of experimental chickens

Three hundred fifty day old unsexed broiler chicks were bought from Debre Zeit Agricultural Research Center. The 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. Experimental pens, watering and feeding troughs were cleaned and disinfected with appropriate disinfectants. Chicks were vaccinated against Newcastle and Infectious Bursal Diseases (Gumboro) as shown in Table 7. The vaccines were obtained from National Veterinary Institute (Debre Zeit, Ethiopia). Moreover, anti coccidiostat and oxytetracycline was given with drinking water. 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. Wood shavings were used as litter at a depth of 5 cm to cover the concrete floor. Mortality and any abnormality were recorded throughout the entire experimental period. The experimental period lasted 42 days exclusive of the brooding period.

Table 7. Vaccination schedule of the experimental broiler chickens

Bird’s age (days)	Name and types of vaccination	Route of administration
3	NCDV (HB1 strain)	Ocular type (Eye droplet)
7	Gumboro (IBDV)	Drinking water
12	Gumboro (IBDV)	Drinking water
21	NCD (Lasota strain)	Drinking water

NCDV = Newcastle disease vaccine; IBDV = infectious Bursal disease vaccine

3.6. Data collection procedures

3.6.1. Feed intake and body weight parameters

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 present. 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) values were calculated by dividing on total feed intake by total weight gain.

3.6.2. Carcass parameters

At the end of the experimental period, two chickens (1 male and 1 female) per replicate whose body weight was closest to the mean of their respective groups with a total of 40 chickens were selected and kept in a separate pen without feed. After overnight fasting of the selected birds, each of them was weighed (considered as slaughter weight) and eviscerated manually. 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 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.

3.7. 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 (AOAC, 1995). Total nitrogen content of the feed was determined 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.

3.8. Statistical Analysis of Data

Data obtained on feed intake, body weight and weight gain, feed conversion ratio and carcass parameters were subjected to Analysis of Variance using the General Linear Model (GLM) procedures of SAS ver. 9.2 (SAS, 2010). Means were 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 summarize the statistics employed to analyze the data.

The following statistical models were used to analyze the data:

ANOVA Model 1

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

Yij = individual values of the dependent variables (feed intake, nutrient intake, body weight and weight gain and carcass parts)

μ = overall mean of the response variable

A_i = the effect of the i^{th} cassava leaf meal level (i = 1, 2, 3, 4, 5) on the dependant variable

ANOVA Model 2 for carcass analysis parameters

$Y_{ijk} = \mu + T_i + S_j + T_i*S_j + e_{ijk}$, where:

Y_{ijk} = the observed k variable in the i^{th} treatment and j^{th} sex

μ = overall mean of the observed variable

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

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

T_i*S_j = the interaction effects between i^{th} treatment and j^{th} sex

E*ijk* = random residual error

4. RESULTS AND DISCUSSION

4.1. Results

4.1.1. 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 8 and 9, respectively. Accordingly, the CP and ash contents of cassava leaf are found to be relatively high. The crude fat and crude fiber contents of cassava leaf are also high. The calculated ME value of CLM is also relatively high. As shown in the Table 9, the CP contents of the all experimental diet were similar although it was slightly higher in 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.

Table 8. Chemical composition of cassava leaf meal

Nutrients	Composition (on % 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

Table 9. Nutrient and energy contents of experimental diets (on % DM basis)

Nutrients	Treatment diets				
	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

4.1.2. Intake of nutrients

Feed intake of the broiler chickens fed at different level of the cassava leaf meal up to 6th week of experimental period is shown in Table 10. The feed intake of chickens during the first week of the experiment was similar across treatment diets. Thereafter, there was a significance difference in feed intake between treatment diets. Accordingly, chickens reared in T1 (control diet), T2 and T3 showed a significantly higher feed intake than those fed with other treatment diets. The result

Also showed that the feed intake was lower ($p<0.05$) among the chickens receiving higher inclusion level of the experimental diet at all weeks.

Table 10. Weekly mean daily feed intake (g/ chick/day) of broiler chickens raised on treatment diets containing various levels of the cassava leaf meal

Experimental weeks	T1	T2	T3	T4	T5	SEM	Sig.
W1	59	58	59	56	56	0.28	NS
W2	68^{a}	67^{a}	68^{a}	64^{b}	61^{b}	0.64	**
W3	77^{a}	76^{a}	77^{a}	73^{b}	70^{b}	0.62	**
W4	84^{a}	83^{a}	84^{a}	80^{b}	77^{b}	0.63	**
W5	95^{a}	95^{a}	95^{a}	92^{b}	88^{c}	0.62	**
W6	103^{a}	102^{a}	103^{a}	99^{b}	96^{c}	0.62	**

$^{a\text{-}c}$ Means with different superscript letters with the same row are significantly different ($p<0.05$)
SEM = standard error of the mean

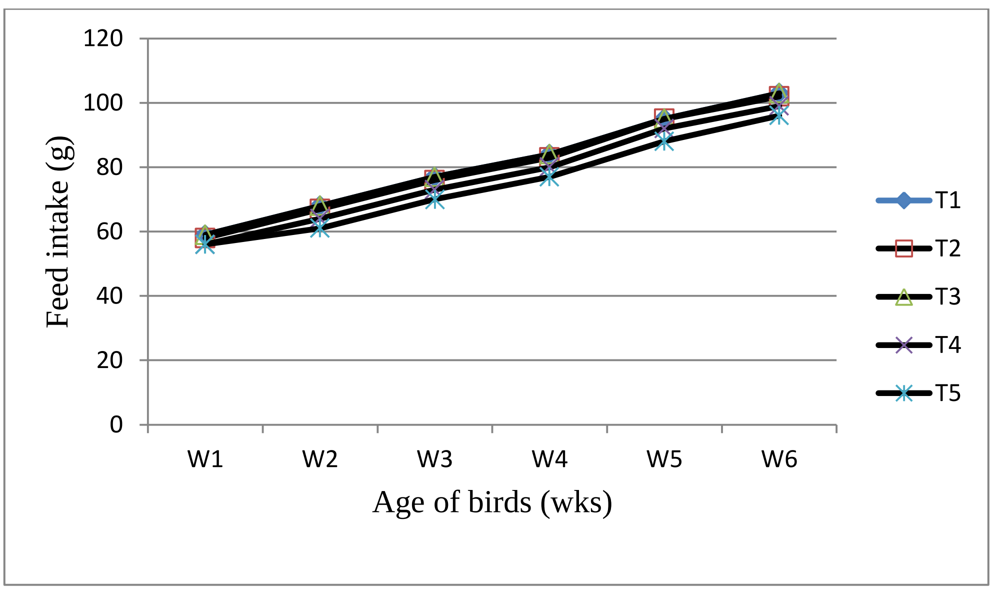

Figure 1. Average weekly mean daily feed intake (g/ chick/day) of broiler chickens raised on dietary treatments containing various levels of the cassava leaf meal

The effects of feeding the diet containing different level of cassava leaf meal on daily nutrient and energy intakes of growing Ross 308 chicken are presented in Table 11. There was a significant difference among the treatments in the intakes of DM, CP, EE, CF and ME. Accordingly, the DM intake was higher among chickens reared on T1, T2 and T3 diets. Similarly, the CP and EE intake was higher in chickens fed with T1, T2 and T3 diets than those reared in T4 and T5. On the other hand, chickens reared in T4 and T5 had the lowest CF intake as compared to those fed with other treatment diets. . The ME intake was significantly higher in chickens fed with T4 and T5 diets than those reared in other treatments.

Table 11.Nutrient (g/chick/day) and energy (kcal/ chick /day) intakes of broiler chickens fed diets containing various levels of cassava leaf meal

Nutrients	Treatment Diets					SEM	P-value
	T1	T2	T3	T4	T5		
Dry matter	92.9[a]	92.3[a]	92.4[a]	87.1[b]	84[b]	2.6	0.001
Crude protein	21.6[a]	21.4[a]	21.6[a]	20[b]	19.7[b]	0.5	0.001
Ether extract	12.5[a]	12.2[a]	12.4[a]	9.9[b]	9.5[b]	0.06	0.001
Crude fiber	4.92[a]	5.17[a]	4.72[b]	4.5[c]	4.45[c]	0.4	0.0001
Metabolizable energy (kcal)	142.4[c]	145.9[c]	151[b]	164.5[a]	167[a]	4.6	0.0001

[a-c] Means with different superscript letters with the same row are significantly different

SE = standard error of the mean

4.1.3. Body weight and weight gains

As presented in Table 12, there was no significant difference in initial body weight of chickens among the treatments. However, the final body weight was ($P<0.05$) higher among the chickens receiving T1, T2 and T3 diet than those reared in other treatments. The total body weight gain was significantly higher in chickens fed with T1, T2 and T3 than those of T4 and T5, which again differed significantly from each other. The average daily weight gain per hen and per day also followed similar trend. The daily feed intake was significantly higher in chickens fed on T1, T2 and T3 diets than those of T4 and T5. The value pertaining to FCR, although not significant, chickens reared in T1, T2 and T3 had the numerically higher value than those of T5 and T4. The mortality was recorded at the first two weeks in T1 because of coccidiosis which lead to the poor feed and water consumption and pain in their body as told by veternerians. Nevertheless, immediately they were substituted with other chicken, which weigh nearly to the average weight of the treatment.

Table 12. Average values for initial and final body weight, calculated gain values, and feed conversion ratio of Ross 308 chicken fed different level of cassava leaf meal

Parameters	Treatment diets					SEM	Sig.
	T1	T2	T3	T4	T5		
Initial weight (g/chick)	207	203	201	202	206	33	NS
Final weight (g/chick)	1238[a]	1233[a]	1231[a]	1190[b]	1155[c]	48.9	**
Total gain (g/chick)	1031[a]	1030[a]	1030[a]	988[b]	948[c]	58.3	**
Daily weight gain (g/chick/d)	24.5[a]	24.5[a]	24.5[a]	23.5[b]	22.6[c]	1.2	**
Feed intake (g/chick/d)	80.9[a]	80.4[a]	80.9[a]	77.0[b]	74.0[b]	1.87	**
FCR (g feed/g gain)	3.30	3.28	3.30	3.28	3.27	0.09	NS

[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

4.1.4. Effects of feeding cassava leaf meal on carcass characteristics of chickens

The effects of feeding graded level of cassava leaf meal on different carcass parts and interaction effects of sex by treatment are presented in Table 13. In general, male chickens had significantly higher carcass component weights than females. The 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 with similar values. Chickens reared in T1 had significantly higher dressed carcass weight than those of other treatments. Chickens fed with T3 had higher dressed carcass weight than those of T4 and T5 while chickens fed with T2 had intermediate value. The values for dressing percentage, and drumsticks were significantly higher in chickens reared in T1 and T2 diets than those fed of T4 and T5. Chickens fed on T1, T2 and T3 had significantly higher values for thigh and wing as compared with those reared in other treatments. The weight for gizzard was significantly higher 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 while it was insignificant for other carcass components (Table 13).

Table 13. Least square means (g) of main carcass components as affected by the interaction of sex of the chickens and treatment diets

Carcass Components	Sex		Treatment diets					ANOVA		
	Male	Female	T1	T2	T3	T4	T5	Sex	Treatment (Trt)	Sex x Trt
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;

4.2. DISCUSSION

4.2.1. Nutrient and energy contents of cassava leaf and experimental diets

4.2.1.1. Cassava leaf

The results of this study indicated that CLM is rich in protein contents (25.6%), which is in good agreement with those findings reported by Aberra et al. (unpublished data). Ravindran (1993) 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) and environmental factors (climate, soil). A lack of repeatability of analytical methods, especially for the dietary fibre fractions, may also explain these differences.

In the present study, the petioles were excluded and this may have been the reason for the higher CP. The ash content of the cassava leaf meal is relatively high which might be due to the plentiful amount of calcium in it (Aletor and Adeogun, 1995; Aberra et al., unpublished data). In addition, Gómez (1985) reported similar data in terms of the amount of calcium in the leave of cassava. Since high Ca to P ratio (1-2:1) is desirable for poultry as compared to other livestock, (Phillips1990), CLM 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 CLM make it potentially good alternative feed to substitute the conventional feeds like Noug cake, which contain high amount of the fiber in the diets of growing chickens.

4.2.1.2. Treatment diets

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 et al., 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 Aberra et al. (unpublished data) indicated 24.5% of CF level in Noug seed cake which is considerably higher than that of CLM (12.5%).

4.2.2. Feed intakes

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 higher in chickens reared in the T1, T2 and T3. This could be explained by the unpalatable taste of the CLM, which might have inhibited the birds from consuming adequate quantities (Omekan, 1994). Birds are known to eat more when diets are acceptable and coarse than when they are finely ground (Leeson, 2000). The feed conversion ratio (FCR) was similar across all treatment diets indicating that CLM might be used to partially substitute Noug seed cake in broiler rations.

The improvement in nutrient intake up to the T3 diet as observed in the present study might indicate that CLM inclusion until 4% could be the optimum level for broiler chickens. Thus, beyond that limit the inclusion of the CLM might have a negative effect on feed intake and there by depressing growth performance of the broilers. Still, new study is required to come up with the appropriate inclusion levels of CLM to dual purpose and layer breeds of chickens.

4.2.3. Body weight and gain

Body growth is determined by deposition of protein, fat and water in the 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 (Rickefs et al., 1985). Chickens fed on T4 and T5 diet showed depressed performance compared with those fed other treatment diets and are in good agreement with the results of Olugbemi et al., (2010) and Aberra et al., (2013) who reported a depressed growth in birds fed *Moringa oleifera* and *M. stenopetala* leaf meals at higher levels without affecting the dry matter intake. This might be attributed to the effects of nutrient imbalance and poor metabolism on monogastric animals fed high levels of unconventional feed ingredients (Esonu et al., 2006; Iheukwumere et al., 2008). This nutrient imbalance in CLM could probably occur due to the presence of various anti-nutritional factors like tannins (Aberra et al. unpublished data), which might impair the bioavailability of the nutrients like energy and protein..

The observed lower body weight gain (T4 and T5) might be further associated with lower feed intake at higher level of cassava leaf meal inclusion and possibly due to the deficiency of certain amino acids like methionine. Apart from this, the depressed body weight gain of the broilers at higher level inclusion of CLM might be due to the fact that feed intake was low due to high bulk or fibre content of the leaf meal resulting in insufficient consumption of digestible nutrients particularly protein and energy required to sustain rapid growth.

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). Sundrying the leaves to produce cassava hay will result in a reduction in HCN (Ravindran, 1992 and Wanapat et al., 2000). The concentration of HCN in the diets, between 0 and 32.4 mg/kg DM was below the recommended 50 mg/kg DM safe level of HCN in the diet (Bolhuis, 1954). The depression in performance seen in this study agrees with the general observation that at high leaf meal inclusion levels in poultry diets negatively affected the growth performances (Ash and Petaia, 1992; Opara, 1996). 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.

4.2.4. Carcass traits

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

Slaughter weight was affected by sex where males were significantly heavier than females which could be due to the effect of sex hormone (androgen) in males that favors muscle development which is in agreement with the reports of Tegene and Asrat (2010) and Aberra et al. (2013) that revealed males have heavier slaughter weight due to higher feed intake of males than females in one hand and also due to sex hormones that favor fat deposition in females.

In the present study, non significant interactions between sex and the treatment diets were observed for slaughter weight, dressed carcass weight, dressing percentages, thigh, wing and neck indicating that the MLM had similar effect on both the sexes and are in good agreement with the findings of López et al. (2011) and Aberra 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 CLM.

As expected, male birds had higher weights of dressed carcass, thighs and drumsticks than females and are consistent with the results of Tegene and Asrat (2010) for Rhode Island Red chickens, Aberra 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 meal which disagrees with report of the Born *et al.*, (2006), who reported that there is usually increment in the weight of the gizzard in chickens reared on leaf meal based diets. 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.

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

From the present study, it can be concluded that partial substitution of Noug seed cake with cassava leaf meal (CM) resulted in improvement of final body weight gain, total body weight gain and daily body weight gain among the broilers receiving T3 diet (4% substitution levels) similar to those reared on control diet (T1) treatment. However, at higher substitution (T5 diet) there was a detrimental effect on the growth of the chickens in all the above mentioned traits.

The dry matter and crude protein intake was highest among the chickens receiving the T3 diets. The result also indicated that the growth of the chickens increased up to the sixth week but the increasing level of T4 and T5 are poor as compared to the other treatments.

The result indicated non-significant difference between treatment two, three and five in dressing percentages. Even though, treatment one has higher dressing percentage than that of the others. Also carcass cut parts are better at T1 as compared to other treatment, but T2 and T3 showed the comparable value. In contrast, the last two treatments showed poor result with the carcass parameters. The study also indicated that the male chickens were far better than the females in carcass parameters.

5.2. Recommendations

- Up to 4% cassava leaf meal could be included in the diet of growing broiler chickens by replacing Noug seek cake.

- Further research is necessary to determine how to increase the nutritive value of cassava leaf meal for monogastric animals in view of its cheapness and abundance.

- Studies need to be initiated to come up with result on blood chemistry and meat quality parameters of chickens receiving the leaf meal of cassava and observe whether there are any significant changes due to extended time of feeding programme.

6. REFERENCES

Aberra Melesse, W.Tiruneh and T. Negesse 2011. Effects of feeding Moringstenopetala leaf meal on nutrient intake and growth performance of Rhode Island Red chicks under tropical climate. Tropical and Subtropical Agroecosystems, 14: 485-492.

Aberra, (2014). Significance of scavenging chicken production in the rural community of Africa for enhanced food security. World's Poultry Science Journal 70: 593-606.

Aberra, Getye Y, 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.

Aderemi et al., 2012 F.A. Aderemi, T.K. Adenowo, A.O. Oguntunji.Effect of whole cassava meal on performance and egg quality characteristics of layers JAS, 5 (2) (2012), pp. 195–200.

Akoroda, M.O. and Ikpi, A.E. 1992. The adoption of improved cassava varieties and their potential as livestock feeds in southwestern Nigeria. In: Hahn, S.K., Reynolds, L. and Egbunike, G.N. (eds), Proceedings of the IITA/ILCA/University of Ibadan workshop on the potential utilization of cassava as livestock feed in Africa, 14–18 November 1988, Ibadan, Nigeria. Ibadan, Nigeria: International Institute of Tropical Agriculture, and Addis Ababa, Ethiopia: International Livestock Centre for Africa.

Aletor, V. A.; Adeogun, O. A. Nutrients and anti-nutrient components of some tropical leafy vegetables. Food Chem**.**, Oxford, v. 53, n. 4, p. 375-379, 1995.

Allen, R. D. (1984). Feedstuffs ingredient analysis Table. Feedstuff (USA), 56 (30), 25.

Amos TT (2006). Analysis of Backyard Poultry Production in Ondo State, Nigeria. International Journal of Poultry Science 5(3): 247 - 250.

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

Ash, A.J. and L. Akoh Petaia, 1992. Nutritional value of *Sesbania grandiflora* leaves for ruminant and monogastrics. Trop. Agri. (Trinidad), 69: 223-228.

Avila, M.1985.Intra and Inter- household decision making in the Mangwende and Chivi Communal Areas: Preliminary results, Farming System Research UNITS, Harare5 (3), 47-50.

Ayssiwede S. Mankor., Dahouda H. Hornic and Missohou.2011. Effect of moringa olifera leaf meal in corporation in diets on growth performance, carcass characteristics and economic results of growing Senegal chickens. *Journal of natural* 10(12):1132-1145.

Bokanga, M. 1994. Processing of cassava leaves for human consumption cassava safety. Acta Horticulture 375:203-207.

Bolhuis, G. G. 1954. The toxicity of cassava root. J. Agric. Sci. 2:176-185.

Borini K., J. E. Lindberg and R. B. Ogle, 2006. Digestibility and digestive organ development in indigenous and improved chickens and duck fed diet with increasing inclusion levels of cassava leaf meal. Journal of Animal Physiology and Animal Nutrition 90 (2006) 230-237.

Cadavid, L.F., El-Sharkawy M.A., Acosta, A., Sanchez, T., 1998. Longterm effects of mulch, fertilization and tillage on cassava grown in sandy soils in northern Colombia. Field Crops Research 57, 45-56.

CSA (Central Statistics Authority). 2015/16. Agricultural sample survey Vol. 2. Statistical Bulletin No.505. CSA, Addis Ababa, Ethiopia.

D'Mello, J. P. E.; T. Acamovic and A. G. Walker. 1987. Evaluation of Leucena leaf meal for broiler growth and pigmentation. Trop. Agric (Trinidad) 64: 33-35.

Demeke, S. 2004.Egg Production and Performance of local white leghorn hens under intensive and rural household conditions in Ethiopia. 16(2).

ECOCROP 2011. Ecocrop database. FAO, Rome.

Eggum, O. L. 1970. The protein quality of cassava leaves. British Journal of Nutrition 24: 761–769.

Enriquez F.Q. and Ross E. 1972. Cassava root meal in grower and layer diets. Poult. Sci. 51: 228-234.

Esonu B.O., Emenalom O.O., Udedibie A.B.I., Herbert U., Ekpor C.F., okoli I.C. and Iheukwumere F.C. 2001. Performance and blood chemistry of weaner pigs fed raw Mucuna (velvet bean) meal. Trop. Anim. Prod. Invest. 4:49-54.

Esonu, B.O., F.C. Iheukwumere, O.O. Emenalom, M.C. Uchegbu and E.B. Etuk, 2002. Performance, nutrient utilization and organ characteristics of broilers.Hitt: //www,cipavorg.Co/Irrd//Irrd 14/6/eson/146 htn.

Esonu, B.O., Opara, M.N., Okoli, I.C., Obikaonu, H.O., Udedibie , C., Iheshiulor, O.O.M., 2006. Physiological response of laying birds to Neem (Azadrachita Indica) leaf meal-based diets: Body weight, organ charactersics and hematology. Online J. Health. App. Sci. 2, 4. (http://www.ojhas.org./isssue18/2006-2-4.htm).

FAOStat. 2013. Food and Agriculture Organization of the United Nations.

Fisseha Moges, Azage Tegegne and Tadelle Dessie.2010.Indiginous chicken production and marketing system in Ethiopia: Characteristics and opportunities for market oriented development. IPMS (Improving Productivity and Market Success) of Ethiopian farmers project working paper 24. Nairobi, Kenya, ILRI.

Gómez, G.; Valdivieso, M. Cassava foliage: chemical composition, cyanide content and effect of drying on cyanide elimination. J. Sci. Food Agric., Chichester, v. 36, n. 6, p. 433-441, 1985.

Gómez, G.G., 1991. Use of cassava products in pigs feeding. Pigs News and Information 12, 387-390.

Hudspeth, J.. P., C. E. Lyon, B. G. Lyon, and A. J. Mercuri, 1973. Weights of broiler parts as related to carcass weights and type of cut. J. Food Sci. 38:145–150.

Iheukwumere, F. C. ;Ndubuisi, E. C. ; Mazi, E. A. ;Onyekwere, M. U. ,2007. Growth, blood chemistry and carcass yield of broiler fed cassava leaf meal (Manihot esculenta Crantz). Int. J. Poult. Sci., 6 (8): 555-559.

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

Khajarern S. and Khajarern J.M. 2007. Use of cassava products in poultry feeding. FAO Corporate Document Repository.

Lebot, V. 2009. Tropical root and tuber crops: cassava, sweet potato, yams and aroids. Crop Production Science in Horticulture (17), CAB books. Wallingford, UK: CABI.

Leeson, S., 2000. Is Feed efficiency still a useful measure of broiler performance? Department of Animal and Poultry Science, University of Guelp, Ministry of Agriculture, Food and Rural Affairs Canada.

Lopez, K.P., Schilling, M.W., Corzo, A., 2011. Broiler genetic strain and sex effects on meat characterstics. Poult. Sci. 90,1105-1111.

Nigussie Dana and Alemu Yemi, 2005. Characterization and classification of potential poultry feeds in Ethiopia using cluster analysis. Eth. J. Anim. Prod. 5(1):107-123.

Nikolova, N., Pavlovski, Z., 2009. Major caracass parts of broiler chicken from different genotype ,sex, age and nutrition system. Biotechnol. Anim. Husband. 25, 1045-1054.

Nwoche, G.N., E.C. Ndubuisi and F.C. Iheukwumere, 2006. Performance of finisher broilers and cost implication of feeding palm oil as energy supplement. Niger Agri. J., 37: 44-49.

Olugbemi T.S., S.K. Mutayoba and F.P. Lekule , 2010. Effect nof Moringa (Moringa oleifera) inclusion in Cassava based diet fed to broiler chickens . Int.J. Poul. Sci. 9(4) :363-367,2010.

Omekan, V.N., 1994. Studies on Nutrition and health implications of dietary inclusion of dried poultry waste for broilers. MSc. Thesis, Federal University of Technology, Owerri, Nigeria.

Onibi, G. E. ; Folorunso,O. R. ;C. Elumela,C., 2008. Assessment of partial equi-protein replacement of soybean meal with cassava and leucaena leaf meals in the diet of broiler chicken finishers. Int. J. Poult. Sci., 7(4): 408-413.

Opara C.C. 1996. Studies on the use of *Aklchornia cordifolia* leaf meal as feed ingredient in poultry diets, MSc. Thesis, Federal University of Technology, Owerri, Nigeria.

Panigrahi, S., Rickard, J., O'Brien, G.M., Gay, C., 1992. Effects of different rates of drying cassava root in its toxicity to broiler chicks. British Poultry Science 33, 1025-1041.

Phengvilaysouk, A.; Wanapat, M., 2008. Study on the effect of harvesting frequency on cassava foliage for cassava hay production and its nutritive value. Livest. Res. Rural Dev., 20 (suppl).

Phuc, B. H. N.; B. Ogle and J. E. Lindberg. 2000. Effect of replacing soybean protein with cassava leaf meal in cassava root meal based diets for growing pigs on digestibility and N retention. Anim. Feed Sci. and Tech. 83: 223-235.

Ravindran, V.(1993), Cassava leaves as an animal feed: Potential and limitations. J. Sci. Food Agric., 61:141-150. Doi: 10.1002/jsfa. 2740610202.

Ravindran, V., 1991. Preparation of cassava leaf products and their use as an animal feed. Roots, Tubers, Plantains, and Banans in Animal Feeding: Anim. Prod. Health Paper, vol.95. FAO, Rome,pp.81-98.

Ravindran, V., Kornegay E.T., Rajaguru S.B. and Notter D.R. 1987b. Cassava leaf meal as a replacement for coconut oil meal in pigs diets. J. Sci. and Food Agric. 41:45-53.

Ravindran,S., Kenkpen, D., 1992. Cassava production and utilization in Liberia. In : Workshop on the potential utilization of cassava as livestock feed in Africa, 14-18 November. International Institute of Tropical Agriculture (IITA), Ibadan Nigeria, pp. 142-145.

Ravindran. G.; Ravindran, V. Changes in the nutritional composition of cassava (*Manihot esculenta Crantz*) leaves during maturity. Food Chemitry**.**, New York, v. 27, n. 4, p. 299-309, 1988.

Regnier, C., B. Bocage, H.Archimede, J. Noblet D. Renaudeau, 2013. Digestive utilization of tropica foliages of cassava, sweet potatoes, wild cocoyam and erythrina in Creole growing pigs. Animal Feed Science and Technology 180,44-54.

Rickefes et al. 1985. Modification of growth and development of mescles in poultry. *Poultry Science***,** v.64, p.1563-1576.

SAS I nstitute.2010. SAS version 9.2. SAS Institute Inc., NC, USA.

Scanes, Congrent, G., 2003. Growth performance enhancement, in:Scanes, C.G. (Ed.), Biology of Domestic Animals , Wiley-Blackwell,Iowa.

Scanes, Congrent, G., and Ensminger, M.E., 2004. Poultry Science. Pearson education, Inc.,Upper Saddopler, New jersey 07458. Pp.77, pp, 242-245, pp.225.

Sundaresan, S., Amma, C.S.E., Nambisan, B., 1987. Bitterness in cassava in relation to cyanoglucoside content. Indian Journal of Agricultural Science 57, 37-40.

Tegene Negesse and Asrat Tera, 2010. Effects of feeding different levels of cooked and sun dried fish offal on carcass trait of growing Rhode Island Red chicks. Trop Anim Health Prod 42:45-54.

Van Eekeren N., A. Mass, H.W.Saatkamp and M. Verschuur, 2006. Small-scale chicken production. Agrodoc 4. Agronomisa Foundation and CTA, Wageningen, The Netherlands.

Wanapat, M. 2002. The role of cassava hay as animal feed in research and development in Asia.

Wiseman J., 1987. Feeding of non-ruminant livestock. Butterworth and Co. Ltd., pp. 9-15.

APPENDIX

Appendix Table 1. ANOVA result regarding daily feed intake of the broilers chickens fed on the different levels of the Cassava (Manihot Escutulata Crantz) leaf meal for 42 days of age

Source	Dependent variable	Sum of square	Degree of Freedom	Mean square	F	Sig.
Trt	Daily FI	5148	4	1287.0694	5.68	F>0.0002
Error	Daily FI	18914.1205	835	226.5511		
Total	Daily FI	194293.3980	839			

Appendix Table 2. ANOVA result regarding nutrient intake of broiler chickens fed on different levels of cassava (*Manihot escutulata* Crantz) leaf meal for 42 days of age

Nutrients	Source	Sum of square	Degree of Freedom	Mean square	F	Sig.
DMI	Trt	10671.5	4	2667.87	11.7	0.0001
	Error	615.8	835	0.74		
	Total	11287	839			
CPI	Trt	512.5	4	128.7	12.5	0.0001
	Error	33.6	835	0.04		
	Total	546.1	839			
EEI	Trt	1412.6	4	353.15	13.5	0.0001
	Error	8.4	835	0.01		
	Total	1421	839			
CFI	Trt	344.1	4	86	10.40	0.0001
	Error	6.9	835	0.08		
	Total	351	839			
MEI	Trt	82140.6	4	20535	14.20	0.0001
	Error	0.000	835	0.000		
	Total	82140	839			

Appendix Table 3. ANOVA result regarding initial body weight of broilers fed on different levels of cassava leaf meal (Manihot Escutulata Crantz) for 42 days of experimental period**.**

Source	Sum of Squares	Degree of freedom	Mean square	F	P value
Treatment	1440.87	4	360	0.33	0.857
Error	255979.7	235	1089.3		
Total	257420.56	239			

Appendix Table 4. ANOVA result regarding final body weight of broilers fed on different levels of cassava leaf meal (Manihot Escutulata Crantz) for 42 days of experimental period

Source	Sum of Squares	Degree of freedom	Mean square	F	P value
Treatment	252767.57	4	63191.88	21.6	0.0001
Error	562546.8	235	2393.82		
Total	562546.8	239			

Appendix Table 5. ANOVA result regarding total body weight gain of broilers fed on different levels of cassava leaf meal (Manihot Escutulata Crantz) for 42 days of experimental period**.**

Source	Sum of Squares	Degree of freedom	Mean square	F	P value
Treatment	257622.8	4	6405.7	18.9	<0.0001
Error	800293.6	235	3404.5		
Total	1057916.4	239			

Appendix Table 6. ANOVA result regarding average daily body weight gain of broilers fed on different levels of cassava leaf meal (*Manihot escutulata* Crantz) for 42 days of experimental period

Source	Sum of Squares	Degree of freedom	Mean square	F	P value
Treatment	127.2	4	31.8	18.9	<0.0001
Error	395.2	35	1.7		
Total	522.4	239			

Appendix Table 7. ANOVA results regarding effect of treatment on carcass characteristic of Ross 308 chicken fed different level of cassava leaf meal

Source of variance	Parameters	Sum of square	Degree of freedom	Mean square	F value	F
Treatment	Slaughter Weight	33422	4	8355.7	45.2	<0.0001
	Total carcass	73202.9	4	18300.7	18	<0.0001
	Dressing percentage	204	4	51	9.23	<0.0001
	Breast (g)	2370	4	592.5	5.46	<0.0002
	Thigh (g)	2978.6	4	744.7	41.21	<0.0001
	Drumstick (g)	3346.5	4	836.6	37.68	<0.0001
	Back (g)	3950.8	4	987.7	27.27	<0.0001
	Wing (g)	1003	4	250.8	12.38	<0.0001
	Neck (g)	183	4	45.8	4.78	<0.00038
	Gizzard (g)	475.4	4	118.8	11.15	<0.0001
	Skin (g)	1436	4	359	37.6	<0.0001

Appendix Table 8. ANOVA results regarding effect of sex on carcass characteristic of Ross 308 chicken fed different level of cassava leaf meal

Source of variance	Parameters	Sum of square	Degree of freedom	Mean square	F value	P value
Sex	Slaughter Weight	3802.5	1	3802.5	20.56	<0.0001
	Total carcass	24354	1	24354	23.93	<0.0001
	Dressing percentage	95.7	1	95.7	17.3	<0.0001
	Breast (g)	7049	1	7049	64.96	<0.0001
	Thigh (g)	2970	1	2970	164.4	<0.0001
	Drumstick (g)	1575	1	1575	70.93	<0.0001
	Back (g)	1742	1	1742	48.1	<0.0001
	Wing (g)	861	1	861	42.5	<0.0001
	Neck (g)	1806	1	1806	192	<0.0001
	Gizzard (g)	724	1	724	68	<0.0001
	Skin (g)	1239.8	1	1239.8	128	<0.0001

Appendix Table 9. ANOVA results regarding effect of treatment by sex and on carcass characteristic of Ross 308 chicken fed different level of cassava leaf meal

Source of variance	Parameters	Sum of square	Degree of freedom	Mean square	F value	P value
Treatment*Sex	Slaughter Weight	975.75000	4	243.93750	1.32	0.2855
	Total carcass	7079.90000	4	1769.97500	1.74	0.1674
	Dressing percentage	52.0035000	4	13.0008750	2.35	0.0765
	Breast (g)	3003.100000	4	750.775000	6.92	0.0005
	Thigh (g)	93.516500	4	23.379125	1.29	0.2947
	Drumstick (g)	366.402500	4	91.600625	4.13	0.0088
	Back (g)	3026.177500	4	756.544375	20.89	<.0001
	Wing (g)	160.343500	4	40.085875	1.98	0.1232
	Neck (g)	86.014000	4	21.503500	2.29	0.0834
	Gizzard (g)	493.8940000	4	123.4735000	11.59	<.0001
	Skin (g)	209.274000	4	52.318500	5.40	0.0021

BIOGRAPHICAL SKETCH

The author Mengistu Masebo was born in Korga Beshilo kebelle, East Badewacho Woreda, Hadiya zone in 1982 G.C. in southern Regional state of Ethiopia. He attended his primary school at Korga beshilo primary school from 1997 G.C. up to 2004 G.C. He started his junior secondary education at Shone high school in 2005 G.C. He continued his secondary school in Shone high school and completed in 2008. Then, he joined Hawassa University in 2009 G.C, and graduated with B.Sc. degree in Animal and Range Sciences in 2011 G.C. After graduation, he was served at East Badewacho Woreda Agricultural and Rural Development office as Extension Communication expert until 2014 G.C. In 2015 G.C., he joined again Graduate studies in School of Animal and Range Sciences at Hawassa University to pursue his Degree of Master in the field of Animal Production.