PERFORMANCE OF BROILER CHICKENS FED BITTER LEAF AND MORINGA LEAF MEAL BASED DIETS UNDER SINGLE PHASE FEEDING REGIME

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ABSTRACT

The effect of feeding bitter leaf and moringa leaf meals based diets under single phase feed regime on growth performance, nutrient digestibility, carcass characteristics and sensory evaluation of broiler chickens was investigated. One hundred and eighty Cobb 500 strains of day old chicks were sorted and randomly distributed to six dietary treatments. Each treatment was replicated thrice with ten birds per replicate in a completely randomized design experiment. The treatments were 0 % each of bitter leaf meal and moringa leaf meal for the control. Treatment 2 and 3 were 2 % bitter leaf meal and 2 % moringa leaf meal respectively. While Treatment 4 contained 2 % each of bitter leaf meal and moringa leaf meal. Treatments 5 and 6 contained 4 % bitter leaf meal and moringa leaf meal respectively. Results showed that feed intake, weight gain and feed conversion ratio, apparent nutrient digestibility and carcass cuts part where all influenced by the dietary treatments ($p<0.05$). But birds on 2 % and 4 % moringa leaf meal diet performed better on feed intake and weight gain. While birds on 2 % combination of bitter leaf and moringa leaf meals had better feed conversion than other dietary treatments. Ash, either extract and NFE where influenced as birds on 2 % moringa leaf meal. Carcass cuts part were significantly influenced by bitter leaf and moringa leaf meals. However, sensory evaluation were not influenced by the dietary treatment. It could therefore be recommended that 4% moringa leaf meal be included in the diets of broiler chickens for better improved performance. The carcass characteristics indicate that birds fed 2 % of bitter leaf and 2 % of moringa leaf meals have the highest dressing percentage and also have the highest abdominal fat.Sensory evaluation indicated that all the meat were generally accepted in terms of colour, juiciness, flavor, aroma, tenderness and overall acceptability.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Poultry production remains the most widespread of all livestock enterprises; it constitutes an important pillar of food security improvements as well as socio-cultural and economic developments in most countries (Alders, 2005, Dieye *et al.*, 2010). Broiler chickens production is a source of income; it is also a good source of protein and have quick returns to investment (Kekocha, 1994). However, the industry in the developing countries is facing some challenges. These challenges include high feed to gain ratio and increase in the cost of feed because of high prices of feed ingredients (Abbas, 2013). Numerous attempts have been made to overcome these challenges, and one of them involves the use of feed additives.

Feed additives are ingredients added to poultry diets to enhance production efficiency, improve health and reduce morbidity (FAC, 1998). Recently, plant based feed additives also known as phytogenics have been advocated to be included in broiler chickens feeds as growth promoting feed additives, because of their abundance in our natural environment and the fact that they do not have residual effect (Ndelekwute *et al*., 2015). Their non-residual effect is because, according to Kohlert *et al.* (2000), the active ingredients of phytogenic feed additives are absorbed in the intestine by enterocytes and are quickly metabolized by the body. Phytogenics can improve feed consumption, feed conversion, feed digestibility and weight gain of broiler chickens (Cardoso *et al*., 2012).

Bitter leaf (*Vernonia amygdalina*) is a valuable plant with antimicrobial activity that is widespread in East and West Africa (Burkill, 1985). In Nigeria, it is a staple vegetable leaf used to prepare soup especially in the South Eastern part. Some principal chemical constituents found in bitter leaf are steroid glycoside and vernonioside B1, which possesses potent anti-parasitic, anti-tumor and bactericidal properties (Tadesse *et al*., 1993). Durunna *et al*. (2011) reported that bitter leaf contained 15.67 % crude protein, 11.53 % crude fibre and 6.95 % ether extract. It has been reported that bitter leaf meal used in poultry production was able to increase feed conversion efficiency of broiler birds without affecting their haematological profile (Olobatoke and Olonirula, 2009). Bitter leaf may provide anti-oxidant benefits (Erasto *et al.*, 2007).

Moringa oleifera leaves are reported to have potential prebiotic effects and potentially antioxidant phytochemicals, such as chlorogenic acid and caffeic acid (Siddhuraju and Becker, 2003). *Moringa oleifera* leaf meal, is widely available in many tropical countries. It is also a good source of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids (Teixeira *et al.*, 2014). The underlying effects of the bioactive compounds in *M. oleifera* leaves are not clear. However, they are believed to induce prebiotic effects, bacterial and immune-stimulant activities (Ghazalah and Ali, 2008) resulting in increased productivity of broiler chickens. Similar effects have been observed in the presence of antibiotic growth promoters (Gbasi *et al.*, 2000; Khalafalla *et al.*, 2010; Olugbemi *et al*, 2010). *Moringa oleifera* leaf has the calcium equivalent of four glasses of milk, three times the iron of spinach, four times the amount of vitamin A in carrot, and two times the protein in milk (Loren, 2007). The leaf of Moringa is a good source of protein, vitamins A, B, C and minerals such as calcium and iron (Dahot, 1988). The leaf of Moringa has high protein content which is between 20-33 % on a dry weight bases. The protein is of high quality having significant quantities of all the essential amino acids as reported by Foibl and Paull (2008). Murro *et al.* (2003) reported that the leaves contain a high level of vitamin A, B, C and calcium. Kakengi *et al.* (2003) reported that Moringa *oleifera* leaf meal was substituted for sun flower seed meal as a protein source for layers. The effects of substitution on feed intake, dry matter intake, body weight gain, laying percentage and feed conversion ratio were investigated and it was found that Moringa leaves could completely replace soya meal up to 20 % without detrimental effects on layers performance. However, the crude fibre content if high can impair nutrient digestion and absorption (Aderemi, 2003; Omu 2011).

1.2 Statement of the Research Problem

Growing concern about antibiotic growth promoters in poultry nutrition has resulted into efforts being made to use different alternative growth promoting agents. This is because of the emergence of antibiotic resistant pathogens and its residual effects in meat and meat products which constitute adverse effect to consumers (Lee *et al*., 2004). Consequently, this has resulted to a ban on the use of synthetic antibiotics in poultry production (Donoghue, 2003). However, there is limited research work on the combination of these two leaves on the performance of broiler chicken.

1.3 Justification for the Study

The use of antibiotic growth promoters has been criticized due to its possible anti-microbial resistance in humans, thus the search for alternatives. Bans on the use of antibiotics as feed additives have accelerated and led to investigations of natural alternative feed additives in animal
Production (Polatetal, 2011).

Numerous studies have indicated the benefits of bitter leaf (Chiemela *et al.,* 2015*)* and moringa *(*Banjo, 2012) on broiler chicken.

Bitter leaf and moringa are readily available, affordable and possesses a lot of medicinal values with no reported negative effects thus its usage will reduced the cost of poultry production.

1.4 Aim and Objectives of the Study

This study is aimed at generating information on the effect of feeding diets containing bitter leaf and moringa leaf meals with their combinations on the performance and carcass characteristics of broiler birds.

The objectives of the study are to**:**

i. Monitor the growth performance of broiler chickens fed diets containing bitter leaf and moringa leaf meals with their combinations
ii. Assess the nutrient digestibility of broiler birds fed diets containing bitter leaf and moringa leaf meals with their combinations
iii. Determine the effect of feeding diets containing bitter leaf and moringa leaf meals with their combinations on the carcass characteristics of broiler chickens.

CHAPTER TWO

2.0 LITRATURE REVIEW

2.1 Addressing the Problem of High Feed Cost

Rising feed cost and competition between human and animals for food items strongly suggest that alternative energy sources should be used partially or wholly to replace maize in livestock diet to reduce cost of meat production and to make available the major cereals for human consumption (Ngou and Mafeni, 1983). In developing countries, labour is cheap and climatic conditions require simple and inexpensive housing for poultry but feed cost is the most important component accounting for 55 to 75 % (Ensminger *et al*., 1990) and 70-85 % (Opara, 1996) of total production cost of poultry. The bulk of the feedcost arises from protein concentrates such as groundnut cake, fishmeal 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 (Opara, 1996; Esonu *et al*., 2001). According to Moghazy and Elwatak (1982), most experiments on poultry nutrition simply deal with the substitution of one ingredient by another but making sure of maintaining a well-balanced diet. This situation warrants the evaluation of agricultural by-products (nonconventional feeds) and incorporation of suitable ones in poultry feeds (Moghazy and Elwatak, 1982). This is one of the solutions to increase the supply of animal protein. Broiler production should be supported with efficient techniques of incorporating locally available agricultural by-products. The use of agricultural by-products in poultry nutrition represents valuable means of the indirect production of food from waste (El Boushy and Vanderpoel, 2000). There is the need therefore to look for locally available and cheap sources of feed ingredients particularly those that do not attract competition in consumption between humans and livestock. One possible source of cheap protein is the leaf meal of some tropical legumes and browse plants.

According to D’Mello *et al*. (1987) and Opara (1996), leaf meals do not only serve as protein source but also provide some necessary vitamins.

2.2 Bitter Leaf *(Vernonia amygdalina)*

Vernonia amygdalina, a member of the *Asteraceae* family, is a small ever green shrub that grows in tropical Africa. It is a shrub of 1 - 3 m in height with petiole leaf of about 6 mm in diameter and elliptical in shape (Igile *et al*., 1995). The plant is mostly found in West Africa where the most used part is its leaves (called bitter leaf). The leaves are dark green in colour with a characteristic odour and when chewed has a bitter taste but delicious in meals due to its pleasant nostalgic bitterness when it interacts with proteinous ingredients (such as meat, fresh or dry fish) in the soup. Local names by which the plant is called in Nigeria include: *Onugbu* (in Igbo), *Ewuro* (in Yoruba) and *Shiwaka* (in Hausa). The leaves are used as soup condiment and as vegetable after crushing and washing off using water to remove some of the bitterness (Mayhew and Penny, 1998). Other African soups, in which bitter leaf is used apart from *Egusi* soup, include: *Ogbono* and *Okra* soups. In many parts of West Africa, the leaves could also be used for washing slime off fish and snail before cooking while roots and twigs could be used as chewing-stick. All parts of the plant are pharmacologically suspected to be useful. Both the roots and leaves are used in the treatment of fever, hiccups, kidney disease and stomach discomfort, among others (Gill *et al*., 1992; Homoiona and Saffaf, 1994). The plant is claimed to also exhibit anti-helmitic and anti-malaria properties (Abosi and Raserika, 2003) as well as anti-tumourgenic properties (Izevbigie *et al.,* 2004). Locally it is used in treating stomach ache (for immediate relief). The expressed extract is used in treating skin infection such as ringworm, itching, rashes and eczema. It is also claimed to cure diabetes, loss of memory, pneumonia and arthritis (Godwin, 2016).

Studies by Ibironke and Akintola (2017) indicated that *V. amygdalina* fresh leaf had moisture content of 5.66 %; dry matter of 94.12 %; protein 44.86 % and ash content 4.38 %). Its mineral content (per gram) is Phosphorus 61·55 µg; Selenium 8·2 µg; Iron 4·71 µg and Zinc 1·13 µg.

2.3 Moringa Leaf (*Moringa oleifera*)

Moringa oleifera (*M. oleifera*) is the most extensively cultivated tree species of the genus Moringa that belongs to the family *Moringaceae*. *M. oleifera* is a highly valued plant, distributed in different parts of tropics and sub-tropics around the world (Anwar *et al*., 2007). Each part of this tree is edible and could be consumed by humans. The *M. oleifera* tree has numerous vernacular names such as Horse radish tree Marango, Kelor, Drumstick tree, Horseradish tree, Mlonge (Fahey, 2005). *M. oleifera*is considered as one of the most beneficial tree in the world, it has several traditional medicines, industrial and nutritional uses (Fuglie, 1999; Anwar *et al*., 2007; Wadhwa, 2013). This tree is a perennial softwood tree with timber of low quality, as an important crop in some countries in the world such as India, Ethiopia, and Sudan. Moringa tree has also been grown in African countries, Latin America, tropical Asia, and in Pacific (Meena *et al*., 2010). Various parts of *M. oleifera* are highly nutritious and contain important minerals, proteins, vitamins, antioxidant, β-carotene amino acids and various phenolic (Anwar *et al*., 2007). The leaves of *M. oleifera* are a good source of a natural antioxidant due to the presence of various compounds such as ascorbic acid, flavonoids, phenolic and carotenoids (Makkar and Becker, 1997). The antioxidants are capable of performing a number of functions including acting as free radical scavengers, enzyme inhibitors, reduce damage caused by free radical activity and oxidation (Larson, 1988), it have significant role in preventing stress that might cause several degenerative diseases. The tree leaves have also been reported to become a rich source of β-carotene, protein, vitamin C, due to some different elements like calcium and potassium (Dillard and German, 2000). The tree roots and seeds extract have shown to have antimicrobial effects (Wealth, 1966; Eilert *et al*., 1981). *M. oleifera* has enormous medicinal value, and the different parts of the tree leaves, roots, seeds, bark, fruits, flowers and immature pods have been used for treatment of different human diseases in the indigenous medicine especially in South Asia (Anwar *et al*., 2007), and act as cardiac and circulatory stimulants, possess antitumor, antipyretic, antiepileptic, anti-inflammatory, antispasmodic, antioxidant, antibacterial and antifungal activities (Santos *et al*., 2011).

Furthermore, *M. oleifera* is a great potential tree that grow fast and cultivates best in temperature ranging from 25 to 35 ºC, but tolerates up to 48 ºC in the shade and survives a light forest (Palada and Chang, 2003). The drought tolerant species grow healthy in areas with annual rainfall that ranges from 250 mm and 1500 mm for minimum and maximum, respectively. It grows better in a well-drained sandy loam or loam soil but tolerates clay (Palada and Chang, 2003; Coppin, 2008). The Moringa trees are naturally found in tropical climates around different zones in the world, the extent of their adaptability to cooler climates, adaptation to all these stresses is related with metabolic modifications that lead to the increase in several organic solutes such as sugars, prolinepolyols, and amino acids (Tesfay *et al*., 2011).

2.4 Leaf Meals in Broiler Chicken Diets

2.4.1 Sweet potato leaf meal

Tsega and Tamir (2009) assessed the effect of increasing levels (5,10,15 and 20 %) of dried leaves of sweet potato (*Ipomoea batatas*) on dry matter intake and body weight gain of broiler-finisher chickens. They concluded that the optimum inclusion level of 10 % sweet potato leaf meal improved body weight gain of broiler chickens. Teguia *et al*. (1993) used up to 20 % of sweet potato leaf to replace maize in broiler diets. They observed, however, that the leaves of sweet potato have some adverse effects on weight gain and feed consumption. This may be due to the fact that sweet potato leaf is deficient in essential amino acid, lysine, necessitating the inclusion of feed ingredients with adequate lysine contents in poultry diets (Fuller and Chambellain, 1982; Teguia and Beynen, 2005). Mmereole. (2009) conducted an experiment to test the effects of sweet potato leaf as a supplement in broiler chickens diet with or without enzyme (Roxazyme 20 %). The results obtained revealed that the birds fed with diets containing Roxazyme 20 % treated sweet potato leaf proved superior in all parameters evaluated. It was recommended that farmers could include up to 20 % sweet potato leaf with enzyme in their feed formulation for improved broiler production.

2.4.2 Cassava leaf meal

Cassava leaf meal is nutritionally rich in nutrients and could be fed to livestock to supply protein, energy, minerals and vitamins (Okai *et al*., 1984). It contains most of the essential amino acids such as valine (1.06 %), threonine (0.7 %), arginine (1.22 %), histidine (0.49 %), lysine (1.13 %), methionine (0.07 %). Ravindran *et al*. (1986) evaluated cassava leaf meal as a replacement for Coconut Oil Meal in tropical broiler diets and concluded that broilers can tolerate a level of 15 % cassava leaf meal without adversely affecting their growth. The use of high level of cassava leaf meal in broiler diets is limited by its bulkiness, low energy content, methionine deficiency, and the presence of anti-nutritional factors (Ravindran *et al*., 1986). The inclusion of 100 g/kg of a cassava product (50:50 of cassava root and leaf meal) in the broiler diet had no effect on growth, feed conversion, and carcass characteristics (Eruvbetine *et al*., 2003). Iheukwumere *et al*. (2007) carried out a 25-day feeding trial with 120 five-week old Anak broilers to evaluate growth, blood chemistry and carcass yield of broilers fed cassava leaf meal at dietary levels of 0, 5, 10, or 15 %. Results of the trial indicated that, feed intake, bodyweight gain, feed conversion ratio of the control (0 % leaf meal) were superior ($P<0.05$) to the groups on 10 and 15 % leaf meal diets. The total serum protein, albumen and haemoglobin at 0 and 5 % leaf meal were within the normal levels for chickens. Cholesterol, creatinine and urea showed no significant (P>0.05) differences among the treatment groups. The cut parts of the carcass showed superior values (P<0.05) in the control treatment and they differed significantly (P<0.05) from broilers fed on 5, 10 and 15 % leaf meal in carcass yield. They concluded that 5 % of cassava leaf meal could be used in broiler finisher diet without any deleterious effect on growth, blood chemistry and carcass yield.

2.4.3 *Microdesmis puberula* leaf meal (MPLM)

Esonu *et al*. (2002) conducted a 35-day feeding trial involving 180, 5-week old Hubbard broilers to evaluate the performance, nutrient utilization and organ characteristics of broilers fed *Microdesmis puberula* leaf meal at dietary levels of 0, 10 and 15 %. Feed intake, body weight gain, feed conversion ratio and organ weight of birds on the control (0 %) and 10 % leaf meals diets were significantly (P<0.05) superior to those from the group on 15 % leaf meal diet. The utilization of dry matter (DM), crude protein, ether extract and ash was significantly poorer at the 15 % dietary level. It was suggested that 10 % *Microdesmis puberula* leaf meal could be used in broiler finisher diets without any deleterious effects on the birds. In another study Esonu *et al*. (2004) conducted a fifty-day feeding trial to evaluate the MPLM as feed ingredient in laying hen diets. Seven experimental layer diets were formulated incorporating the *Microdesmis puberula* leaf meal at 0.0, 2.5, 5.0, 7.5, 10.0, 12.5 and 15.0 % dietary levels. One hundred and five (105), Shikka brown layers already 10 months in lay were divided into seven groups of 15 birds each and randomly assigned to the seven treatment diets in a completely randomized design. There were no significant (P>0.05) differences in body weight, Haugh unit, shell thickness, yolk index and albumen among the treatments. The results of this study suggest that 15 % *Microdesmis puberula* leaf meal could be used in layers diets without any deleterious effects on performance. Esonu *et al*. (2004) also conducted a thirty-five day feeding trial to evaluate the performance of broiler finishers fed *Microdesmis puberula* leaf meal supplemented with `SafzymeR` (a cellulolytic enzyme). Three broiler finisher diets were formulated to contain 0.0, 12.5 % *Microdesmis puberula* leaf meal without enzyme and 12.5 % *Microdesmis puberula* leaf meal with 0.10 % enzyme. One hundred and twenty (120) four-week-old Hubbard broiler chicks were divided into three groups of forty (40) birds each and randomly assigned to the three treatment diets in a completely randomized design. The result showed that there was significant ($P<0.05$) differences in feed intake between birds on 0.0 % leaf meal diet and birds on 12.5 % leaf meal diet. Daily body weight gain of the birds on the leaf meal with enzyme diet did not significantly ($P>0.05$) differ from birds on leaf meal diets without enzyme supplementation. Birds on 0.0 % leaf meal diet recorded the highest daily bodyweight gain. Feed conversion ratios of all treatment groups were comparable. The result suggests that 0.10 % enzyme supplementation in diets containing 12.5 % *Microdesmis puberula* leaf meal did not improve the performance of broiler finishers.

2.4.4 *Amaranthus cruentus* leaf meal

According to Fasuyi *et al.* (2007), the sun-dried leaves of *Amaranthus cruentus* leaf meal has the following proximate profile: crude protein: 23.0±0.55 %; crude fat: 5.4±0.01 %; crude fibre: 8.8 ±0.02 %; ash: 19.3±0.01 %; gross energy, 3.3±0.01 kcal g-1; and metabolisable energy: 2.8±0.21 kcalg-1 all on dry matter basis. Methionine and to a lesser extent, lysine, arginine, leucine and aspartate were high. Fasuyi *et al.* (2007) evaluated protein supplementary quality of *Amaranthus cruentus* leaf meal in broiler starter diets. The *Amaranthus cruentus* leaf meal was incorporated into six formulated broiler starter diets at varying inclusion levels of 0, 5, 10, 15, 20 and 25 % respectively. The control diet 1 had no *Amaranthus cruentus* leaf meal inclusion. All the six diets including control (diet 1) were isocaloric and isonitrogenous and were fed to the experimental chicks (n = 540). Birds fed diet 2 (5 % *Amaranthus cruentus* leaf meal) had the best average weight gain of 372.9±29.94 g chick-1 butthis was statistically similar to values obtained for birds on Diets 1, 3 and 4. The Nitrogen Retention (NR) and Apparent Nitrogen Digestibility (AND) values obtained for Diet 2 were the highest (1.48±0.24g and 63.12 % ± 10.28, respectively). Except for dressed weight, all the organs weights taken were similar (P>0.05). Haematological results were similar (P>0.05). The results generally indicated that *Amaranthus cruentus* leaf meal could be a useful dietary protein source for broiler starter chicks at 5% inclusion level.

2.4.5 *Gliricidia* leaf meal

Odunsi *et al*. (2002) studied the effect of feeding *Gliricidia sepium* leaf meal on the performance and egg quality of layers. Seventy-two laying hens were allotted to four dietary treatments containing 0, 5, 10 or 15 % *Gliricidia* leaf meal. The inclusion of the *Gliricidia* leaf meal in the layer diets significantly (P<0.05) reduced feed consumption. Layers fed 0 and 5 % *Gliricidia* leaf meal had similar (P>0.05) hen-day egg production, body weight changes and feed conversion ratio but this worsened significantly (P<0.05) at 10 and 15% *Gliricidia* leaf meal levels. Egg quality values showed no significant (P>0.05) differences in terms of egg weight, haugh units and shell thickness while yolk index increased (P<0.05) with *Gliricidia* leaf meal and was found to be best at 10 and 15 % *Gliricidia* leaf meal. Yolk colour was positively enhanced at all levels of *Gliricidia* leaf meal inclusion. Proportionally, egg membrane values were lower (P<0.05) on *Gliricidia* leaf meal diets compared to the control while the egg yolk, albumen and shell were not affected. Results of the study indicated that at dietary levels greater than 5 %, *Gliricidia* leaf meal depressed feed intake and egg production.

2.4.6 *Chromolaena odorata* leaf meal

The response of broiler chickens to dietary inclusion of *Chromolaen aodorata* was studied by Donkoh *et al*. (2002). The study determined the nutrient composition of the leaf meal of the tropical plant *Chromolaena odorata*, and its value as a feed ingredient and colouring agent in broiler chickens diets. *Chromolaena odorata* leaf meal *Chromolaena odorata* leaf meal contained (on dry matter basis) crude protein 218.0 g , crude fibre 141.0 g , and metabolisable energy 5.42 MJ, tannic acid equivalent 143 g. Two hundred and forty, 2-week-old broiler chickens were used in a complete randomised design to evaluate the effect of diets containing varying amounts of *Chromolaena odorata* leaf meal (0, 25, 50 and 75 g/kg) on growth performance and some physiological parameters. The diets were fed *ad libitum* for six weeks. The *Chromolaena odorata* leaf meal addition had an adverse effect on the performance of broiler chickens by reducing feed intake (r=-0.97), body weight gain (r=-0.99), feed conversion ratio (r=0.96), water consumption (r=-0.74) and carcass yield (r=-0.98). Mortality rates were, however, unaffected by dietary treatments. Body colour intensity increased with increasing levels of *Chromolaena odorata* leaf meal. At dietary levels of 0, 25, 50 and 75 g , the skin, beak and 20 shank colour scores on the Roche colour fan were 0, 4.6, 6.8 and 7.9, respectively, Haematological and blood biochemical indices and spleen, liver, heart, gizzard and intestinal weights were unaffected by the level of inclusion of *Chromolaena odorata* leaf meal.

Ekenyem *et al.* (2010) evaluated the effect of *Chromolaena odorata* leaf meal on the growth performance of broiler finisher chickens. The chickens were grouped into four dietary treatments namely 0, 2.5, 5 and 7.5 % *Chromolaena odorata* leaf meal; the treatments were replicated thrice. Initial weights of the birds, that is 633.00, 636.67, 630.00 and 585.67 g for treatments 0, 2.5, 5 and 7.5 % *Chromolaena odorata* leaf meal respectively did not vary significantly (P>0.05). However, significant (P<0.05) differences occurred between the final weights of 2120,00, 2096.67, 2003.33 and 1506.67 g for treatments 0, 2.5, 5.0 and 7.5 % *Chromolaena odorata* leaf meal respectively. Daily weight gain, daily feed intake and feed conversion ratio, showed similar trends for birds on the 0, 2.5 and 5.0 % *Chromolaena odorata* leaf meal diets but differed significantly(P<0.05) from the values for birds on 7.5 % *Chromolaena odorata* leaf meal diets. The results confirmed that *Chromolaena* *odorata* leaf meal could substitute soya bean meal, as feed ingredient for broiler chicks up to 7.5 % but 5.0 % is optimal.

2.4.7 Chaya (*Cnidoscolus aconitifolius*) leaf meal

Donkoh *et al.* (1998) evaluated Chaya (*Cnidoscolus aconitifolius*) leaf meal (CALM) as poultry feed ingredient in a series of two pilot studies. In experiment I, diets containing 25, 50 and 75 g CALM kg−1 were fed, *ad libitum*, to 480 day-old broiler chicks for a period of 8 weeks. Birds had free access to water. The concentration of Chaya (*Cnidoscolus aconitifolius*) leaf meal in the diet had no effect on feed consumption. Overall, significant correlations were found between the concentrations of Chaya (*Cnidoscolus aconitifolius*) leaf meal in the diet and weight gain ($r = -0.98$) and feed: gain ratio ($r= 0.99$). The level of Chaya (*Cnidoscolus aconitifolius*) leaf meal in the diet was shown to be strongly correlated with the carcass dressing percentage ($r = -0.97$). Mortality rates of birds fed CALM – containing diets were markedly lower than for those fed the Chaya free diet. Increased concentrations of red blood cells, haemoglobin, haematocrit and decreased total serum cholesterol as well as increased liver and heart weights were observed in birds fed the diets containing high amounts of Chaya (*Cnidoscolus aconitifolius*) leaf meal. It can be concluded that Chaya (*Cnidoscolus aconitifolius*) leaf meal could be included in chicks' diet at concentrations up to 25 g kg−1 without any adverse effect on performance. In experiment II, 240 broiler chicks were fed diets containing either 0 or 25 g Chaya (*Cnidoscolus aconitifolius*) leaf meal kg−1 and with or without 100 g oil palm slurry kg−1 from day-old to 8 weeks of age. The diets were formulated to be isonitrogenous but not isocaloric. The oil palm slurry containing diets were higher in energy content. Birds fed the oil palm slurry diet and the Chaya (*Cnidoscolus aconitifolius*) leaf meal and oil palm slurry diet gained the highest ($p<0.01$) weight. Carcass dressing percentage followed the same trend. Moreover mortality rates of birds fed the Chaya (*Cnidoscolus aconitifolius*) leaf meal -free diets were markedly higher than those fed the Chaya (*Cnidoscolus aconitifolius*) leaf meal -containing diets.

2.4.8 *Ipomoea asarifolia* leaf meal

Ekenyem and Madubuike (2006a) assessed *Ipomoea asarifolia* leaf meal as feed ingredient in broiler chick production. Two hundred and forty one week old Anak broiler chicks were involved in a 49-day feeding trial in a completely randomized design to assess the effects of 0 %, 5 %, 10 % and 15 % inclusion levels of *Ipomoea asarifolia* leaf meal on the performance, organ and carcass characteristics of broiler chicks. The birds were fed the experimental diets for 28 days while they were fed the finisher diets for the remaining 21 days. The initial weight, final weight, weight gain, feed intake, feed conversion ratio and feed cost per broiler were evaluated. The results showed that the final live weight of birds on the control (0 %) diet i.e. 2.200 kg and the 5 % *Ipomoea asarifolia* leaf meal i.e. 2.050 kg diet were significantly(P< 0.05) higher to the values for birds on the 10 % *Ipomoea asarifolia* leaf meal (1.775 kg) and 15 % *Ipomoea asarifolia* leaf meal (1.600 kg). Feed conversion ratio for the control (0 %) was significantly superior (P< 0.05) to those for the 10 % and 15 % *Ipomoea asarifolia* leaf meal inclusions, while 0 % and 5 % levels were statistically similar (P>0.05). Daily feed intake at the 0 %, 5 % and 10 % levels were significantly higher (P< 0.05) than that of 15% level of *Ipomoea asarifolia* leaf meal inclusion. Dressed weights for 0 % and 5 % levels were similar (P>0.05) but superior (P< 0.05) to 10 % and 15 % levels. Ekenyem and Madubuike (2006a) concluded that from the results of the experiment the optimum inclusion level of *Ipomoea asarifolia* leaf meal in broiler diets is between 5 % and 10 % and they recommended that a further research was necessary to improve the nutritive value of *Ipomoea asarifolia* leaves for livestock because of its abundance and cheapness for improved meat production.

A 49-day feeding trial involving 240 one-week old Anak broiler chicks was carried out by Ekenyem and Madubuike (2006b) to study the haematology and serum biochemistry of broilers fed varying dietary inclusion levels of *Ipomoea asarifolia* leaf meal. The birds were grouped into four dietary treatments namely: 0 %, 5 %, 10 % and 15 % levels of *Ipomoea asarifolia* leaf meal, which were further replicated 4 times in a completely randomized design. Results of the haematology parameters showed significant (P<0.05) differences between treatments, indicating that *Ipomoea asarifolia* leaf meal influenced the values of the parameters. However, packed cell volume and Eosinophil did not significantly (P>0.05) differ between their treatments. Ekenyem and Madubuike (2006a) concluded that the *Ipomoea asarifolia* leaf meal influenced the serum chemistry of Anak broilers as their values reduced with increasing levels of *Ipomoea asarifolia* leaf meal.

2.4.9 Neem leaf meal

Opara *et al.* (2006) conducted a twelve week feeding trial to evaluate the effects of Neem (*Azadirachta indica*) leaf meal on body weight gain, carcass and organ characteristics and haematological values of laying hens. Four layer diets were formulated to contain the Neem leaf meal at 0 %, 5 %, 10 % and 15 % dietary levels respectively and were used to feed 120 Shikka Brown layers already 10 months in lay. The birds were divided into 4 groups of 30 each and randomly assigned to four treatment diets in a completely randomized design. The Neem leaf meal inclusion did not cause any appreciable difference in weight gain between the birds at 0 % and those at 5 %, 10 % dietary levels. Carcass weight, dressed weight, liver, heart and gizzard weights were significantly (P<0.05) increased at the 5 % dietary level of Neem leaf meal.

The performance and economic indices of broilers fed varying dietary levels of sun dried Neem leaf meal were investigated by Onyimonyi *et al.* (2009) using ninety 'Ross' unsexed two weeks old broilers. The birds were randomly assigned to five treatment groups of eighteen birds each in which

Neem leaf meal was incorporated at 0, 0.5, 1.0, 1.5 and 2 % for treatments 1, 2, 3, 4 and 5 respectively. Each treatment was further replicated twice with nine birds per replicate in a completely randomized design. Results showed that treatment effects on Average Final Body Weight (AFBW), Average Daily Gain (ADG), Average Daily Feed Intake (ADFI) and Feed Conversion Ratio (FCR) were significant ($p<0.05$). Birds on the 0.5 % Neem leaf meal had significantly ($P<0.05$) superior AFBW, ADG and FCR. The ADFI of birds on the 0.5 % Neem leaf meal was statistically the same with the control birds but differed from the Neem leaf meal remaining treatments. Gross margin analysis revealed that a profit of ₦ 707.30 was made per bird on the 0.5 % Neem leaf meal as against ₦ 630.97, ₦ 620.73, ₦ 621.81 and ₦ 507.06 for birds on the control, 1.0, 1.5 and 2.0 % Neem leaf meal respectively. It was concluded that inclusion of 0.5 % Neem leaf meal in the diets of broilers would support optimum performance and economic benefit.

2.5 Use of Herbs in Poultry Production

Antibiotic growth promoters have been helpful in improvement of growth performance and feed conversion ratio in poultry (Miles *et al.*, 2006; Dibner and Buttin, 2002; Izat *et al.*, 1990). However, constant treatment of poultry by antibiotic may result in residues of these substances in poultry products and bacteria resistance against treatments in human body. Due to such threats to human health, use of antibiotics in poultry is banned (Owens *et al.*, 2008; Alcicek *et al.*, 2004; Botsoglou and Fletouris, 2001; Hinton, 1988). Many studies have been carried out on using additives, including herbs, as alternatives to antibiotics, with direct or indirect effects on intestinal microflora, in poultry products (Taylor, 2001). Several studies have shown antimicrobial properties of herb extracts (Cowan, 1999; Hammer *et al.*, 1999) which can improve intestinal microflora population and enhance health in birds' digestive systems through reduction in number of disease-making bacteria (Mitsch *et al.*, 2004). In addition, modified harmful microbial population in intestines will change intestinal morphology.

Intestinal health is of great importance in poultry for improved performance and reduced feed conversion ratio (Montagne *et al.*, 2003). However, properties of other herbs, such as antioxidant, antiviral, or immunomodulatory properties and their effects on performance and digestive health cannot be ignored.

2.6 Growth Performance of Broiler Birds fed Herbal Feed Additives

David *et al.* (2012) reported the effects of herbal feed additives on body weight gain, feed consumption and feed conversion ratio of broiler chicks during the starter (0-21 days) and finisher (22-42 days) for a total (0-42 days) periods. Their results showed that there were significant ($P<0.05$) differences recorded in the body weight gain and FCR during finisher periods. There was a significant difference in feed intake of the chicks. The positive control diet and the diets supplemented with herbal feed additives significantly improved the body weight gain and FCR of broiler chicks during finisher periods compared to the negative control. Their findings revealed that a growth promoter effect was exerted by the herbal feed additives similar to the antibiotic growth promoter. In addition, the herbal feed additives improved the FCR of broiler chicken similar to the antibiotic growth promoter.

Several research findings reported that herbal extracts could increase the broiler performance by improving live weight gain and FCR of broiler chicken (Jamroz and Kamel, 2002; Jamroz *et al.*, 2003; Al-Kassie and Jameel, 2009). In contrast, Botsoglou *et al.* (2002) showed that oregano oil showed no growth promoting effect when administered at 50 or 100 mg/kg of feed. The broiler chickens fed with diets containing the commercial herbal product, Zigbir recorded the lowest FCR during total period and the highest body weight gain during finisher period. This might be due to the digestion stimulatory and the gastroprotective effects as reported by Abdulla *et al*. (2010), for the herbal components *Androgra phispaniculata* and *Phylanthus niruri* in the commercial herbal product Zigbir.

Abubakar *et al*. (2010) reported that phytogenic feed additives are often associated with the improvement of flavour and palatability of feed, thus bitter leaf extract enhances production performance of birds. Onunkwo *et al*. (2015) evaluate the effects of *Moringa oleifera* Leaf Meal (MOLM) on growth performance and carcass characteristics of boiler chicks. A total of 120 day-old broiler chicks of the ANAK – 2000 strain were weighed and allotted to four (4) experimental groups in a completely randomized design and fed graded levels (0.0 %, 5.0 %, 7.5 % and 10 %) of MOLM for seven weeks (49 days). The experimental groups, which were designed as Treatment T1, T2, T3 and T4 respectively the result shows that birds fed diet with 0% *Moringa oleifrea* leaf meal gained significantly (P<0.05) higher weight than birds fed *Moringa oleifrea* leaf meal based diets. Birds on T2, T3, and T4 were observed to be analogous in average daily weight gain but its value decreased as inclusion of *Moringa oleifrea* leaf meal increased. This confirmed the observations made by Ash and Petaia (1992) and Olugbemi *et al*., (2010) that increasing inclusion level of leaf meals in broiler diets results in depressed growth performance. This observation could be generally traced to increasing fiber content of the diet which may have impaired nutrient digestibility and absorption (Ige *et al*., 2006 and Onu, 2010). It could also be attributed to the crude protein content or palatability of the control feed which enhances its acceptability and utilization. The negative effect of the anti-nutritional factors and phytochemical compounds present in *Moringa oleifrea* leaf meal on the birds could be responsible for decreasing performance.

Moringa oleifera leaves contain tannin at 1-23g/kg (Kakengi, 2003). Leaf meals are generally bitter in taste, therefore, the inclusion of MOLM in the diets could have resulted in reduced palatability and thus reduce feed intake of the broiler diets. Omekam (1994) observed that unpalatability nature of a feedstuff will consequently prevent chicks from consuming adequate quantity of the feed. There was a significant decrease in the feed conversion ratio of the birds fed *Moringa oleifrea* leaf meal based diets than birds that are fed without *Moringa oleifrea* leaf meal. This suggests that birds fed *Moringa oleifrea* leaf meal based diets had better utilization potential of the nutrients probably because of the increased bulkiness as inclusion level increased.

2.7 Carcass Characteristics of Broilers Chickens fed Herbal Feed Additives

David *et al.* (2012) reported the effects of herbal feed additives on the carcass characteristics of broiler chickens. The results of the study indicated that all the herbal dietary treatments improved ($P<0.05$) the live weight and carcass yield significantly. The herbal dietary supplements increased ($P<0.05$) the live weight, weight after bleeding, weight after defeathering and dressing percentage of broiler chicken similar to the positive control diet. This might be due to the improvement in the digestibility of feed ingredient by the inclusion of herbal dietary supplements (Jamroz *et al.,* 2003) and the growth promoting effect of antibiotics in positive control. The findings supported the concept that plant extracts improved the carcass yield of broiler chicken as reported by Alcicek *et al*. (2004). Moreover, the findings revealed that live weight, weight after bleeding, weight after defeathering increased with increasing levels of *Moringa* leaf and fruit powders. Total organ weights were found to be lower in the birds fed with antibiotic as well as 0.05 % *Moringa* fruit powder. This might be due to the gut thinning and shortening effect of antibiotics as reported by Visek (1978). A significant effect of herbal dietary treatment was not observed on (neck, breast and leg) of broiler carcass and on a (heart and vent) except the fat around gizzard. The findings is similar to the observation made by Sarica *et al*. (2005), and Cabuk *et al*. (2006), that, oregano leaf extracts had no significant effect on the carcass characteristics of birds. The dietary herbal supplement of 0.1 % of *Moringa* fruit powder increased the gizzard fat content while 0.1 % of *Moringa* leaf powder reduced the same. Sarica *et al*. (2005), and Cabuk *et al*. (2006) suggests that different parts of the plants have varying effects on the carcass characteristics of birds. The result of the carcass quality of the birds given 0, 25, 50 and 75 ml of bitter leaf extract shows that most of the parameters for T3 and T4 are comparable. However, T3 and T4 had higher values in some of the parameters when compared to T1 and T2. Abubakar *et al.* (2010) observed variation in carcass characteristics of broiler birds fed varying levels of garlic. The values for dressing percentage were significantly higher in T4. Tarek *et al.* (2013) reported no significant difference on thigh, drum stick, wings, breast and back on birds fed olive leaf extract. This may be as a result of different leaf extract of shrubs used. The significant ($P<0.05$) higher dressing percentage of birds on T3 and T4 in this study confirms a better and most efficient utilization of nutrients in terms of digestion, absorption and assimilation as reported by Bamgbose *et al.*, (1999). According to the results by Odoemelam *et al.*, (2013), the inclusion of bitter leaf in broiler diets leads to improvement in body weight, dressing percentage and significantly promoted higher dressed weight and carcass quality.

2.8 Cost Analysis of Broiler Birds Fed Herbal Feed Additives

Chiemela *et al*. (2016) worked on effect of *vernonia amygdalina* (Bitter Leaf) Extract on growth performance, carcass quality and economics of production of broiler chickens as the result of economics of production of the inclusion of bitter leaf aqueous extract on broiler chickens revealed that the cost/kg feed consumed/bird as well as cost of production increased with increase in the quantity of bitter leaf in the drinking water. Onukwo *et al.* (2015) reported that dietary inclusion of *Moringa oleifera* leaf meal reduced the cost of producing in kilogram of feed and this was reflected in the cost of a kilogram weight gain. The lower feed cost per kilogram of meat produced on the leaf meal incorporated up to 7.5 % level suggests that the material is economically viable alternative feed ingredient. The high cost feed/bird recorded in the control was due to non-inclusion of moringa. The cost of a kilogram of feed progressively declined with increased leaf meal incorporation in the diets. The cost of a kilogram weight gain was similar ($P>0.05$) in all the treatment groups but higher in birds fed 10 % leaf meal diet. The costs of kilogram weight gain of the leaf meal based diets were lower than the control diet. Their observation could be traced to reduced daily gain of the birds fed 10 % *Moringa* oleifera leaf meal. This implies that it is cheaper to produce a kilogram of leaf meal based feed and one kilogram of broiler meat when *Moringa* oleifera leaf meal was incorporated up to 7.5 % level in broiler diets. khule *et al*. (2007) also reported that non-conventional feed stuff often reduces feed cost. This confirms that there is better economic gain by feeding moringa to broilers since it has the potential of reducing feeding cost of broilers. Reduced cost of a kilogram of feed and cost of kilogram weight gain when oil palm leaf meal was incorporated up to 10 % in the broiler diets have been reported (Esonu *et al*., 2008). This could be relatively cheaper leaf meal which replaced proportions of costlier soya bean and palm kernel meal in the leaf meal based diets

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Location of the Research Study

The experiment was carried out at the Poultry Unit of the Department of Animal Production, Teaching and Research Farm, School of Agriculture and Agricultural Technology, Federal University of Technology Minna. Minna is the capital of Niger State and it is situated at latitude 9^{o} 33` North and longitude 9$^{o}$ 37` East. The mean annual rainfall ranges between 1200 mm and 1300 mm and mean annual temperature is between 38 ^{o}C and 42 ^{o}C. Geographically, Minna is located in the Southern Guinea Savanna vegetation belt of Nigeria and it is characterized by wet and dry seasons. (Niger State Agricultural Development Project, 2009).

3.2 Source of Experimental Materials.

Fresh bitter leaf, moringa leaf and other feed ingredients was purchased from Kure Modern Market, Minna, Niger State, Nigeria. The broilers were obtained from an Agent of Chikun Chicks Kaduna, Kaduna state.

3.3 Preparation of Bitter Leaf and Moringa Leaf Meal

Fresh bitter leaf and moringa leaf were washed thoroughly without squeezing with clean water to remove dirt (sand and dust). The washed leaves were air dried at room temperature (38 ^{o}C) for two weeks until they become brittle. The dried leaves were pulverized using a hammer mill and then sieved through a (2 mm) siever. Thereafter, they were stored separately in plastic containers until needed for use. The powdered bitter leaf and moringa leaf meal were then mixed with other feed ingredients to formulate the diet used for the experiment (Table 3.1).

Table 3.1: Experimental diet of broiler birds containing Bitter Leaf and Moringa Leaf Meals with their combinations

	B_0M_0	B_2M_0	B_0M_2	B_2M_2	B_4M_0	B_0M_4
Ingredients	0 %	2 %	2 %	2,2 %	4 %	4 %
Maize	44.00	43.00	43.00	46.00	43.00	43.00
maize offal	8.00	8.00	9.00	3.00	7.00	6.00
Groundnut cake	6.00	5.00	5.00	3.00	3.00	3.00
Full fat soya	35.00	35.00	34.00	37.00	36.00	37.00
Fish meal	2.00	2.00	2.00	2.00	2.00	2.00
Limestone	2.00	2.00	2.00	2.00	2.00	2.00
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin Premix	0.25	0.25	0.25	0.25	0.25	0.25
L-Lysine	0.25	0.25	0.25	0.25	0.25	0.25
DL-Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Bitter leaf	0.00	2.00	0.00	2.00	4.00	0.00
Moringa leaf	0.00	0.00	2.00	2.00	0.00	4.00
TOTAL	100	100	100	100	100	100
Crude Protein %	22.00	22.00	22.00	22.00	22.00	22.00
M.E (kcal/kg)	3156.5	3101.05	3150.06	3102.14	3066.55	3164.56
Crude Fiber (%)	4.26	4.08	4.43	4.25	4.43	4.35
Ether Extract (%)	8.85	7.70	8.74	8.20	9.03	8.74
Lysine (%)	1.35	1.25	1.31	1.21	1.33	1.28
Methionine (%)	0.87	0.85	0.84	0.81	0.84	0.83
Calcium (%)	1.45	1.65	1.47	1.58	1.55	1.59
Phosphorus (%)	0.44	0.41	0.44	0.43	0.44	0.43

Key ME – Metabolizable energy, B_0M_0 – control no bitter leaf and moringa leaf meals, B_2M_0 – contains 2 % of bitter leaf and 0 moringa leaf meals, B_0M_2 – contains 0 % of bitter leaf and 2 % of moringa leaf meals, B_2M_2 contains 2 % bitter leaf and 2 % moringa leaf meals B_4M_0 – contains 4 % bitter leaf and 0 % moringa leaf meals, B_0M_4 contains 0% of bitter leaf and 4% moringa leaf meals.

3.4 Experimental Design

A total of one hundred and eighty (180) day-old Chikun boiler chicks were used for the study. The birds were randomly allotted into six treatment groups B_0M_0, B_2M_0, B_0M_2, B_2M_2, B_4M_0 and B_0M_4 respectively. Each treatment had three replicates. There were ten birds per replicate. A completely randomized design was used. B_0M_0 (control) contained 0 % bitter leaf meal and 0 % moringa leaf meal, B_2M_0 and B_0M_2 contained 2 % of bitter leaf meal and 2 % of moringa leaf meal while B_2M_2 contained 2 % combination each of bitter leaf and moringa leaf meal while B_4M_0 and B_0M_4 contained 4 % of both bitter leaf and moringa leaf meal separately as indicated in (Table 3.1).

3.5 Management of the Experimental Birds

The birds were housed in deep litter system where they received uniform care and management. The experiment lasted for eight weeks. Light were provided 24 hours daily, while feed and clean cool drinking water were given *ad libitum* throughout the experimental period. An open sided wall house were used and experimental birds were managed on deep litter system. Prior to the arrival of the birds, the pens were subjected to thorough washing with disinfectant (Izal® solution), followed by scrubbing, cleaning, removal of debris and cobwebs. The outer wall of the pens were properly covered with tarpaulin in order to avoid heat loss. Fresh wood shavings were spread to a depth of 5 cm in order to help in conserving heat, particularly during the brooding stage. Abacha lamps and rechargeable lamps were used as sources of lighting, and charcoal stoves were used as sources of heat during the brooding stage. Other appliances such as drinkers and feeders were also provided.

3.6 Data Collection

On arrival, the initial live weights of chicks were taken at the commencement of the experiment. Thereafter, average live weights per bird were measured at weekly intervals by weighing the chicks in each pen and the total weight was divided by the total number of birds in each pen. These live weights were used to calculate growth rates of the chicks. Weekly mean feed intakes were determined until termination of the experiment. These weights were used to calculate daily mean feed intake. Feed conversion ratio per pen was calculated as total feed consumed divided by the weight gain of the birds in that pen.

3.7 Growth Performance

The parameters that were measured under growth performance included: feed intake, body weight gain and feed conversion ratio.

3.7.1 Feed intake

A known quantities of feed were offered every morning and the left over were measured the next morning. The difference between the feed offered and the leftover was considered as feed intake. Average feed intake was calculated using the formula below.

$$\text{Avearage feed intake (g)} = \frac{\text{Quantity of feed given (g)} - \text{Quantity of leftover (g)}}{\text{Number of birds}}$$

3.7.2 Body weight gain

This was calculated from the body weight data. Body weight gain was obtained by subtracting the previous week body weight from the current week body weight.

Body weight gain (g) = Present week weight (g) - Previous week weight (g)

3.7.3 Feed Conversion Ratio (FCR)

Feed conversion ratio was computed as the ratio of feed intake to body weight gain (g).

Feed Conversion Ratio (FCR) = $\frac{\text{Average weekly feed intake (g)}}{\text{Avearageweeklyweightgain(g)}}$

3.8 Apparent Nutrients Digestibility

The total collection method was used. Digestibility was measured when the chicken were between 56 and 64 days old. It was conducted in specially designed metabolism cages having automated and separate watering and feeding troughs. Three birds per replicate were randomly selected from each treatment and transferred to metabolism cages for measurement of apparent digestibility of nutrients. They were allowed three days acclimatization, thereafter, they were fasted overnight and feed and water were served *ad-libitum* to the chickens. Their total droppings were collected for four days and oven dried at 68 ^{o}C until a constant weight was gotten daily and the replicates from each treatment were bulked and used for proximate analysis. Proximate composition of the feed and droppings were analyzed in the Animal Production Laboratory. Care was taken to avoid feathers, scales, feeds and debris mixing with the droppings. The apparent nutrients digestibility was determined using the formula below.

$$\text{Digestibility coefficient} = \frac{\text{Nutrient in feedintake} - \text{nutrient in droppings voided}}{\text{Nutrient infeedintake}} \times 100$$

(Aduku and Olukosi, 1990)

3.9 Carcass and Organ Measurements

At the end of the experiment, three birds per replicate were randomly selected from each of the treatments and were used for the carcass evaluations and organ measurements. The birds were kept off-feed overnight to empty their gut before weighing and slaughtering the next morning. The birds were defeathered and the inner organ was removed. The birds were dressed and the dressed weight and dressing percentage (carcass yield) were computed. Cut-up parts were all weighed and expressed as percentage of live weight. The visceral organs for each bird, which included full gizzard, liver, full intestine, heart, spleen, abdominal fats and caeca were also weighed and expressed as percentage of live weight.

3.10 Sensory Evaluation of Birds

The sensory evaluation of meat of broiler chicken was performed according to the methodology of Dutcosky, (2007). The cut sample of the breast was cooked for twenty minutes in 500 mls of water with a pinch of common salt in an aluminum pot without any other spice added. The meats were served to a 20 man semi-trained panelists, comprising of staff and students which were randomly selected from the School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Nigeria. A 9- point hedonic rating scale from 1 to 9 (1: disliked extremely; 2: dislike very much; 3: dislike moderately; 4: dislike slightly; 5: neither like nor dislike; 6: like slightly; 7: like moderately; 8: like very much; 9: like extremely) was used to evaluate the following characteristics of the chicken meat: aroma, flavour, colour, texture and overall acceptability.

3.11 Chemical Analysis

Dry matter of the feeds and faecal samples were determined by drying the samples in the oven for 24 hours at a temperature of 105 °C. Faeces were oven-dried before analysis according to the method of (AOAC, 2005). Ash contents of the feeds and faeces were analysed by ashing the samples at 600 °C in a muffle furnace overnight. The determined chemical compositions of the feed were used to calculate apparent nutrients digestibility of the broiler chickens fed bitter leaf meal, moringa leaf meal and their combinations.

3.12 Data Analysis

All data collected on feed intake, body weight gain, apparent nutrient digestibility, feed conversion ratio and carcass characteristics of the chickens were analysed by one-way analysis of variance using (SAS 2015).

CHAPTER FOUR

4.0 RESULTS

4.1 Proximate Composition of Bitter Leaf Meal and Moringa Leaf Meal

The results of the proximate composition of bitter leaf and moringa leaf meals are presented in Table 4.1. The results showed that bitter leaf meal had 3.98 % moisture content, 29.00 % crude protein content, 0.98 % ether extract content, 6.14 % ash content, 10.84 % crude fibre content and 53.04 % nitrogen free extract content respectively. While moringa leaf meal had 2.16 % moisture content, 34.40 % crude protein content, 1.24 % ether extract content, 11.50 % ash content, 11.50 % crude fibre content and 41.36 % nitrogen free extract.

4.2 Proximate Composition of the Experimental Diet fed to Broilers

The results of the proximate composition of bitter leaf and moringa leaf meals are presented in Table 4.2. The results showed that bitter leaf meal had 3.98 % moisture content, 29.00 % crude protein content, 0.98 % ether extract content, 6.14 % ash content, 10.84 % crude fibre content and 53.04 % nitrogen free extract content respectively. While moringa leaf meal had 2.16 % moisture content, 34.40 % crude protein content, 1.24 % ether extract content, 11.50 % ash content, 11.50 % crude fibre content and 41.36 % nitrogen free extract.

4.3. Effect of Bitter Leaf Moringa Leaf Meals and their Combinations on Growth Performance of Broiler Chickens

Results of the effect of bitter leaf moringa leaf meals and their combinations on growth performance of broiler birds are presented in Table 4.3. The results obtained indicates that Bitter leaf Moringa leaf meals and their combinations diets had no significant ($P>0.05$) different on final weight, total weight gain, daily weight gain and mortality. However, total feed intake, daily feed intake and feed conversion ratio were influenced ($P<0.05$) by the dietary treatments. The results on feed intake

Table 4.1. Proximate composition of bitter leaf meal and moringa leaf meal

Nutrient %	Bitter Leaf Meal	Moringa Leaf Meal
Moisture	3.98	2.16
Crude protein	29.00	34.40
Ether extract	0.98	1.24
Ash	6.14	11.50
Crude fibre	10.84	11.50
Nitrogen free extract	53.04	41.36
Metabolizable energy	336.39	314.2

Table 4.2. Proximate Composition of the Experimental Diet Fed to Broilers

Nutrients	B_0M_0	B_2M_0	B_0M_2	B_2M_2	B_4M_0	B_0M_4
Moisture %	7.84	8.11	8.33	7.62	7.48	8.11
Crude protein%	19.60	24.00	24.06	22.75	24.00	25.38
Crude fibre %	6.90	6.15	6.15	8.20	8.20	8.35
Ash %	8.52	8.25	7.07	8.74	8.22	8.04
Ether extract %	5.48	6.73	7.48	6.33	7.24	6.92
Nitrogen free extract%	51.66	46.76	46.94	46.38	44.86	43.20
TDN	90.49	92.65	93.91	91.52	93.35	92.50

Note: TDN: Total digestible Nutrient, B_0M_0 – control no bitter leaf and moringa leaf meals, B_2M_0 – contains 2 % of bitter leaf and 0 moringa leaf meals, B_0M_2 – contains 0 % of bitter leaf and 2 % of moringa leaf meals, B_2M_2 contains 2 % bitter leaf and 2 % moringa leaf meals B_4M_0 – contains 4 % bitter leaf and 0 % moringa leaf meals, B_0M_4 contains 0% of bitter leaf and 4% moringa leaf meals.

indicated that birds on B_0M_0, B_0M_2 and B_0M_4 diets had similar (P>0.05) values. However birds on B_2M_0, B_2M_2 and B_4M_0 diets had lower (P>0.05) total feed intake than those on B_0M_0, B_0M_2 and B_0M_4 diets.

Daily weight gain results indicates that birds on B_0M_0, B_0M_2 and B_0M_4 diets had similar (P>0.05) daily feed intake. Similarly birds on B_2M_0, B_2M_2 and B_4M_0 diets had similar (P>0.05) values. However birds on B_0M_0, B_0M_2 and B_0M_4 diets had higher (P<0.05) daily weight gain than those on B_2M_0, B_2M_2 and B_4M_0 diets. Results on feed conversion ratio showed that birds B_4M_0 diet the best (P<0.05) feed conversion ratio than birds on other dietary treatments followed by birds on B_2M_2 diet. However birds on B_0M_0, B_2M_0 and B_0M_2 diets had similar (P>0.05) values. Birds on B_0M_4 diet had the lowest (P>0.05) value compared to other dietary treatments.

4.4 Apparent Nutrient Digestibility (%) of Broilers Chicken Fed Bitter Leaf Moringa Leaf Meals Diets.

The results of the apparent nutrient digestibility of broiler chickens fed diets containing bitter leaf meal, moringa leaf meal and their combinations are presented in Table 4.3. All the parameters measured were significantly (P<0.05) influenced by the dietary treatments. Birds on 2 % moringa leaf meal diet had the highest dry matter, ether extract, ash and nitrogen free extract digestibility and their values were significantly (P<0.05) higher than those on other treatments. Birds on 4 % bitter leaf meal diets had lowest dry matter, crude protein and nitrogen free extract digestibility and there values were significantly (P<0.05) lower than those on other treatments. Birds on 4 % moringa leaf meal diets had the highest crude protein and crude fibre digestibility and their values were significantly (P<0.05) higher than those on other treatment.

Table 4.3. Effect of bitter leaf moringa leaf meals diets on growth performance of broiler chickens

	Treatments							
Parameter	B_0M_0	B_2M_0	B_0M_2	B_2M_2	B_4M_0	B_0M_4	SEM	P-Values
Average initial weight (g)	57.91	56.03	56.20	56.26	56.60	56.23	0.265	0.35
Average final weight (g)	1233	1000	1266	1100	1133	1200	38.11	0.38
Average weight gain (g)	1175.09	943.97	1209.80	1043.74	1076.40	1143.77	38.15	0.39
Average daily weight gain (g)	18.65	14.94	19.21	16.56	17.09	18.15	0.605	0.39
Average feed intake (g)	3213^{a}	2308^{b}	3264^{a}	2308^{b}	1938^{b}	3373^{a}	1.45	0.01
Average daily feed intake (g)	51.00^{a}	37.27^{b}	51.82^{a}	36.63^{b}	30.77^{b}	53.53^{a}	2.31	0.01
FCR	2.76^{bc}	2.51^{bc}	2.70^{bc}	2.21^{ab}	1.84^{a}	2.98^{c}	0.109	0.01
Mortality (%)	26.66	23.33	26.66	33.33	33.33	13.33	3.62	0.68

^{abc} = means with different superscripts in the same row were significantly ($P<0.05$) different.
SEM= standard error of mean
FCR = Feed conversion ratio
P-Values= probability value
B_0M_0 – control no bitter leaf and moringa leaf meals, B_2M_0 – contains 2 % of bitter leaf and 0 moringa leaf meals, B_0M_2 – contains 0 % of bitter leaf and 2 % of moringa leaf meals, B_2M_2 contains 2 % bitter leaf and 2 % moringa leaf meals B_4M_0 – contains 4 % bitter leaf and 0 % moringa leaf meals, B_0M_4 contains 0% of bitter leaf and 4% moringa leaf meals.

Table 4.4. Apparent Nutrient Digestibility (%) of Broilers Fed Bitter Leaf Moringa Leaf Meals and their combinations

PARAMETRS	B_0M_0	B_2M_0	B_0M_2	B_2M_2	B_4M_0	B_0M_4	SEM	p-values
Dry matter (%)	73.99^c	67.76^d	79.03^a	52.89^e	52.92^f	79.92^b	2.77	0.15
Crude protein (%)	63.45^c	58.67^d	72.46^b	43.64^e	39.02^f	72.65^a	3.93	0.42
Crude fiber (%)	86.79^b	79.18^e	81.53^d	70.49^f	82.78^c	89.72^a	1.84	0.23
Ether extract (%)	69.11^c	66.73^d	76.52^a	52.32^f	54.38^e	71.74^b	2.67	0.12
Ash (%)	38.88^c	24.36^d	44.46^a	38.31^c	38.78^c	40.44^b	1.88	0.11
NFE (%)	84.89^b	81.91^d	89.49^a	80.09^e	70.87^f	84.45^c	1.73	0.13

abc= means with different superscripts on the same row are significantly ($P<0.05$) different.
SEM= standard error of mean
NFE = Nitrogen free extract
B_0M_0 – control no bitter leaf and moringa leaf meals, B_2M_0 – contains 2 % of bitter leaf and 0 moringa leaf meals, B_0M_2 – contains 0 % of bitter leaf and 2 % of moringa leaf meals, B_2M_2 contains 2 % bitter leaf and 2 % moringa leaf meals B_4M_0 – contains 4 % bitter leaf and 0 % moringa leaf meals, B_0M_4 contains 0% of bitter leaf and 4% moringa leaf meals.

4.5 Carcass Characteristics of Broiler Chickens Fed Bitter Leaf Moringa Leaf Meals Diets

The results of the carcass characteristics of broiler chickens fed bitter leaf moringa leaf meals and their combinations are shown in Table 4.5. The results indicated that bitter leaf moringa leaf meals and their combinations had no significant effect (P>0.05) on live weight, slathered weight, drum stick, gizzard, liver, heart and wings. However eviscerated weight, breast, thigh and abdominal fat were influenced (P<0.05) by the dietary treatments. The results on eviscerated weight showed that birds on B_0M_0 and B_0M_2 diets had similar (P<0.05) values. However, birds on B_2M_2, B_4M_0 and B_0M_4 diets had similar (P<0.05) values, while birds on B_0M_2 diets had the least (P>0.05) values. Results of breast indicated that birds on B_0M_0 diet had higher (P<0.05) values compared to other dietary treatments. Birds fed B_2M_0, B_0M_2, B_2M_2 and B_0M_4 diets had similar (P<0.05) values. While birds on B_4M_0 diet had lowest (P>0.05) value. Results of thigh shown that birds of B_2M_2 diet had higher (P<0.05) value than birds on other dietary treatments. However birds on B_0M_0, B_0M_2, B_4M_0 and B_0M_4 diets had similar (P<0.05) values. Birds on B_2M_0 diet had the least (P>0.05) values. The results of abdominal fat indicates that birds on diet had higher (P<0.05) values than all other dietary treatments. However birds on B_0M_0, B_4M_0 and B_0M_4 diet had similar (P<0.05) values. Similarly birds on B_2M_0 and B_0M_2 diet had lower (P>0.05) values.

4.6 Sensory Evaluation of Broiler Chicken Fed Bitter Leaf Moringa Leaf Meals diets

The results of sensory evaluation of broiler chickens fed bitter leaf moringa leaf meals and their combinations are presented in table 4.5. The results showed that there were no significance (P<0.05) difference in all the parameters measured.

Table 4.5. Carcass characteristics of broiler chickens fed bitter leaf and moringa leaf meals diets

Parameters	B_0M_0	B_2M_0	B_0M_2	B_2M_2	B_4M_0	B_0M_4	SEM	p-values
Live weight (g)	1233.33	1000.00	1266.67	1100.00	1133.33	1200.00	38.11	0.38
Slathered weight (g)	1050.00	833.33	1083.33	966.67	933.33	1066.67	29.67	0.23
Eviscerated weight(g)	866.67^{a}	633.33^{b}	866.69^{a}	800.00^{ab}	766.67^{ab}	833.33^{ab}	29.67	0.31
Dressing percent (%)	70.00	63.00	68.00	72.00	67.00	69.00	12.00	0.18
Breast (%)	15.71^{a}	13.26^{ab}	14.50^{ab}	15.38^{ab}	8.70^{b}	13.73^{ab}	0.89	0.17
Drum stick (%)	8.43	8.14	8.66	9.58	8.13	9.23	0.28	0.07
Thigh (%)	10.04^{ab}	8.21^{b}	8.94^{ab}	10.89^{a}	8.59^{ab}	9.69^{ab}	0.34	0.72
Gizzard (%)	3.21	2.74	2.74	3.07	2.44	2.40	0.14	0.15
Liver (%)	2.61	3.61	2.65	2.43	2.74	2.78	0.17	0.71
Heart (%)	0.98	0.75	0.63	0.73	2.18	0.60	0.27	0.61
Proventiculus (%)	0.94	0.99	0.86	0.99	1.06	0.86	0.06	0.88
Abdominal fat (%)	1.60^{ab}	0.26^{c}	0.00^{c}	2.45^{a}	0.93^{bc}	0.95^{bc}	0.24	0.00
Wing (%)	9.45	9.66	9.42	10.50	9.39	10.35	0.34	0.95

^{abc} = means with different superscripts on the same row are significantly ($p<0.05$) different.
SEM= standard error of mean
B_0M_0 – control no bitter leaf and moringa leaf meals, B_2M_0 – contains 2 % of bitter leaf and 0 moringa leaf meals, B_0M_2 – contains 0 % of bitter leaf and 2 % of moringa leaf meals, B_2M_2 contains 2 % bitter leaf and 2 % moringa leaf meals B_4M_0 – contains 4 % bitter leaf and 0 % moringa leaf meals, B_0M_4 contains 0% of bitter leaf and 4% moringa leaf meals.

Table 4.6 Sensory evaluation of broiler chicken fed bitter leaf and moringa leaf meals diets

Parameters	B_0M_0	B_2M_0	B_0M_2	B_2M_2	B_4M_0	B_0M_4	SEM	p-value
Juiciness	7.05	7.27	6.54	7.13	6.68	7.13	0.13	0.61
Appearance	6.72	7.00	6.86	7.09	7.04	7.54	0.13	0.72
Flavour	6.22	7.00	6.54	6.63	7.13	6.95	0.15	0.47
Aroma	5.68	6.90	5.90	6.36	6.72	6.90	0.18	0.22
Tenderness	7.00	7.18	7.18	7.31	7.31	7.24	0.14	0.80
Overall acceptability	7.18	7.86	7.36	7.45	7.31	7.45	0.12	0.70

SEM= standard error of mean

B_0M_0 – control no bitter leaf and moringa leaf meals, B_2M_0 – contains 2 % of bitter leaf and 0 moringa leaf meals, B_0M_2 – contains 0 % of bitter leaf and 2 % of moringa leaf meals, B_2M_2 contains 2 % bitter leaf and 2 % moringa leaf meals B_4M_0 – contains 4 % bitter leaf and 0 % moringa leaf meals, B_0M_4 contains 0% of bitter leaf and 4% moringa leaf meals.

CHAPTER FIVE

5.0 DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

The results of proximate composition of *Moringa oleifera* leaf meal was lower to the result of Odey *et al.,* (2019) with their results having 24.06 % crude protein, 6.00 % ash, 3.50 % moisture, 12.00 % crude fibre and 6.00 % ether extract similarly to the results obtain in the present study. The study by Ibironke and Akintola (2017) was lower to the results of proximate composition of *Vernonia amygdaline* obtain from Table 4.1 where they observed 5.66 % moisture, 44.86 % crude protein and 4.38 % ash.

5.1.1 Effect of bitter leaf and moringa leaf meals on growth performance

The results of growth performance of bitter leaf and moringa leaf on broiler chickens. Birds on 4% bitter leaf meal showed low feed intake. This might be attributed to the bitter nature of the bitter leaf which reduced the palatability of the feed. This is in consonance with the observations of Ahaotu *et al.,* (2013a), who fed rabbits with raw bitter leaf and reported reduced feed consumption among the rabbits on the test diets. Ahaotu *et al*. (2013b) has also established the presence of bitter triterpenoids. Also the decrease in feed intake observed could be as a result of anti-nutritional factors present in the test ingredient. This agrees with the findings of Melesse *et al.* (2009) that incorporated different leaf meals noted for their anti-nutritional factors in the diets of poultry, decreased their feed intake. The result of the feed conversion ratio of this study is in line with the findings of Olobotoke and Oloniruha (2009) who reported that inclusion of bitter leaf in cockerels feed significantly improved feed conversion ratio. This could be associated with its effect on enhancing the gastro intestinal enzyme thereby improving digestion and assimilation of nutrients (Adaramoye *et al.,* 2008). The findings by Windisch (2007) also reported improved growth performance of animals fed bitter leaf. Furthermore, the report of Mohammed and Zakariya (2012) supported the observations in the present study. However, the observations made by Mohammed and Zakariya (2012) pertaining to improvement of weight gain and FCR in broilers are contrary with the present result. The difference may be attributed to the inclusion levels of bitter leaf in diet, genotype and environment interaction as the studies are conducted in different locations. In agreement with our observations, Okafor *et al.* (2014) reported that 20 % inclusion level of Moringa olfeifera leaf in broiler diets improved the performance of the chicks. The present study is in contrast to the findings of Juniar *et al.* (2008) and Onunkwo and George (2015) who revealed that the inclusion of *Moringa oleifera* leaf meal up to 10 % did not produce significant effects on feed consumption, body weight, feed conversion ratio, carcass weight and production efficiency.

5.1.2 Effect of bitter leaf and moringa leaf meals with their combinations on apparent nutrient digestibility of broilers

The apparent nutrient digestibility of broilers fed bitter leaf and moringa leaf meal indicate an improvement in crude protein and dry matter and crude fibre digestibility which also compared well with the result of Okafor *et al.* (2014) who reported an improved result in nutrient digestibility of chicks feed *Moringa oleifera* leafs. The low nutrients digestibility observed in birds on 4 % bitter leaf B_4M_0 was in line with the report of Ahaotu *et al.* (2013a, b) who reported that the established presence of bitter leaf triterpenoids in feed fed in broiler chickens, this may be due to the result observed in digestibility. The significant reductions in the nutrient digestibility in birds fed bitter leaf and moringa leaf meal diets in this study could be attributed to higher concentration of anti-nutritional factors in the diet. Kim *et al.,* (1976) reported that anti-nutritional factors can have *in vivo* inhibition of brush border dipeptidases which interfere with the transport of nitrogen through the absorptive cells of the gut and contribute to faecal nitrogen losses. Lorenzon and Olsen, (1992) showed that raw plant seeds rich in toxic factors enhanced shedding of the brush border membranes and decrease in villus length in rats with a conspicuous effect on nutrient absorption. Nuhu, (2010) noticed that offering weaned rabbits a diet containing 10% Moringa leaf meal increased dry matter and protein digestibility .

5.1.3 Effect of bitter leaf and moringa leaf meals with their combinations on carcass cuts

Eviscerated weight, breast, thigh and abdominal fat weights of broiler chickens fed with bitter leaf and moringa leaf meals were significantly influenced In this study, this is in agreement with the findings of Ayssiwede *et al*. (2011) who reported no adverse effect on carcass characteristics of up to 24% inclusion of *Moringa oleifera* leaf meal in the diet of growing indigenous Senegal chickens. These findings are further in agreement with that of Safa (2012), who reported that inclusion of *Moringa oleifera* leaf meal in broiler diets significantly ($P<0.05$) improved dressed carcass weight, dressing percentage, breast meat, and drumsticks. In line with, Onunkwo and George (2015) reported that utilization of *Moringa oleifera* leaf meal in broiler diet had no influence on the organ proportion of poultry. Etalem *et al*. (2013) reported that *Moringa oleifera* leaf meal substitutions for soybean meal in broilers ration reduced yield of most carcass characteristics. Such variations in the literature might be attributed to the type of chicken breed used, method of ration formulation and the environment in which birds were tested. The results of the present study are in accordance with the report of Abubakar *et al.,* (2010) who observed variation in carcass characteristics of broiler birds fed varying levels of garlic. The values for eviscerated weight were significantly higher in birds fed 4 % bitter leaf B_4M_0. The values of dressing percentage obtained in this study are comparable to the observations made by Nweze and Nwankwagu, (2010) for broilers fed diets containing *Tetrepleura tetraptera*. Tarek *et al.* (2013) reported no significant difference on thigh, drum stick, wings, gizzard and heart on birds fed olive leaf extract. This may be as a result of different leaf extract of shrubs used. The significant ($P<0.05$) higher eviscerated weight of birds on 0 % bitter leaf 2 % moringa leaf meals and 0 % bitter leaf 4 % moringa leaf meal B_0M_2 and B_0M_4 in this study confirms a better and most efficient utilization of nutrients in terms of digestion, absorption and assimilation as reported by (Bamgbose *et al.*, 1999).

5.2 Conclusion

Based on the results obtained from this experiment, it can be concluded that:

1. Bitter leaf and moringa leaf meal had effect on the growth performance of broiler chickens, and birds fed on 4 % bitter leaf meal have the best feed conversion ration. Birds on 2 % and 4 % moringa leaf meal had higher feed intake
2. The apparent nutrient digestibility revealed that both moringa leaf and bitter leaf meal had significant effect on the digestibility of the birds with birds on moringa performing better. Birds on 2 % moringa had higher ether extract, Ash and Nitrogen free extract while birds on 4 % moringa had higher Crude Protein and Crude Fiber digestibilty
3. Sensory evaluation indicated that all the meat was generally accepted in terms of colour, juiciness, flavor, aroma, tenderness and overall acceptability.

5.3 Recommendation

1. Bitter leaf meal alone should be included in broiler chicken diets.
2. The combination of bitter leaf and moringa leaf meals will also increase the dressing percentage and also abdominal fat of broiler chickens.
3. Finally more research needs to be done to establish a precise amount, age, serum biochemistry, hematological of broiler and other conditions under which better results can be achieved in the use of bitter leaf moringa leaf meals and their combinations.

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