

EVALUATION OF BENISEED (Sesamum indicum)  
AND DRUMSTICK TREE (Moringa oleifera) LEAF  
MEAL AS SOURCES OF METHIONINE IN BROILER  
DIETS

*BY*

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**NOVEMBER, 2008.**

## **DECLARATION**

I hereby declare that this thesis has been written by me and that it is a record of my own research work. It has not been presented before in any previous application for a higher degree. All quotations are indicated and sources of information are specially acknowledged by means of references.

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**Date**

## CERTIFICATION

This thesis entitled "Evaluation of Beniseed (*Sesamum indicum*) and Drumstick Tree (*Moringa oleifera*) Leaf Meal as sources of Methionine in Broiler Diets" by Abdullahi, Aliyu Mohammed meets the regulations governing the award of the degree of Masters of Science of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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## DEDICATION

I dedicate this work to my late uncle (Mallam Abubakar Yarima) may his soul rest in perfect peace. Ameen.

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First of all, I thank the Almighty God for giving me the fortitude and ability to attain up to this level of academic pursuit. My profound gratitude goes to my major supervisor, Prof. S.O. Ogundipe who dedicated much of his time to make valuable criticisms leading to the success of this study and from whom I learnt a lot from even outside the cycle of academics. Lots of thanks also go to my second supervisor, Dr. G.S. Bawa for his positive contributions during the course of this work. I also acknowledge the support of the former Director of the National Animal Production Research Institute Shika-Zaria, Prof. A.M. Adamu and the former programme leader of the Poultry research Programme of NAPRI, Prof. O.O. Oni for providing me with experimental space. The contribution of Dr. (Mrs.) A.A. Sekoni during my feeding trial is also acknowledged. I also thank the entire poultry attendants of NAPRI poultry farm especially Mallam Aminu Ibrahim for their contributions to the success of this work.

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## ABSTRACT

Proximate and Amino acid analyses of beniseed and *Moringa* leaves were carried out. This was followed by two feeding trials conducted to evaluate Beniseed (*Sesamum indicum*) and Drumstick tree (*Moringa oleifera*) leaf meals as potential feed ingredients and as sources of methionine in Broiler diets. Experiment one was carried out to compare the growth performances of 40 broiler chicks with 20 chicks each on raw or cooked *Moringa* leaf meals. There were two replicates of 10 birds each for the raw and for the cooked *Moringa* leaf meals to determine if raw *Moringa* leaf meal can be safely fed in broiler diets. In experiment two, 252 broiler birds were used for the starter and finisher phases of the experiment on seven dietary treatments comprising of control, three of beniseed diets and three of *Moringa* leaf meal diets in a completely randomized design. The control diet contained neither the beniseed nor the *Moringa* leaf meal. The three beniseed diets contained (a) 6% beniseed plus 0.25% methionine or (b) 6% beniseed plus 0.125% methionine or (c) 6% beniseed without methionine supplementation. The three *Moringa* diets also contained (a) 6% *Moringa* leaf meal plus 0.25% methionine or (b) 6% *Moringa* leaf meal plus 0.125% methionine or (c) 6% *Moringa* leaf meal without methionine supplementation. The results for the proximate analyses showed that beniseed had a crude protein content of 23.13%, raw *Moringa* leaf had 25.25% crude protein, while cooked *Moringa* leaf had a crude protein of 22.44%. The amino acid composition showed that beniseed had 0.87% methionine and 0.99% cystine.

*Moringa* leaf on the other hand had 0.26% methionine and 0.17% cystine. The results for experiment 1 showed that there were no significant differences ( $P>0.05$ ) in terms of final weights (749.85g/bird and 754.27g/bird) and average daily gains (25.31g/bird and 25.47g/bird) between broiler chicks on the raw *Moringa* leaf meal and those on cooked *Moringa* leaf meal respectively. Broiler chicks on cooked *Moringa* leaf meal gave significantly ( $P<0.05$ ) higher cost of feed per kg gain than those on raw *Moringa* leaf meal. The results for experiment 2 for both the starter and finisher phases showed that broilers fed *Moringa* leaf meal at 6% dietary level gave better results in terms of final weight and average daily gains than broilers fed the control or the beniseed diets. Birds on 6% *Moringa* leaf meal diet without supplemental methionine performed equally well as birds on the control diet ( $P>0.05$ ) and significantly better than birds on the beniseed diets without supplemental methionine ( $P<0.05$ ). Carcass characteristics of the broilers at nine weeks of age, showed no significant differences ( $P>0.05$ ) among dietary treatments in terms of the choice parts of the carcass (breast, thighs and drumsticks). Raw *Moringa* leaf meal could be used at 6% dietary level in broiler finisher diets without any adverse effect on growth performance. It was also observed that the use of *Moringa* leaf meal can partially or wholly replace the required level of supplemental methionine in broiler diets.

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## CHAPTER ONE

### 1.0 Introduction

Feed is the most important input in a poultry enterprise where it represents between 60 and 70 percent of the total cost of production (Smith, 2001). In the tropics there is a growing scarcity of animal feed resources. This is one of the major constraints to increased livestock production (Sarwatt, 1989). The potential for greater production is obvious but first the problem of nutritional deficiency must be solved. Aduku (1992), reported that successful animal production requires an adequate supply of cheap and balanced feed. It is therefore important to take advantage of the various feed ingredients available at economical prices at certain times of the year (Kekeocha, 1984). Some of these alternative feed ingredients that could be used to reduce cost are beniseed and Moringa leaf.

Beniseed is an annual tropical crop belonging to the family *Pedaliacea*. The crop originated in Africa and is sensitive to daylength. In fact, both long day and short-day forms are available (Anochili, and Tindall, 1986). Depending on the variety, the seeds vary in colour. There are yellow, brown, black and white (Brouk, 1975). The white beniseed (*Sesamum indicum*) produces white seeds which yields up to 50 percent oil. Another species (*Sesamum radiatum*), produces black or dark brown seeds which yield 32 to 37 percent oil (Anochili and Tindall, 1986). Beniseed is abundantly produced in the Guinea savannah region of Nigeria (Eyo *et al.*, 2004). The meal is a good source of protein and it is especially rich in methionine. It is

used extensively as a protein supplement in poultry and swine rations in the tropical regions where the crop is produced in abundance (Gohl, 1975).

Drumstick tree (*Moringa oleifera*) is a member of *Moringaceae* family which originated from India (Olson, 2001). Drumstick tree is the most common English name for *Moringa oleifera*. Other English names for *Moringa* are Horseradish, Mother's best friend, Radish tree and West Indian ben. The plant is a small tree with thick grey bark, fragrant white flowers and long green pods (Makkar and Becker, 1996). The plant grows throughout most of the tropics, but it is most commonly found in Africa, Asia and the America. There are 13 species of drumstick tree, of which *Moringa oleifera* is the most common (Muriella, 2007). The leaves have been reported to have a high content of methionine (Gupta *et al.*, 1989). *Moringa* leaf is also known to contain some antinutritional factors such as phytic acid, tannins and saponins (Makkar and Becker, 1996).

Methionine plays a number of important roles in the metabolism of farm animals. Apart from being a constituent of proteins, it has a unique role as the initiating amino acid for all polypeptide synthesis. It donates methyl groups in a number of important synthetic reactions and its sulphur moiety can be used in the synthesis of cystine (Saunderson and Mackinlay, 1990). Methionine also improves the efficiency of feed utilization. It reduces mortality, cannibalism, improves egg size and prevents accumulation of excess fat in layers (Oluyemi and Roberts, 1988).

This study was motivated by the fact that synthetic methionine is currently being imported into the country at exorbitant prices, which adds to the cost of

producing poultry feeds. *Moringa* leaves and beniseed have appreciable quantities of methionine and they are available locally. It is hoped that when these two natural sources of methionine are used in broiler diets, their methionine contents could spare wholly or partly the need for supplemental methionine in feeds and enhance growth in addition to provision of other nutrients and bulk to the diets.

### **Objective of the Study**

The objectives of this study were:

- I. To determine the proximate compositions of roasted beniseed and *Moringa* leaf meals.
- II. To determine the amino acid profiles of roasted beniseed and *Moringa* leaf meal.
- III. To determine if *Moringa* leaf meal can be fed in its raw state without any deleterious effects on the growth performance of broiler chicks.
- IV. To determine the nutritional value of *Moringa* leaf meal and roasted full fat beniseed in broiler starter and finisher diets.
- V. To determine further if *Moringa* leaf meal and roasted full fat beniseed can be used as sources of methionine to replace supplemental methionine in broiler starter and finisher diets.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Utilization of Local Plant Materials for Animal Feeds

The utilization of local edible plant materials for animal feeds is of paramount importance because of the role they play as sources of essential nutrients required for growth and survival of living organisms. Even though plant food materials are regarded to be of second class quality, a suitable mixture of vegetable materials in animal feed could increase the quality of the feed (Ega, 1986). Some local plant materials that are being used in Nigeria for animal feeds include: sweet potato peels, cocoyam peels, banana leaves, *Adansonia digitata* leaves, *Acacia albida* leaves, *Ziziphus mauritiana* leaves etc. Oluyemi and Roberts, (1988) called for the evaluation of local plant materials like melon seed (*Citrullus vulgaris*), African locust bean (*Parkia filiciodea*) and other local plant leaves for use in animal feeds.

Chemical and biochemical analysis of local plant materials will provide information on the nutrient potentials of local plants and enable us to design means to harness them as food sources.

#### 2.2 Agronomic Characteristics of Beniseed

Beniseed is a crop of the hot, dry, tropical regions. It is grown in areas which receive 500 to 1120mm of rainfall annually (Anochili and Tindall, 1986). When established, it can withstand short periods of drought but cannot tolerate

water logging. The crop grows well on relatively poor soils, but sandy, loam soils are most suitable. Both early and late crops are grown. The early crop is sown in April and harvested in August while the late crop is sown in the latter part of August after the break in the rains and is harvested between November and December. Beniseed is usually sown as a sole crop, usually as the last crop in the rotational cycle before the land becomes fallow. The average yield from small scale production in West Africa is about 168 to 314kg/ha but higher yields have been obtained in some South Central American countries (Anochili and Tindall, 1986).

### **2.3 Agronomic Characteristics of *Moringa* Plant**

*Moringa* plant is fast growing, resistant to drought and most pests. Out of the 13 known species of *Moringa*, *Moringa oleifera* is particularly easy to reproduce and its growth is very fast (Muriella, 2007). The plant tolerates a wide range of soil and rainfall conditions. Minimum and maximum annual rainfall requirements is estimated to be between 250mm and 3000mm respectively. It grows best at altitudes of 600m but will grow at altitudes of up to 1000m. Presence of long taproot makes the plant to be resistant to periods of drought. *Moringa* prefers neutral to slightly acidic soils and grows best in well drained loam to clay-loam soils (HDRA, 2008). It can tolerate clay soils but does not grow well in waterlogged soils. Its temperature requirements range is between 25-35 °C but the tree will tolerate up to 48 °C and can survive a light frost. *Moringa* loses its leaves between December and January with new growth starting between February and March.

The flowering time of *Moringa* is between January and March with fruit ripening between April and June (Muriella, 2007).

#### **2.4 Chemical and Nutritional Composition of Beniseed and *Moringa* Leaves**

Beniseed (*Sesamum indicum*) contains about 50% oil, 24.2% crude protein, 0.75% methionine and a metabolisable energy value of 4871 kcal/kg (Aduku, 2004). *Moringa* leaves on the other hand were reported to have 25.1% crude protein, 0.50% methionine and a metabolisable energy value of 2271kcal/kg (Makkar and Becker, 1996). A survey of over 120 species of tropical and sub tropical edible plants for nutrient content, antioxidant activity, and plant traits indicated that *Moringa oleifera* is one of the promising plants which could contribute to increased intake of micronutrients and antioxidants (Ray *et al.*, 2006). Research shows that the leaves of *Moringa* are nutritious. *Moringa* leaves can be an excellent source of calcium, vitamin C, vitamin A, potassium and protein (Muriella, 2007). *Moringa* leaves are rich in carotene, iron and ascorbic acid (Chawla *et al.*, 1988). *Moringa* leaves are also high in protein and especially in its methionine content (Sarwatt *et al.*, 2002). *Moringa* leaf extracts had also been reported to exhibit antimicrobial activity including inhibition of the growth of *Staphylococcus aureus* strains that are commonly isolated from food and animal intestines (Ray *et al.*, 2006).

## **2.5 Antinutritional Factors in *Moringa* Leaves and Beniseed**

Antinutritional factors may be defined as those substances generated in natural feed stuffs by the normal metabolism of species and by different mechanisms e.g. inactivation of some nutrients, diminution of the digestive process or metabolic utilization of feed which exert effects contrary to optimum nutrition (Cheeke and Shull, 1985).

*Moringa* leaves were reported to contain 1.4% tannins, 5.0% saponins, 3.1% phytates (Makkar and Becker, 1996). Other antinutritional factors reported for *Moringa* leaves are flatulose factors (sucrose + raffinose + stachyose). These factors are present at 5.6% level and could cause flatulence in monogastric animals (Gupta *et al.*, 1989). Nitrate (0.5mmol per 100g) and oxalate (4.1%) have also been reported in *Moringa* leaves (Gupta *et al.*, 1989).

Beniseed meal however was reported to have high content of phytic acid which makes much of its phosphorous unavailable (McDonald *et al.*, 1994). High contents of oxalates which binds calcium and other minerals were also found in the hulls of beniseed (McDonald *et al.*, 1994). Two major antinutritional components of beniseed were also reported as phytate – 5g/100g and oxalates – 35mg/100g (FAO, 2007).

## **2.6 Factors Affecting the Nutritional Compositions of Beniseed and *Moringa* Leaves.**

Processing method is one of the major factors affecting the nutritional compositions of beniseed and *Moringa* leaves. The full fat beniseed meal normally

has higher oil content, energy and less crude protein than the beniseed cake. Antinutritional factors like oxalic and phytic acids also affects the availability of minerals in beniseed (Weiss, 1971). Specie differences also account for the nutritional composition of beniseed. The white beniseed (*Sesamum indicum*) has more oil than the other species of beniseed (Anochili and Tindall, 1986). Other major factors affecting the nutritional composition of *Moringa* tree leaves are: level of maturity and season (Ray *et al.*, 2006).

Among the various species of *Moringa*, *Moringa oleifera* leaves had been proven to be the most promising in terms of nutrient contents. It has also been found that mature leaves are more nutritious than young leaves and it can be quickly dried with minimum nutrient loss (Yang and Tsou, 2006). Stachyose and raffinose were also not detected in mature leaves, but were detected in young leaves and in seeds. Mature leaves of *Moringa* also contained very low value of oxalate compared to the young leaves. The leaves harvested in hot-wet season were observed to have higher protein, vitamin A and glucosinates contents and antioxidant activity than the leaves harvested in cool-dry season (Ray *et al.*; 2006). Cooking also increased availability of iron and enhanced aqueous antioxidant activity. Reduction of anti-nutritional factors like tannins, trypsin inhibitors and phytates etc. could also be obtained by cooking (Makkar and Becker, 1999).

## **2.7 Processing Methods of Beniseed and *Moringa* Leaves for Feeds**

Beniseed is normally processed by sun drying immediately after harvest. The dried seeds are further processed by cooking or roasting, after which the cooked or roasted seeds are subjected to either mechanical extraction or solvent extraction to get out the oil. The by-product after the oil extraction is the beniseed cake. Beniseed could also be roasted or cooked and ground as full fat beniseed meal (Aduku, 2004).

*Moringa* leaves on the other hand are processed either by cooking the fresh leaves or by sun drying the leaves. The sun dried leaves could also be ground to form a meal (Yang *et al.*, 2006).

## **2.8 Effects of Processing Methods on Antinutritional Contents of *Moringa* Leaves and Beniseed**

Many antinutritional factors are heat labile. Hence simple heating or autoclaving has been found useful in removing the effects of antinutritional factors (Rao *et al.*, 1988). Unfortunately, heating would substantially increase the cost due to the energy involved both in treatment and transport. Simple washing with water removes soluble antinutritional factors but nutrients also leach out (Joshi *et al.*, 1989). Soaking of crushed feed materials in water was also reported to reduce the amount of antinutritional factors especially cyanogens (FAO, 2007). Cooking of legume grains have been shown to improve the nutritive value by destroying most of the antinutritional factors present in the legumes (Ogundipe, 1980).

## **2.9 General Utilization of Beniseed and *Moringa* Plant**

Beniseed is used in the production of vegetable oil for human consumption. It is also used as a condiment in human food. The cake and full fat meal could also be used in feeding farm animals, especially poultry.

*Moringa* leaves are used as food for humans. The leaves contain poly-electrolyte which are highly effective in water treatment and produces a biodegradable flocculent unlike aluminum sulphate, currently used in water treatment (Muriella, 2007). *Moringa* leaves exhibit anti-microbial activity and is a potential bioceutical agent to substitute for antibiotics in livestock production (Ray *et al.*, 2006). The oil extracted from *Moringa* seeds is used in cosmetics. The high composition of protein, lipid and carbohydrate contents of the seeds suggests that it could serve as a supplementary source of essential nutrients to man and livestock, provided the antinutritional contents are considerably reduced or eliminated (Anhwange *et al.*, 2004).

## **2.10 Utilization of Beniseed and *Moringa* Leaves in the Feed of Farm Animals**

Beniseed meals (fullfat and cake) has long been used in the diets of poultry as sources of protein. Aduku (1992) reported that beniseed can be used in the diets of broilers in the range of 5-10% to achieve optimum performance. Soyabean meal had been completely replaced with locally produced beniseed cake in broiler diets in Kenya with significant improvement in both growth rate and feed efficiency (Jacob *et al.*, 1996). Imported soyabean meal had also been completely replaced

with locally produced beniseed cake in the diets of layers in Kenya, though the results were not satisfactory in terms of egg production and egg weight (Mamputu and Buhr, 1991). Beniseed meal at 51% dietary level had been used in the diet of fish (*Heterobranchus longifilis*) with significantly higher values of weight gains and protein efficiency ratio for fish than those on diet with 25.5% beniseed meal and diet without beniseed meal (Eyo *et al.*, 2004).

Dehydrated leaves of *Moringa oleifera* had been used in the diets of broilers (Ray *et al.*, 2006). The trial included five treatments (diet without *Moringa* and diets containing 0.5%, 1%, 2% and 3% dried *Moringa* leaves). Growth performance, immune function and ileum microflora were evaluated. The results indicated that *Moringa* diets significantly increased concentrations of total globulins, reduced *Eschericia coli* and increased *Lactobacillus* counts in ileum. There was also improved growth performance.

Kakengi *et al.* (2007) also carried out a study on the effect of *Moringa oleifera* leaf meal as a substitute for sunflower seed meal on the performance of laying hens in Tanzania. The study consisted of four dietary treatments containing varying combinations of *Moringa oleifera* leaf meal and sunflower seed meal levels. *Moringa* leaf meal reciprocally replaced sunflower seed meal at levels of 20, 15, 10 and 0% giving the dietary treatments containing 0, 5, 10 and 20% *Moringa* leaf meal. The results revealed that there were no significant effect on feed intake and drymatter intake up to 5% *Moringa* leaf meal levels in the diet. However, significant and progressive increases in feed intake were observed on birds fed 10

and 20% *Moringa* leaf meal levels in the diet. There was no significant effect of dietary treatment on Kg feed/Kg eggs up to 10% *Moringa* leaf meal levels. However significantly higher feed/kg eggs were observed in birds fed 20% *Moringa* leaf meal. Egg weight was highest in birds fed diets containing 5% *Moringa* leaf meal and lowest in birds fed diets containing 20% *Moringa* leaf meal.

*Moringa oleifera* leaves had also been used to substitute for sunflower seed cake as a supplemental feed for goats in Tanzania (Sarwatt *et al.*, 2002). The Dietary treatments involved different levels of *Moringa oleifera* leaves replacing dietary levels of sunflower seed cake at 0, 25, 50, 75 and 100% levels. A significantly higher dry matter intake and metabolisable energy intakes were observed at 75% and 100% levels of replacement. Increased replacement levels of sunflower seed cake with *Moringa oleifera* leaves increased the digestibility of dry matter and neutral detergent fibre. Goats fed 25% *Moringa oleifera* leaves had significantly higher nitrogen retention than goats on other treatments. The treatments were not different in terms of their effects on the growth rates of goats.

Reyes, (2007) also carried out a study on *Moringa oleifera* and *Cratylia argentea* as potential fodder species in Creole dairy cows in Nicaragua. The results of the study revealed that feeding *Moringa* and *Cratylia* at 2kg or 3kg dry matter per day can significantly improve dry matter intake and milk yields of Creole dairy cattle without affecting the milk composition or its organoleptic characteristics.

## CHAPTER 3

### MATERIALS AND METHODS

#### 3.1 Experimental Site

The study was carried out at the Poultry Research farm of the National Animal Production Research Institute, Ahmadu Bello University, Shika-Zaria between January and April, 2007.

#### 3.2 Laboratory Analyses of Beniseed and *Moringa* Leaf

The proximate compositions of beniseed and *Moringa* leaf were determined using the A.O.A.C (1990) methods. The amino acid analyses of the beniseed and *Moringa* leaf were also done following the methods described by Spackman *et al.* (1958) with the aid of a Technicon Sequential Multi-sample amino acid analyzer (TSM).

#### 3.3 Processing of *Moringa* Leaves and Formulation of Diets for Experiment 1

Raw, sundried *Moringa* leaves were ground into a meal and used in formulating diet 1. For diet 2, *Moringa* leaves were cooked at 100°C for 20 minutes, dried and ground into a meal before incorporation into the diet.

Two diets were formulated for experiment 1 which lasted for 0 – 4 weeks. Diet 1 was a groundnut cake-based diet containing 6% raw *Moringa* leaf meal plus 0.25% synthetic methionine supplementation, while diet 2 was a groundnut cake-based diet containing 6% cooked *Moringa* leaf meal plus 0.25% synthetic

methionine supplementation. The compositions of the broiler starter diets for Experiment 1 are shown in Table 3.1

### **3.4 Processing of *Moringa* Leaves and Beniseed and Formulation of Diets For Experiment 2**

Raw sundried *Moringa* leaves were ground into a meal while the beniseed was dry roasted on an open fire and later ground into a meal before incorporation into the various diets. Seven diets were formulated for the starter and finisher phases of the second experiment. The compositions of the diets for experiment 2 were as follows:

Diet 1 (control diet): was a groundnut cake-based diet plus 0.25% supplemental methionine. Diet 2 was a groundnut cake-based diet containing 6% roasted beniseed plus 0.25% supplemental methionine. Diet 3 was a groundnut cake-based diet containing 6% raw *Moringa* leaf meal plus 0.25% supplemental methionine. Diet 4 was a groundnut cake-based diet containing 6% roasted beniseed plus 0.125% supplemental methionine. Diet 5 was a groundnut cake-based diet containing 6% raw *Moringa* leaf meal plus 0.125% supplemental methionine. Diet 6 was a groundnut cake-based diet containing 6%

**Table 3.1: Percentage Composition of Starter Diets for Experiment 1.**

Ingredients	Diets	
	Raw <i>Moringa</i> leaves plus 0.25% methionine	Cooked <i>Moringa</i> leaves plus 0.25% methionine
Maize	38.77	38.77
Wheat offal	5.00	5.00
<i>Moringa</i> leaves	6.00	6.00
Groundnut cake	31.26	31.26
Soya cake	6.00	6.00
Fish meal	1.50	1.50
Limestone	0.60	0.60
Bone meal	3.40	3.40
Palm oil	6.22	6.22
Salt	0.35	0.35
*Vit-TM premix	0.25	0.25
L-Lysine	0.40	0.40
DL-Methionine	0.25	0.25
<b>Total</b>	<b>100</b>	<b>100</b>
Cost (₹)/kg Diet	54.36	59.20
<b>Calculated nutrient analysis</b>		
Crude Protein (%)	23.78	23.75
Metabolisable Energy (kcal/kg)	2941	2941
Ether Extract (%)	9.93	9.90
Crude Fibre (%)	4.42	4.44
Calcium (%)	1.30	1.30
Available Phosphorous (%)	0.62	0.62
Lysine (%)	1.30	1.30
Methionine + Cystine (%)	0.88	0.88
Methionine	0.57	0.57

\*Bio-mix Broiler starter premix supplied per kg of diet: vitamin A: 5,000 I.U.; Vit D3: 1,000 I.U.; Vit E: 20mg; Vit K3: 1mg; Vit B1: 0.2mg; Vit B2: 2.4mg; Vit. B6: 2.4mg; Niacin: 16mg; Calcium Pantothenate: 4mg; Biotin: 0.032mg; Vit B12: 0.01mg; Folic acid: 0.4mg; Choline Chloride: 120mg; Manganese: 40mg; iron: 5mg; Zinc: 18mg; Cobalt: 0.1mg; Iodine: 0.62mg; Selenium: 0.04mg.

roasted beniseed with no methionine supplementation while Diet 7 was a groundnut cake-based diet containing 6% raw *Moringa* leaf meal and also with no methionine supplementation. The compositions of the starter and finisher diets fed in experiment two are shown in Tables 3.2 and 3.3 respectively.

### **3.5 Experimental Birds and General Flock Management**

#### **3.5.1 Experiment 1: Evaluation of Raw and Cooked *Moringa* Leaves as Potential Feed Ingredients in Broiler Starter Diets.**

A total of 40-day-old Ross broiler chicks of mixed sexes were used in experiment 1. Ten chicks were housed in each pen for each of the two dietary treatments to be compared. The pens were replicated two times for each treatment with ten chicks per replicate. The objective was to determine if raw *Moringa* leaf meal diet can be safely fed in Broiler diets. This observation was made to last only for the starter phase covering the period between 0 and 4 weeks of age.

#### **3.5.2 Experiment 2: Evaluation of Raw *Moringa* Leaf Meal and Roasted Beniseed as Sources of Methionine in the Diets of Broilers.**

In the second experiment, 252-day-old Ross broiler chicks of mixed sexes were used. There were seven dietary treatments. Each of the seven dietary treatments had three replicates with 12 chicks per pen making a total of 36 chicks per treatment in a completely randomized design. There were two phases for this study. The starter phase which lasted from zero to four weeks of age and the finisher phase which lasted from five to nine weeks of age.

**Table 3.2: Ingredient Compositions of Diets Containing Beniseed and *Moringa* Leaf Meal as Sources of Methionine for Broiler Starters (0 – 4 weeks)**

Ingredients	Diets						
	1 Control	2 Beniseed plus 0.25% methionine	3 <i>Moringa</i> leaf plus 0.25% methionine	4 Beniseed plus 0.125% methionine	5 <i>Moringa</i> leaf plus 0.125% methionine	6 Beniseed, no methionine	7 <i>Moringa</i> leaf, no methionine
Maize	43.12	43.9	38.77	43.76	38.61	43.58	38.43
Wheat offal	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Beniseed	0.00	6.00	0.00	6.00	0.00	6.00	0.00
<i>Moringa</i> leaf meal	0.00	0.00	6.00	0.00	6.00	0.00	6.00
Groundnut cake	33.81	30.51	31.26	30.81	31.58	31.13	31.9
Soya cake	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Fish meal	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Limestone	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Bone meal	3.50	3.30	3.40	3.30	3.40	3.30	3.40
Palm oil	5.22	1.94	6.22	1.91	6.19	1.89	6.17
Salt	0.35	0.35	0.35	0.35	0.35	0.35	0.35
* Vit-TM premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
L-Lysine	0.40	0.40	0.40	0.40	0.40	0.40	0.40
DL-Methionine	0.25	0.25	0.25	0.125	0.125	0.00	0.00
Total	100	100	100	100	100	100	100
Cost (₦)/kg diet	47.50	51.21	54.36	50.35	53.51	49.51	52.74
<b>Calculated Nutrient Analysis</b>							
Crude Protein (%)	23.78	23.78	23.78	23.78	23.78	23.78	23.78
Metabolisable Energy (kcal/kg)	2941	2941	2941	2941	2941	2941	2941
Ether Extract (%)	9.02	8.93	9.93	8.92	9.91	8.91	9.91
Crude Fibre (%)	4.04	4.03	4.42	4.04	4.44	4.06	4.45
Calcium (%)	1.26	1.31	1.30	1.31	1.30	1.32	1.31
Available Phosphorous (%)	0.62	0.63	0.62	0.63	0.62	0.63	0.62
Lysine (%)	1.26	1.31	1.30	1.31	1.30	1.32	1.31
Methionine + Cystine (%)	0.89	0.97	0.88	0.86	0.77	0.75	0.66
Methionine	0.57	0.61	0.57	0.49	0.45	0.36	0.32

\*Bio-mix Broiler starter premix supplied per kg of diet: vitamin A: 5,000 I.U.; Vit D3: 1,000 I.U.; Vit E: 20mg; Vit K3: 1mg; Vit B1: 0.2mg; Vit B2: 2.4mg; Vit. B6: 2.4mg; Niacin: 16mg; Calcium Pantothenate: 4mg; Biotin: 0.032; Vit B12: 0.01mg; Folic acid: 0.4mg; Choline Chloride: 120mg; Manganese: 40mg; iron: 5mg; Zinc: 18mg; Cobalt: 0.1mg; Iodine: 0.62mg; Selenium: 0.04mg.

**Table 3.3: Ingredient Compositions of Diets Containing Beniseed and *Moringa* Leaf Meal as Sources of Methionine for Broiler Finishers (5 – 8 weeks).**

Ingredients	Diets						
	1 Control	2 Beniseed plus 0.25% methionine	3 Moringa leaf plus 0.25% methionine	4 Beniseed plus 0.125% methionine	5 Moringa leaf plus 0.125% methionine	6 Beniseed, no methionine	7 Moringa leaf, no methionine
Maize	53.12	53.9	48.77	53.76	48.61	53.58	48.43
Beniseed	0.00	6.00	0.00	6.00	0.00	6.00	0.00
Moringa leaf meal	0.00	0.00	6.00	0.00	6.00	0.00	6.00
Groundnut cake	28.91	25.61	26.36	25.9	26.68	26.23	27.00
Soya cake	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Fish meal	1.50	1.50	1.50	1.50	1.60	1.50	1.50
Limestone	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Bone meal	3.50	3.30	3.40	3.30	3.40	3.50	3.40
Palm oil	5.22	1.94	6.22	1.91	6.19	1.89	6.17
Salt	0.35	0.35	0.35	0.35	0.35	0.35	0.35
* Vit-TM premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
L-Lysine	0.20	0.20	0.20	0.20	0.20	0.20	0.20
DL-Methionine	0.25	0.25	0.25	0.125	0.125	0.00	0.00
Total	100	100	100	100	100	100	100
Cost (₦)/kg diet	45.65	43.96	52.51	43.10	51.66	42.26	48.57
<b>Calculated Nutrient Analysis</b>							
Crude Protein (%)	21.51	21.51	21.51	21.51	21.51	21.51	21.51
Metabolisable Energy (kcal/kg)	3105	3105	3105	3105	3105	3105	3105
Ether Extract (%)	8.97	8.89	9.88	8.87	9.86	8.87	9.86
Crude Fibre (%)	3.42	3.40	3.80	3.42	3.81	3.43	3.83
Calcium (%)	1.28	1.28	1.45	1.29	1.45	1.29	1.45
Available Phosphorous (%)	0.60	0.61	0.60	0.62	0.60	0.62	0.60
Lysine (%)	1.01	1.06	1.04	1.06	1.05	1.07	1.05
Methionine + Cystine (%)	0.86	0.93	0.84	0.82	0.73	0.71	0.62
Methionine	0.55	0.58	0.54	0.43	0.42	0.34	0.29

\*Bio-mix Broiler finisher premix supplied per kg of diet: Vit A: 5,000 I.U.; Vit D3: 800 I.U.; Vit E: 12mg; Vit K3: 1.5mg; Vit B1: 1mg; Vit B2: 2mg; Vit B6: 1.5mg; Niacin: 12mg; Pantothenate acid: 5mg; Biotin: 0.02mg; Vit B12: 10mg; Folic acid: 0.3mg; Choline Chloride: 150mg; Manganese: 60mg; Iron: 10mg; Zinc: 15mg; Copper: 0.8mg; Iodine: 0.4mg; Cobalt | : 0.08mg; Selenium 0.04mg; Growth promotant: 8mg; Anti-oxidant: 40mg.

There was an adjustment period of one week after the starter phase between 4 and 5 weeks of age, when the birds were fed on a common ration before they were randomly re-assigned to the various treatments for the finisher phase. This was done to minimize or totally eliminate the carryover effects of the starter phase diets into the finisher phase of the experiment.

The birds were supplied with heat for the first 3 weeks of age. Neimycin soluble powder was given in drinking water during the first seven days of age. The first dose of Gumboro disease vaccine was administered on the 10<sup>th</sup> day of age while the second Gumboro disease vaccine was administered on the 24<sup>th</sup> day. Newcastle disease vaccine (Lasota strain) was administered five days after the second Gumboro disease vaccine. Amprolium-200 drug was administered in the drinking water for five days for prevention against coccidiosis after three weeks of age. Water and feed were provided *ad libitum*.

### **3.6 Data Collection**

For both feeding experiments, data collected for each pen included: mean initial weights, weekly mean weights, and average feed consumption mean weight gain, feed to gain ratio and feed cost per kg gain were calculated. Mortality was recorded as it occurred. In addition, for experiment 2 carcass analysis was done at the end of the finisher phase by selecting three birds per pen. The selected birds were slaughtered by severing the structures of the neck with a sharp knife and bled. They were then defeathered and eviscerated. The birds selected were those

whose weights were close to the average weight of the birds in the pen. The dressed weights were also taken. Cut-up part weights such as the neck, back, breast, thighs, drumsticks, wings, gizzard and liver were also determined and expressed as percentages of the dressed weights.

### **3.7 Data Analyses**

For experiment 1, simple t-test was applied for each parameter studied. For experiment 2 the data generated were subjected to the analysis of variance (ANOVA) using SAS (2002) statistical package and where significant differences were observed, the means were compared using the Duncan's Multiple range test (SAS, 2002).

## CHAPTER FOUR

### RESULTS

#### 4.1 Proximate Analyses of Beniseed, Raw and Cooked *Moringa* Leaves

The proximate analyses of roasted beniseed, raw and cooked *Moringa* Leaves were as shown in Table 4.1 Average dry matter contents were 94.30%, 95.14% and 93.56% for beniseed, raw *Moringa* leaf and cooked *Moringa* leaf respectively. Raw *Moringa* leaf had higher values for crude protein when compared with the cooked *Moringa* leaf and roasted beniseed. Cooked *Moringa* leaf had higher value of crude fibre when compared with the raw *Moringa* leaf and roasted beniseed. Higher values for ether extract and ash were however obtained for roasted beniseed when compared with raw and cooked *Moringa* leaves, while the % Nitrogen free extract was higher for the cooked *Moringa* leaf than the value obtained for the raw *Moringa* leaf and roasted beniseed.

**TABLE 4.1: Proximate Composition of Beniseed and *Moringa* Leaves.**

Proximate component	Roasted Beniseed	Raw <i>Moringa</i> leaf	Cooked <i>Moringa</i> Leaf
Dry matter (%)	94.30	95.14	93.56
Crude Protein (%)	23.13	25.25	22.44
Crude Fibre (%)	2.77	9.02	10.62
Ether extract (%)	50.34	11.48	8.70
Ash (%)	9.48	5.09	6.67
Nitrogen free extract (%)	14.28	49.18	51.57

#### 4.2 Amino Acid Analyses of Roasted Beniseed and Raw *Moringa* leaf

The amino acid compositions for roasted beniseed and raw *Moringa* leaves were as presented in Table 4.2 roasted beniseed showed higher values for all the amino acids compared with the values for raw *Moringa* leaves except for valine in which raw *Moringa* leaf showed slightly higher value than the roasted beniseed.

**Table 4.2: Amino Acid Compositions of Roasted Beniseed and Raw *Moringa* Leaf.**

<b>Amino Acids</b>	<b>Roasted Beniseed</b>	<b>Raw <i>Moringa</i> Leaf</b>
Methionine (%)	0.87	0.26
Cystine (%)	0.99	0.17
Lysine (%)	1.60	1.29
Arginine (%)	2.16	1.36
Histidine (%)	0.71	0.56
Aspartic Acid (%)	2.06	2.01
Threonine (%)	0.86	0.52
Serine (%)	1.06	0.53
Glutamic acid (%)	4.41	2.71
Proline (%)	0.79	0.37
Glycine (%)	1.53	0.31
Alanine (%)	1.94	0.71
Valine (%)	0.97	1.04
Isoleucine (%)	0.83	0.75
Leucine (%)	2.08	1.57
Tyrosine (%)	1.42	0.77
Phenylalanine (%)	1.70	1.24

#### 4.3 Experiment 1: Comparison of Raw and Cooked *Moringa* Leaves as Potential Feed Ingredients in Broiler Diets (0 – 4 weeks)

The performance of broiler chicks fed raw or cooked *Moringa* leaf meal were presented in Table 4.3. Final weight, weight gain, feed intake, feed-gain ratio and

mortality rates were not significantly different ( $P>0.05$ ) for both diets. Significant differences ( $P<0.05$ ) were observed with regard to cost of feed/kg gain. Cooked *Moringa* leaf diet resulted in higher cost per kg gain. Mortality was low and not significantly different ( $P>0.05$ ) for both diets.

**Table 4.3: Effect of Raw and Cooked *Moringa* Leaf Meal on the Growth Performance of Broilers (0-4 weeks).**

Parameter	Raw <i>Moringa</i> plus 0.25% Methionine	Cooked <i>Moringa</i> plus 0.25% Methionine	Lev. of Sig.
Initial weight(g/bird)	41.30	41.10	NS
Final weight(g/bird)	749.85	754.27	NS
Weight gain(g/bird)	708.55	713.17	NS
Average daily weight gain (g/bird/day)	25.31	25.47	NS
Feed intake(g/bird)	1391.55	1410.20	NS
Average daily feed intake(g/bird/day)	49.70	50.36	NS
Feed-gain ratio	1.96	1.98	NS
Cost of feed(₹)/kg gain	106.76 <sup>b</sup>	117.06 <sup>a</sup>	*
Mortality (%)	10	5	NS

<sup>ab</sup> Mean values on the same row with different superscripts differ significantly ( $P< 0.05$ )

NS = Not significant  
\* = Significant at 5% level

#### **4.4 Experiment 2: Evaluation of Raw *Moringa* Leaves and Roasted Beniseed as Sources of Methionine in Broiler Diets.**

##### **4.4.1 Performances of Broilers Fed Control, Three of Beniseed or Three of *Moringa* Leaf Diets (0 – 4 weeks)**

The comparison of the performances of birds fed seven diets comprising one control diet, three beniseed diets and three *Moringa* leaf diets were shown in Table 4.4. There were no significant differences ( $P>0.05$ ) between treatment means for the initial weights. Final weights and average daily gain however showed highly significant differences ( $P<0.01$ ) between dietary treatments. Birds on diet 3 (*Moringa* plus 0.25% supplemental methionine) gave the highest final weight and average daily gain although the values were not significantly ( $P>0.05$ ) higher than those obtained from birds fed the control diet, *Moringa* leaf plus 0.125% supplemental methionine (diet 5) and *Moringa* leaf without supplemental methionine (diet 7). Birds on diets 2 (beniseed plus 0.25% supplemental methionine) and diet 4 (beniseed plus 0.125% supplemental methionine) were not significantly different from each other ( $P>0.05$ ) but their values were significantly lower than those on diet 3 (*Moringa* plus 0.25% supplemental methionine). The lowest final weight and weight gain were obtained from birds on diet 6 (beniseed without supplemental methionine).

Dietary treatments also showed significant effects on feed intake ( $P<0.05$ ). Birds fed *Moringa* diets plus either 0.25% or 0.125% supplemental methionine (diets 3 and 5) had significantly ( $P<0.05$ ) the highest feed intake.

**Table 4.4: Effects of the Control, Three Beniseed and Three *Moringa* Leaf Diets as Sources of Methionine in Broiler Starter Diets (0 – 4 Wks)**

Parameter	Control	Treatments						SEM	Lev. of Sig.
		1 Beniseed Plus 0.25% Methionine	2 <i>Moringa</i> leaf Plus 0.25% Methionine	3 Beniseed Plus 0.125% Methionine	4 <i>Moringa</i> leaf Plus 0.125% Methionine	5 Beniseed, no Methionine	6 <i>Moringa</i> leaf, no Methionine		
Initial weight (g/bird)	41.38	41.80	41.66	41.80	41.80	41.66	41.66	0.054	NS
Final weight (g/bird)	688.13 <sup>ab</sup>	577.52 <sup>bc</sup>	756.6 <sup>a</sup>	570.70 <sup>bc</sup>	722.85 <sup>a</sup>	500 <sup>c</sup>	688.66 <sup>ab</sup>	22.73	**
Weight gain (g/bird)	646.74 <sup>ab</sup>	535.60 <sup>bc</sup>	715 <sup>a</sup>	528.90 <sup>bc</sup>	681.05 <sup>a</sup>	458.34 <sup>c</sup>	625 <sup>ab</sup>	22.75	**
ADWG (g/bird/day)	23.10 <sup>ab</sup>	19.13 <sup>bc</sup>	25.53 <sup>a</sup>	18.89 <sup>bc</sup>	24.32 <sup>a</sup>	16.37 <sup>c</sup>	22.32 <sup>ab</sup>	0.81	**
Feed intake (g/bird)	1164.14 <sup>b</sup>	1068.30 <sup>b</sup>	1399.33 <sup>a</sup>	1078.02 <sup>b</sup>	1272.59 <sup>ab</sup>	1094.44 <sup>b</sup>	1160.72 <sup>b</sup>	32.38	*
ADFI (g/bird/day)	41.58 <sup>b</sup>	38.15 <sup>b</sup>	49.97 <sup>a</sup>	38.50 <sup>b</sup>	45.45 <sup>ab</sup>	39.09 <sup>b</sup>	41.47 <sup>b</sup>	1.16	*
Feed-gain ratio	1.82 <sup>b</sup>	1.99 <sup>b</sup>	1.96 <sup>b</sup>	2.05 <sup>b</sup>	1.87 <sup>b</sup>	2.39 <sup>a</sup>	1.86 <sup>b</sup>	0.052	*
Cost of feed (N)/kg gain	86.66 <sup>c</sup>	102.06 <sup>abc</sup>	106.83 <sup>ab</sup>	103.02 <sup>abc</sup>	100.46 <sup>abc</sup>	118.22 <sup>a</sup>	97.92 <sup>bc</sup>	2.603	*
Mortality (%)	2.78	2.78	5.56	0.00	2.78	0.00	5.56	0.11	NS

<sup>abc</sup> Mean values on the same row with different superscripts differ significantly (P < 0.05)

- ADWG = Average Daily Weight Gain
- ADFI = Average Daily Feed Intake
- NS = Not significant
- \* = Significant at 5% level
- \*\* = Significant at 1% level (Highly significant)
- SEM = Standard Error of Means

Lower feed intake values were obtained from birds on diet 1 (control), diet 2 (beniseed plus 0.25% supplemental methionine), diet 4 (beniseed plus 0.125% supplemental methionine) and on diet 7 (*Moringa* without supplemental methionine).

Feed to gain ratio was significantly affected ( $P < 0.05$ ) by dietary treatments. Significantly ( $P < 0.05$ ) higher feed – gain ratio (poorer feed efficiency) was obtained from birds fed Diet 6 (6% beniseed diet without supplemental methionine). There were no significant differences in feed to gain ratios for all other diets.

The cost of feed per kg gain was also significantly affected by dietary treatments ( $P < 0.05$ ). Birds on beniseed diet without synthetic methionine (diet 6) had significantly ( $P < 0.05$ ) higher cost per kg gain than those on the control diet (diet 1). There were no significant differences in cost per kg gain for diets 2, 3, 4, 5 and 7 respectively. There were also no significant effect of broiler starter diets on the mortality rate ( $P > 0.05$ ).

#### **4.4.2 Performances of Broilers fed Control Diet, Beniseed Diets and *Moringa* Leaf Meal Diets (0 – 4 weeks).**

The comparisons of the performances of broiler chicks fed control beniseed and *Moringa* leaf meal diets were presented in Table 4.5.

There were no significant differences ( $P > 0.05$ ) between treatment means with regard to the effects of the groups of diets on the initial weights. Final weights and average daily gain however, showed highly significant differences ( $P < 0.01$ ). The performances of the birds fed the control diet and all diets containing

**Table 4.5: Effects of the Control Diet, Beniseed Diets and *Moringa* Leaf Diets on the Performance of Broiler Chicks (0 – 4 weeks).**

Parameter	Treatments			SEM	Lev. of Sig.
	Control	Beniseed Diets (Pooled)	<i>Moringa</i> leaf Diets (Pooled)		
Initial weight (g/bird)	41.38	41.75	41.71	0.054	NS
Final weight (g/bird)	688.13 <sup>a</sup>	549.41 <sup>b</sup>	715.39 <sup>a</sup>	22.73	**
Weight gain (g/bird)	646.74 <sup>a</sup>	507.61 <sup>b</sup>	673.69 <sup>a</sup>	22.75	**
ADWG (g/bird/day)	23.10 <sup>a</sup>	18.13 <sup>b</sup>	24.06 <sup>a</sup>	0.81	**
Feed intake (g/bird)	1164.14 <sup>ab</sup>	1080.25 <sup>b</sup>	1277.52 <sup>a</sup>	32.38	**
ADFI (g/bird/day)	41.58 <sup>ab</sup>	38.58 <sup>b</sup>	45.63 <sup>a</sup>	1.16	**
Feed-gain ratio	1.82 <sup>b</sup>	2.14 <sup>a</sup>	1.90 <sup>ab</sup>	0.052	*
Cost of feed (₦)/kg gain	86.66 <sup>b</sup>	107.77 <sup>a</sup>	101.74 <sup>a</sup>	2.603	*
Mortality (%)	2.77	0.93	4.63	0.11	NS

<sup>abc</sup> Mean values on the same row with different superscripts differ significantly (P < 0.05)

ADWG = Average Daily Weight Gain  
 ADFI = Average Daily Feed Intake  
 NS = Not significant  
 \* = Significant at 5% level  
 \*\* = Significant at 1% level (Highly significant)  
 SEM = Standard Error of Means

*Moringa* were similar and they both had significantly ( $P < 0.01$ ) higher final weights, weight gains and average daily gains than the birds fed all diets containing beniseed.

Dietary treatments also showed significant ( $P < 0.01$ ) effects on feed intake of birds. Birds on all diets containing *Moringa* leaf had significantly ( $P < 0.01$ ) highest feed intake with a value of 1277.52g/bird. This value was not significantly higher ( $P < 0.01$ ) than the value of 1164.14g/bird obtained for birds on the control diet but it was significantly higher than the value of 1080.25g/bird obtained for birds on all diets containing beniseed.

Broiler starter diets also showed significant effects on feed to gain ratio ( $P < 0.05$ ). Birds on all diets containing beniseed had significantly ( $P < 0.05$ ) higher (poorer) feed gain ratio. *Moringa* leaf diets gave slightly better feed to gain ratio than the beniseed diets. Although feed to gain ratio for the control diet was slightly better than the value obtained for the *Moringa* diets, the difference was not significant ( $P > 0.05$ ).

The cost per kg gain also showed significant differences ( $P < 0.05$ ) between treatment means. Both the beniseed diets and the *Moringa* diets resulted in higher cost of feed per kg gain than the control diet. The lowest cost of feed per kg gain was obtained from the control diet when compared with either the beniseed or the *Moringa* diets ( $P < 0.05$ ). There were no significant effects of starter diets on the mortality rate ( $P > 0.05$ ).

#### **4.4.3 Performances of Broiler Chicks fed Beniseed Diets and *Moringa* Leaf Diets.**

The comparisons of the performances of broiler chicks on all diets containing beniseed and all those containing *Moringa* leaf were as shown in Table 4.6. There were no significant differences ( $P>0.05$ ) with regard to the effects of diets on initial weights, feed to gain ratio and on cost of feed per kg gain.

Final weight, weight gain, average daily gain, feed intake showed highly significant differences ( $P<0.01$ ). The *Moringa* diets gave significantly ( $P<0.01$ ) higher final weight, weight gain, average daily gain, feed intake than the beniseed diets. Birds on *Moringa* diets gave significantly ( $P<0.05$ ) higher mortality rate than the beniseed diets.

#### **4.5 Performances of Broilers Fed Control Diet, Three Beniseed Diets and Three *Moringa* Leaf Diets (5 – 8 weeks)**

The comparisons of the effects of the seven diets consisting of one control, three of beniseed diets and three of *Moringa* leaf meal diets on the performances of broiler finishers between 5 and 8 weeks of age are shown in Table 4.7. There were significant effects of diets on final weights and average daily gain ( $P<0.05$ ). Diets had no significant effects on feed intake, average daily feed intake, feed to gain ratios, and on cost of feed per kg gain ( $P>0.05$ ). Diets 3 and 5 (that is *Moringa* diets plus 0.25% or plus 0.125% supplemental methionine) gave slightly higher final weight and weight gain compared with beniseed diets plus either 0.25% or plus

**Table 4.6: Performances of Broiler Chicks fed Beniseed Diets and *Moringa* Leaf Meal Diets (0 – 4 wks)**

Parameter	Treatments		SEM	Lev. of Sig.
	Beniseed Diets pooled	<i>Moringa</i> Leaf Diets pooled		
Initial weight (g/bird)	41.75	41.66	0.08	NS
Final weight (g/bird)	549.41 <sup>b</sup>	711.66 <sup>a</sup>	33.31	**
Weight gain (g/bird)	507.61 <sup>b</sup>	670 <sup>a</sup>	33.28	**
ADWG (g/bird/day)	18.13 <sup>b</sup>	23.93 <sup>a</sup>	1.19	**
Feed intake (g/bird)	1080.30 <sup>b</sup>	1280 <sup>a</sup>	71.21	**
ADFI (g/bird/day)	38.58 <sup>b</sup>	45.72 <sup>a</sup>	2.54	**
Feed-gain ratio	2.14	1.91	0.11	NS
Cost of Feed (₦)/kg gain	107.77	102.38	5.58	NS
Mortality (%)	0.93 <sup>b</sup>	4.63 <sup>a</sup>	0.22	*

<sup>abc</sup> Mean values on the same row with different superscripts differ significantly (P < 0.05)

ADWG = Average Daily Weight Gain  
 ADFI = Average Daily Feed Intake  
 NS = Not significant  
 \* = Significant at 5% level  
 \*\* = Significant at 1% level (Highly significant)  
 SEM = Standard Error of Means

0.125% supplemental methionine. The values obtained for the *Moringa* diets 3 were also not significantly different from the values obtained for the control diet but was significantly (P < 0.05) higher than the values obtained for diets 4 and 6 (beniseed with 0.125% supplemental methionine or beniseed without supplemental methionine).

Dietary treatments had no significant effects on the mortality rate (P > 0.05).

**Table 4.7: Effects of the Control Diets, Three Beniseed Diets and Three *Moringa* Leaf Meal Diets as Sources of Methionine in Broiler Finisher Diets (5 – 8 weeks)**  
**Treatments**

		1	2	3	4	5	6	7		
Parameter	Control	Beniseed plus 0.25% Methionine	<i>Moringa</i> leaf plus 0.25% Methionine	Beniseed plus 0.125% Methionine	<i>Moringa</i> leaf plus 0.125% Methionine	Beniseed, no Methionine	<i>Moringa</i> leaf, no Methionine	SEM	Lev. of Sig	
Initial weight (g/bird)	1042.67	1041.67	1043	1042.33	1041.67	1043	1041.67	0.309	NS	
Final weight (g/bird)	2166.67 <sup>ab</sup>	2050 <sup>abc</sup>	2190 <sup>a</sup>	2033.33 <sup>bc</sup>	2163.70 <sup>ab</sup>	1974.80 <sup>c</sup>	2135.20 <sup>ab</sup>	22.36	*	
Weight gain (g/bird)	1124 <sup>ab</sup>	1008.33 <sup>abc</sup>	1147 <sup>a</sup>	991 <sup>bc</sup>	1121.03 <sup>ab</sup>	931.81 <sup>c</sup>	1093.52 <sup>ab</sup>	22.40	*	
ADWG (g/bird/day)	53.52 <sup>ab</sup>	48.01 <sup>abc</sup>	54.61 <sup>a</sup>	47.19 <sup>bc</sup>	53.38 <sup>ab</sup>	44.37 <sup>c</sup>	52.06 <sup>ab</sup>	1.07	*	
Feed intake (g/bird)	2560	2650	2800	2683.3	2896.7	2693.7	2768.1	34.75	NS	
ADFI (g/bird/day)	121.91	126.19	133.33	127.78	137.77	128.77	131.82	1.65	NS	
Feed-gain ratio	2.28	2.64	2.45	2.71	2.58	2.92	2.54	0.06	NS	
Cost of feed (₦)/kg gain	104.10	116.04	128.67	116.74	133.52	123.49	123.54	2.75	NS	
Mortality (%)	0.00	0.00	0.00	6.67	0.00	3.33	3.33	0.11	NS	

<sup>abc</sup> Mean values on the same row with different superscripts differ significantly (P < 0.05)

- ADWG = Average Daily Weight Gain
- ADFI = Average Daily Feed Intake
- NS = Not significant
- \* = Significant at 5% level
- \*\* = Significant at 1% level (Highly significant)
- SEM = Standard Error of Means

#### **4.5.1 Broiler Performances when fed the Control Diet, Beniseed Diets and *Moringa* Leaf Diets (5 – 8 weeks).**

The comparisons of the effects of feeding either the control diet, all diets containing beniseed and all diets containing *Moringa* leaf were as shown in Table 4.8. Initial weights showed no significant effect of diets ( $P>0.05$ ). There were significant effects of diets ( $P<0.01$ ) on final weights, weight gains and on average daily gain. Birds on the control diet and those on all diets containing *Moringa* were not significantly ( $P>0.01$ ) different and they both had significantly ( $P<0.01$ ) higher final weights and average daily gains than the birds on the beniseed based diets. Feed intake showed significant differences between treatment means ( $P<0.05$ ). Birds on all diets containing *Moringa* gave significantly ( $P<0.05$ ) higher feed intake of 2821.60g/bird, although this value was not significantly different from the value of 2675.68g/bird obtained from the birds on beniseed diets ( $P>0.05$ ). It was however significantly higher ( $P<0.05$ ) than the value of 2560g/bird obtained from the birds on the control diet.

The control diet gave significantly ( $P<0.05$ ) the lowest feed intake.

Feed to gain ratio showed significant ( $P<0.01$ ) effects among dietary treatments. Birds on all diets containing beniseed gave significantly ( $P<0.01$ ) the poorest feed-gain ratio although the value was not significantly different ( $P>0.01$ ) from those on all diets containing *Moringa*. All diets containing beniseed gave significantly ( $P<0.01$ ) higher feed to gain ratio than the value obtained from the

**Table 4.8: Effects of the Control Diet, Beniseed Diets and *Moringa* Leaf Diets as Sources of Methionine in Broiler Finisher Diets (5 – 8 weeks)**

Parameter	Treatments			SEM	Lev. of Sig.
	Control	Pooled Beniseed Diets	Pooled <i>Moringa</i> leaf Diets		
Initial weight (g/bird)	1042.67	1042.33	1042.11	0.309	NS
Final weight (g/bird)	2166.67 <sup>a</sup>	2019.38 <sup>b</sup>	2162.97 <sup>a</sup>	22.36	**
Weight gain (g/bird)	1124 <sup>a</sup>	977.05 <sup>b</sup>	1120.52 <sup>a</sup>	22.40	**
ADWG (g/bird/day)	53.52 <sup>a</sup>	46.52 <sup>b</sup>	53.35 <sup>a</sup>	1.07	**
Feed intake (g/bird)	2560 <sup>b</sup>	2675.68 <sup>ab</sup>	2821.60 <sup>a</sup>	34.75	*
ADFI (g/bird/day)	121.91 <sup>b</sup>	127.41 <sup>ab</sup>	134.31 <sup>a</sup>	1.65	*
Feed-gain ratio	2.28 <sup>b</sup>	2.76 <sup>a</sup>	2.53 <sup>ab</sup>	0.06	**
Cost of feed (₦)/kg gain	104.10 <sup>b</sup>	118.76 <sup>a</sup>	128.58 <sup>a</sup>	2.75	**
Mortality (%)	0.00	3.33	1.11	0.11	NS

<sup>abc</sup> Mean values on the same row with different superscripts differ significantly (P < 0.05)

ADWG = Average Daily Weight Gain  
 ADFI = Average Daily Feed Intake  
 NS = Not significant  
 \* = Significant at 5% level  
 \*\* = Significant at 1% level (Highly significant)  
 SEM = Standard Error of Means

birds on the control diet. Birds on the control diet gave the best feed to gain ratio, though it was not significantly ( $P>0.05$ ) different from birds on *Moringa* leaf meal.

There was also a significant ( $P<0.01$ ) dietary effect on cost of feed per kg gain. Birds on all diets containing beniseed and *Moringa* leaf were not significantly different in term of cost per kg gain ( $P>0.01$ ) but they both gave higher cost of feed per kg gain than the control diet. There were no significant effects of diet on the mortality rate.

#### **4.5.2 Performances of Broilers fed Beniseed Diets and *Moringa* Leaf Meal Diets (5 – 8 weeks).**

The comparisons of the performances of broilers fed diets containing beniseed and containing *Moringa* leaf meal are shown in Table 4.9 The table indicated no significant differences ( $P>0.05$ ) between beniseed and *Moringa* diets with regard to their effects on initial weights, feed intake, average daily feed intake, cost of feed per kg gain and on the mortality rate. However, there were highly significant differences ( $P<0.01$ ) final weights, weight gains and average daily gain.

Birds on all diets containing *Moringa* had significantly higher final weights, weight gains and average daily gains ( $P<0.01$ ) when compared with those birds on all diets containing beniseed.

Feed-gain ratio was significantly ( $P<0.01$ ) better for birds on diets containing *Moringa* leaf meal than for birds on diets containing beniseed.

**Table 4.9: Effects of Beniseed Diets and *Moringa* Leaf Meal Diets on the Performance of Broiler Finishers (5 – 8 weeks)**

Parameter	Treatments		SEM	Lev. of Sig
	Pooled Beniseed Diets	Pooled <i>Moringa</i> leaf Diets		
Initial weight (g/bird)	1042.3	1042.3	0.76	NS
Final weight (g/bird)	2019.4 <sup>b</sup>	2162.6 <sup>a</sup>	45.40	**
Weight gain (g/bird)	977.05 <sup>b</sup>	1120.3 <sup>a</sup>	45.64	**
ADWG (g/bird/day)	46.52 <sup>b</sup>	53.34 <sup>a</sup>	2.17	**
Feed intake (g/bird)	2675.70	2784.10	71.77	NS
ADFI (g/bird/day)	127.41	132.57	3.42	NS
Feed-gain ratio	2.76 <sup>a</sup>	2.50 <sup>b</sup>	0.13	**
Cost of feed (₦)/ kg gain	118.76	126.11	5.71	NS
Mortality (%)	3.33	1.11	0.32	NS

<sup>abc</sup> Mean values on the same row with different superscripts differ significantly (P< 0.05)

ADWG	=	Average Daily Weight Gain
ADFI	=	Average Daily Feed Intake
NS	=	Not significant
*	=	Significant at 5% level
**	=	Significant at 1% level (Highly significant)
SEM	=	Standard Error of Means

#### **4.6 Effect of the Control, Three Beniseed and Three *Moringa* Leaf Meal Diets on the Carcass Characteristics of Broiler finishers**

The comparisons of the effects of feeding the control diet, three of beniseed diets and three of *Moringa* diets on the carcass characteristics of broiler finishers at 9 weeks of age are shown in Table 4.10. There were significant effects of diets on live weights (P<0.05), dressing % (P<0.01), % back (P<0.01), % wings (P<0.05), % gizzard (P<0.01) and on % liver (P<0.01). Birds on *Moringa* based Diet 3 (*Moringa*

**Table 4.10: Effects of the Control, Three Beniseed, and Three *Moringa* Leaf Meal Diets as sources of Methionine on the Carcass Characteristics of Broiler Finishers (9 weeks).**

Parameter	Treatments							SEM	Lev. of Sig.
	Control	1	2	3	4	5	6		
		Beniseed plus 0.25% Methionine	<i>Moringa</i> leaf plus 0.25% Methionine	Beniseed Plus 0.125% Methionine	<i>Moringa</i> leaf Plus 0.125% Methionine	Beniseed, No Methionine	<i>Moringa</i> leaf no Methionine		
Live weight (g/bird)	2538.3 <sup>ab</sup>	2313.3 <sup>bc</sup>	2761.7 <sup>a</sup>	2346.7 <sup>bc</sup>	2573.3 <sup>ab</sup>	2105 <sup>c</sup>	2551.7 <sup>ab</sup>	58.97	*
Dressed weight (g/bird)	1845.1	1838.3	2046.7	1678.3	1848.3	1625	1858.3	41.23	NS
Dressing %	72.70 <sup>c</sup>	79.55 <sup>a</sup>	74.06 <sup>cb</sup>	71.47 <sup>c</sup>	71.85 <sup>c</sup>	77.23 <sup>ab</sup>	72.83 <sup>c</sup>	0.76	**
% Neck	4.27	5.32	3.86	4.60	4.46	4.67	4.50	0.13	NS
% Back	13.33 <sup>b</sup>	17.88 <sup>a</sup>	15.65 <sup>ab</sup>	15.16 <sup>ab</sup>	13.18 <sup>b</sup>	17.25 <sup>a</sup>	13.73 <sup>b</sup>	0.49	**
% Breast	19.98	21.48	20.75	18.40	20.75	21.38	21.12	0.44	NS
% Thighs	11.92	12.95	12.08	11.57	12.74	12.99	12.70	0.18	NS
% Drumsticks	10.11	10.77	9.07	9.95	9.07	9.74	9.72	0.18	NS
% Wings	8.47 <sup>ab</sup>	9.00 <sup>a</sup>	7.77 <sup>b</sup>	8.11 <sup>ab</sup>	7.78 <sup>b</sup>	9.02 <sup>a</sup>	7.82 <sup>b</sup>	0.16	*
% Gizzard	2.17 <sup>b</sup>	2.54 <sup>a</sup>	2.69 <sup>a</sup>	2.21 <sup>b</sup>	2.27 <sup>b</sup>	2.53 <sup>a</sup>	2.16 <sup>b</sup>	0.05	**
% Liver	1.97 <sup>ab</sup>	2.42 <sup>a</sup>	2.30 <sup>a</sup>	1.43 <sup>bc</sup>	1.22 <sup>c</sup>	1.66 <sup>bc</sup>	1.69 <sup>bc</sup>	0.11	**

<sup>abc</sup> Mean values on the same row with different superscripts differ significantly (P < 0.05)

NS = Not significant

\* = Significant at 5% level

\*\* = Significant at 1% level (Highly significant)

SEM = Standard Error of Means

plus 0.25% methionine) gave significantly ( $P < 0.05$ ) higher live weight ( $P < 0.05$ ) compared to the value obtained for Diet 2 (beniseed diet plus 0.25% methionine) but not significantly higher than of the control Diet 1. The lowest live weight of all the diets was that of beniseed diet without supplemental methionine (diet 6). For each level of methionine supplementation, *Moringa* diets were always better in terms of live weight than the beniseed diets.

Dressing percentage of birds fed Diet 2 (beniseed based diet plus 0.25% methionine) produced the highest value which was not significantly ( $P > 0.05$ ) different from birds on Diet 6 (beniseed based diet without supplemental methionine). For % wings, beniseed diets gave higher values compared to the values obtained from *Moringa* diets at each level of methionine supplementation. Percent wings for the control diet fell in between those of the beniseed and of the *Moringa* leaf diets at 0% and at 0.25% methionine supplementation. For % gizzard and % liver, significant effects of dietary treatment were observed, although no particular trend was observed for both parameters.

The diets indicated no significant effects on birds with regard to dressed weight, % neck, % breast, % thighs and % drumsticks.

#### **4.6.1 Effects of the Control Diet, Beniseed Diets and the *Moringa* Leaf Diets on Carcass Characteristics of Broiler Finishers.**

The comparisons of effects of the control diet, all diets containing beniseed and all diets containing *Moringa* leaf on the carcass characteristics of broiler

finishers were as shown in Table 4.11 There were highly significant differences ( $P<0.01$ ) with regards to the effect of diets on live weights. Birds on the control diet and those on pooled *Moringa* diets gave similar live weights and their weights were significantly higher ( $P<0.01$ ) than birds fed on all diets containing beniseed based diets.

Percent back showed highly significant ( $P<0.01$ ) effect of diets. Birds on all diets containing beniseed gave higher % back than birds on the control diet or those on all diets containing *Moringa*. Percent drumsticks showed significant ( $P<0.05$ ) effect of diets. Birds on the control diet and those on all diets containing beniseed had higher % drumsticks than the birds on all diets containing *Moringa*. Percent wings also showed a highly significant effect of diets ( $P<0.01$ ). Birds fed on all diets containing beniseed gave similar % wings as those birds fed on the control diet. The % wings obtained for all diets containing beniseed were significantly higher than the value obtained from all diets containing *Moringa* leaf ( $P<0.01$ ). There were no significant effect of diets ( $P>0.05$ ) on dressed weight, dressing %, % neck, % breast, % thighs, % gizzard and % liver.

#### **4.6.2 Carcass Characteristics of Broilers fed Beniseed Diets and *Moringa* leaf Diets**

The comparisons of the effects of all diets containing beniseed and all diets containing *Moringa* leaf on the carcass characteristics of broiler finishers are shown in Table 4.12. There were no significant effect of diets on dressing percentage, %

**Table 4.11: Effects of the Control, Beniseed Diets and *Moringa* Leaf Meal Diets on the Carcass Characteristics of Broiler Finishers (9 weeks)**

Parameter	Treatments			SEM	Lev. of Sig.
	Control	Pooled Beniseed Diets	Pooled Moringa leaf Diets		
Live weight (g/bird)	2538.3 <sup>a</sup>	2255 <sup>b</sup>	2628.9 <sup>a</sup>	58.97	**
Dressed weight (g/bird)	1845	1713.9	1917.8	41.23	NS
Dressing %	72.70	76.08	72.91	0.76	NS
% Neck	4.27	4.87	4.27	0.13	NS
% Back	13.33 <sup>b</sup>	16.76 <sup>a</sup>	14.07 <sup>b</sup>	0.49	**
% Breast	19.98	20.42	20.87	0.44	NS
% Thighs	11.92	12.50	12.42	0.18	NS
% Drumsticks	10.11 <sup>a</sup>	10.15 <sup>a</sup>	9.29 <sup>b</sup>	0.18	*
% Wings	8.47 <sup>ab</sup>	8.71 <sup>a</sup>	7.79 <sup>b</sup>	0.16	**
% Gizzard	2.17	2.43	2.37	0.05	NS
% Liver	1.97	1.84	1.74	0.11	NS

<sup>abc</sup> Mean values on the same row with different superscripts differ significantly (P < 0.05)

NS = Not significant  
 \* = Significant at 5% level  
 \*\* = Significant at 1% level (Highly significant)  
 SEM = Standard Error of Means

breast, % thigh, % drumsticks, % gizzard and % liver ( $P>0.05$ ). There were highly significant differences between treatment means for live weights, birds on all diets containing *Moringa* gave significantly ( $P<0.01$ ) higher live weight than birds on all diets containing beniseed. There were also significant differences ( $P<0.05$ ) with regard to dressed weight. All diets containing *Moringa* resulted in significantly ( $P<0.05$ ) higher dressed weight than the results obtained for beniseed based diets.

Percent neck and % back showed significant effects of diets ( $P<0.05$ ). Birds on all diets containing beniseed had higher % neck and % back than birds on all diets containing *Moringa*. Percent wings were also higher for all diets containing beniseed compared to the result obtained for all diets containing *Moringa*. It was further noticed that birds on all diets containing *Moringa* generally showed deep yellow colouration on their shanks and skins compared to those on all diets containing beniseed.

**Table 4.12: Effects of Beniseed Diets and *Moringa* Leaf Meal Diets on the Carcass Characteristics of Broiler Finishers at 9 weeks of Age.**

Parameter	Treatments		SEM	Lev. of Sig.
	Beniseed diets pooled	<i>Moringa</i> leaf diets pooled		
Live weight (g/bird)	2255 <sup>b</sup>	2656.7 <sup>a</sup>	110.55	**
Dressed weight (g/bird)	1845.6 <sup>b</sup>	2138.3 <sup>a</sup>	91.46	*
Dressing %	76.08	73.45	1.93	NS
% Neck	4.87 <sup>a</sup>	4.18 <sup>b</sup>	0.25	*
% Back	16.76 <sup>a</sup>	14.51 <sup>b</sup>	0.95	*
% Breast	20.42	20.93	1.11	NS
% Thighs	12.50	12.39	0.42	NS
% Drumsticks	10.15	9.40	0.39	NS
% Wings	8.71 <sup>a</sup>	7.79 <sup>b</sup>	0.30	**
% Gizzard	2.43	2.43	0.13	NS
% Liver	1.84	1.99	0.27	NS

<sup>abc</sup> Mean values on the same row with different superscripts differ significantly (P < 0.05)

NS = Not significant  
 \* = Significant at 5% level  
 \*\* = Significant at 1% level (Highly significant)  
 SEM = Standard Error of Means

## CHAPTER FIVE

### DISCUSSION

#### 5.0 Proximate and Amino-Acid Analyses of Beniseed and *Moringa* Leaf Meals

##### 5.1 Proximate Composition and Amino Acid Composition of Beniseed

The results obtained from the proximate analyses of beniseed presented in Table 4.1 showed that beniseed contains 23.13% crude protein and 50.34% ether extract. These values were relatively close to the 24.2% crude protein and 49% Ether extract reported for beniseed by Aduku, (2004). In Table 4.2 a value of 0.87% methionine which was almost exactly the same as the 0.86% methionine value reported by Olomu and Oboh (1995) however, the amino acid analysis of the roasted beniseed revealed a slightly higher value of 0.87% methionine than 0.75% reported by Aduku, (2004). This difference could be due to the procedural difference during laboratory determinations or specie differences. The value of 1.60% lysine observed for roasted beniseed in this study was higher than 0.37% lysine reported by Aduku, (2004). These differences could also be due to specie differences or differences in laboratory procedure.

##### 5.2 Proximate Composition and Amino Acid Composition of *Moringa* Leaves

The proximate analysis of *Moringa* leaf as presented in Table 4.1 gave the same value of 25.1% protein as reported by Makkar and Becker, (1996). The Amino acid composition for raw *Moringa* leaf indicated 0.26% and 0.17% for

methionine and cystine respectively (Table 4.2). These values were approximately half the values of 0.50% for methionine and 0.34% for cystine reported for raw *Moringa* leaf by Makkar and Becker, (1996). The differences in the values could be as a result of either the stage of maturity of the *Moringa* leaves harvested or differences in laboratory procedure, the season of harvest or the method of processing as reported by Yang *et al.* (2006). The lysine content of 1.29% obtained for raw *Moringa* leaf in this study was comparable to the 1.40% Lysine reported for raw *Moringa* leaf by Makkar and Becker, (1996). The cooked *Moringa* leaf had 22.44% crude protein which was lower than the 25.1% crude protein obtained from raw *Moringa* leaves. This result was in agreement with Joshi *et al.*, (1989) who reported that leaching of nutrients occurs in feeds processed with water.

### **5.3 Comparison of the Proximate and Amino Acid Compositions of Beniseed and *Moringa* Leaves**

The dry matter content of beniseed showed 94.30% which was relatively close to the 95.14% dry matter content obtained from raw *Moringa* leaves and 93.56% dry matter contents of cooked *Moringa* leaves. Beniseed revealed a crude protein content of 23.13% which was lower than the 25.25% crude protein content obtained from raw *Moringa* leaf and higher than the 22.44% crude protein content of cooked *Moringa* leaf. On the amino acid composition, beniseed showed a higher methionine content of 0.87% than raw *Moringa* leaf with 0.26%.

The cystine content of beniseed was 0.99% which was also higher than the 0.17% cystine content obtained from *Moringa* leaf. Except for valine, beniseed was higher in all the other amino acids analyzed. This result was in agreement with McDonald *et al.*, (1994) who reported that beniseed is rich in essential amino acid especially leucine, arginine and methionine.

#### **5.4 Experiment 1: Comparison of Raw and Cooked *Moringa* Leaf Meal as Potential Feed Ingredients in Broiler Diets (0 – 4 weeks)**

The birds on the raw *Moringa* leaf meal performed equally as well and had no significant differences ( $P>0.05$ ) in final weight as those fed on the cooked *Moringa* leaf meal (Table 4.3). Mortality rates were also low and not significantly different ( $P>0.05$ ) for both diets. This result suggests that raw *Moringa* leaves in the diet had no detrimental effect on the growth performances of broilers. The results obtained here was in agreement with Makkar and Becker, (1996) who reported that the traces of anti-nutritional factors found in *Moringa* leaves had no adverse effect on the animals that fed on it. The result was also supported by Yang *et al.* (2006) who reported that anti-nutrient factors in *Moringa* leaves were not significant as to cause any adverse effects when consumed by animals. The higher cost of cooked *Moringa* diet led to the significantly ( $P<0.05$ ) higher cost of feed/kg gain observed for the cooked *Moringa* diet. This result was in agreement with Rao *et al.* (1988) who reported that heating a feed material will substantially increase the cost of the feed due to the energy involved both in treatment and

transport. The result of the preliminary research (experiment 1) showed no lethal effect of raw *Moringa* leaf meal on the birds. The result was contrary to Bhatnagar *et al.*, (1996) who reported lethal effects of leaf meals in poultry feeds. Since raw *Moringa* diet gave similar ( $P>0.05$ ) results as obtained for cooked *Moringa* diet in terms of final weight, weight gain and average daily gain and since cooked *Moringa* diet resulted in higher cost ( $P<0.05$ ) in terms of cost of feed/kg gain, cooking *Moringa* leaves before incorporation into broiler diets was uneconomical and therefore unnecessary.

#### **5.5 Experiment 2: Evaluation of Beniseed and *Moringa* Leaf Meal as Sources of Methionine in Broiler Diets (0 – 4 weeks)**

Comparisons of the performances of broilers fed a control diet, three beniseed and three of *Moringa* leaf diets during the broiler starter phase were as presented in Table 4.4. The results suggested that birds on the *Moringa* leaf diets (Diets 3, 5 and 7) showed better performance compared to beniseed diets in terms of final weight, weight gain and average daily gain. These observations could probably be as a result of the higher feed intake of the *Moringa* leaf diets or be due to better utilization of the diets by the birds. It could also be that *Moringa* leaf has some intrinsic factors that contributed to the nutritional value. Feed intakes of birds on the *Moringa* leaf diets were higher than those obtained for other treatments. This result could not be explained on the basis of the energy content of the feeds since the diets were iso-caloric. It appears that the *Moringa*

diets were more acceptable to the birds. *Moringa* leaf meal was also more bulky and palatable than the beniseed hence, birds were able to consume more of the feed than the more dense beniseed feed. These results were in agreement with Kakengi *et al.* (2007) who reported that *Moringa* leaf based diets were highly preferred by chickens because of its palatability.

The higher feed to gain ratio which was observed for the beniseed diets especially for diet 6 could be as a result of the lower intake of the diet or its lower utilization by the birds or further still, due to inadequate amount of sulphur amino acids such as methionine and cystine that was available to the birds. It was also noticed that feed to gain ratios of beniseed diets improved as the level of methionine increased in the diets (compare diets 6, 4, and 2). The lower feed efficiency obtained from birds on beniseed diets agrees with the report of Cuca and Sunde (1967) who observed a depression in growth rate of broilers when beniseed cake was used in their diets.

*Moringa* leaf diets without methionine supplementation gave similar final weight and average daily gain as obtained with the control diet 1 while the *Moringa* leaf diet plus either 0.125% methionine or 0.25% methionine gave slightly better final weight and average daily gain than the control diet. From these results, it was clear that 6% *Moringa* leaf in the diet was able to adequately supply the amount of methionine required by the broilers in the starter phase when compared with the control diet than the birds that were fed on the beniseed based diet. The beniseed diet even with 0.25% methionine

supplementation performed slightly below the control diet. For both the beniseed and the *Moringa* leaf meal diets, the higher the level of supplemental methionine, the higher the final weights and weight gains. This observation agrees with the report of Oluyemi and Roberts, (1988) which stated that methionine supplementation improves the efficiency of feed utilization of poultry diets.

The performances of broiler chicks fed either the control diet, compared with those fed beniseed or with those fed the *Moringa* diets were presented in Table 4.5. Broilers on all diets containing *Moringa* gave slightly higher final weight and average daily gain than those on the control diet. *Moringa* leaf diets also gave slightly higher feed intake resulting from higher acceptability of *Moringa* leaf diets when compared with the control diet. This result was in agreement with the report of Kakengi *et al.*, (2007). The better feed to gain ratio obtained for all diets containing *Moringa* compared to the value obtained for all diets containing beniseed means a better utilization of the *Moringa* leaf diets. This may probably be due to the adequate supply of sulphur amino acid (methionine) and this may be due to higher degree of availability of the amino acid from the *Moringa* leaf meal than available from the beniseed. This result was contrary to Jacob *et al.* (1996) who reported improved growth rate and feed efficiency of broilers when beniseed cake was used in the diets. Both the beniseed diets and the *Moringa* leaf diets gave higher feed cost/kg gain than the control diet. This

observation appears to be a reflection of the higher costs per kg of these diets compared with that of the control diet.

The performances of broilers fed either all beniseed containing diets or all *Moringa* containing diets were compared in Table 4.6. The higher final weight and weight gain obtained for birds on the *Moringa* diets could be as a result of the higher feed intake or feed utilization by the birds on all *Moringa* containing diets. The *Moringa* diets were more efficiently utilized probably due to its adequate supply or availability of the amino acid (methionine). Despite the fact that birds on the *Moringa* diets had higher feed intake compared to the birds on the beniseed diets, feed-gain ratio and feed cost per kg gain for both classes of diets were not significantly different ( $P>0.05$ ) although the *Moringa* diets gave slightly lower (better) values for both parameters. *Moringa* diets were more efficiently utilized than the beniseed diets. The higher ( $P<0.05$ ) percent mortality observed for birds fed all *Moringa* containing diets at the starter phase compared to those on all beniseed containing diets could not be related to any known factor. The higher mortality was contrary to the observation made regarding the better performance of *Moringa* leaf meal diet in terms of better growth rate and more efficient feed utilization.

#### **5.6 The Performance of Broilers Fed Beniseed or *Moringa* Leaf meal Diets with or without Supplemental Methionine (5 – 8 weeks).**

The comparisons of the performances of broilers fed the control diet, three of beniseed diets and three of *Moringa* leaf meal diets during the finisher phase

were as presented in Table 10. For every level of methionine supplementation, *Moringa* leaf meal diets performed slightly better or significantly better than the beniseed diets ( $P < 0.05$ ) for final weights and average daily gains of the birds. Also for either the *Moringa* leaf diets or the beniseed diets, at every level of methionine supplementation, there were improvements in performances with regards to final weights, weight gains and average daily gains of broilers. These results were in agreement with the report of Saunderson and Mackinlay, (1990) who stated that methionine is the main amino acid for all polypeptide synthesis.

It was also observed that there were no significant differences ( $P > 0.05$ ) in the final weight and weight gain between *Moringa* leaf diets without methionine supplementation, *Moringa* leaf diet with 0.125% methionine supplementation, *Moringa* diets with 0.25% methionine supplementation and the control diet. From this observation, it can be deduced that *Moringa* leaf meal at 6% level in broiler finisher diet can supply the methionine need of broilers. For the beniseed diets without methionine supplementation (diet 6) final weight and average daily gain were significantly ( $P > 0.05$ ) lower than the values obtained for the control diet. Methionine supplementation of beniseed diets even at 0.125% and 0.25% methionine levels resulted in slightly lower final weights and weight gains when compared with the value obtained for the control diet. From these results, it can be deduced that methionine in the *Moringa* leaf meal, although not as high as observed for the beniseed, it seems to be more readily available than the methionine in the beniseed. Feed intake, feed-gain ratio and feed cost per kg gain

between the seven dietary treatments were not significantly different ( $P>0.05$ ) from each other. This may be due to lower requirements of the birds for the essential nutrients such as the methionine during the finisher phase. Older broilers were therefore able to utilize feeds of lower grades more efficiently than when they were in their early stage of growth. Percent mortalities for all the treatments were generally low and were not significantly different ( $P>0.05$ ) even though birds on the beniseed diet 4 gave a slightly higher percent mortality of 6.67%. All the mortalities encountered in the study appeared to be as a result of the hot weather spell that occurred between March and April 2007 which coincided with the finisher phase of this study.

The performances of broilers fed the control diet, compared with those on all beniseed containing diets or those on the *Moringa* containing diets were as presented in Table 4.2. The higher final weights and weight gains obtained for the control and all the *Moringa* containing diets compared to the values for all the beniseed containing diets suggest that the control and all *Moringa* containing diets were more superior to all the beniseed containing diets. Feed intakes for the control and for all the beniseed containing diets were lower than that obtained for the birds on all *Moringa* leaf meal diets. This observation could not be related to the energy contents of the diets since all diets were iso-caloric. The higher feed intake may therefore be attributable to the bulkier nature of the *Moringa* leaf meal diets compared to the beniseed diets. Percent mortality was not significantly affected by dietary treatments ( $P>0.05$ ) even though birds on all the

beniseed containing diets had slightly higher percent mortality of 3.33% compared to those birds on all *Moringa* containing diets with 1.11% mortality.

Comparisons of broiler performances on all the beniseed containing diets and those on all the *Moringa* containing diets were as presented in Table 4.9. The significantly higher final weights and weight gains obtained for birds on all the *Moringa* containing diets is also closely related to the better acceptability of the diets, higher intakes or the superiority of the *Moringa* leaf meal diets. Feed intake for the *Moringa* leaf meal diets were slightly higher than that of the beniseed diets although the difference was not significant ( $P>0.05$ ). This could also be as a result of better acceptability of the *Moringa* leaf meal diets. The non significant differences obtained in terms of feed intake between all the beniseed containing diets and all the *Moringa* containing diets at the finisher stage was probably as a result of the fact that the birds were now older and were able to consume and utilize feeds better than when they were much younger. The significantly better feed-gain ratio ( $P<0.05$ ) obtained for birds on all the *Moringa* containing diets also further revealed that all the *Moringa* containing diets were better utilized by the birds than all the beniseed containing diets. This result agrees with Jacob *et al.* (1996) who reported that drastic reduction in both egg production and feed efficiency occurred when beniseed cake was used in poultry diets. The slightly higher feed cost per kg gain for all the *Moringa* containing diets when compared with all the beniseed containing diets could also be attributed to the higher cost of *Moringa* leaf meal in the market. Birds on all the beniseed containing diets had

slightly higher mortality rate (3.33%) than birds on all the *Moringa* containing diets (1.11%) although the differences were not significant. Mortalities encountered were also not related to the effects of the diets.

#### **5.7 Carcass Characteristics of Broiler Finishers Fed Beniseed and *Moringa* Leaf Meal as Sources of Methionine.**

The results of the carcass analyses of broiler chickens fed the control diet, three of beniseed diets and three of *Moringa* leaf meal diets were presented in Table 4.10. Significantly higher live weights were obtained for the control and the *Moringa* leaf meal diets ( $P < 0.05$ ). Birds on *Moringa* leaf meal diets however gave slightly higher live weights than birds on control diet. These results were in agreement with Ray *et al.* (2006) who reported that *Moringa* diets improved growth performance of broilers. A similar trend was observed for dressed weights, although the differences in dressed weights were not significant ( $P > 0.05$ ). Observations show that the higher live weights for birds on *Moringa* leaf meal diet were not in the choice parts of the carcass such as the breast, thighs and drumsticks. No significant differences ( $P > 0.05$ ) between treatment means were observed for the breast, thighs and drumsticks which represent the major edible cuts of the carcass. The results therefore suggest that the better performance of the birds on the *Moringa* leaf meal diets could not reflect on the major edible components of the carcass which could have meant an extra advantage over the control or beniseed diets. No trend was established for

dressing %. Beniseed diet 2 gave significantly the highest dressing percentage ( $P < 0.05$ ) while beniseed diet 4 gave significantly the lowest dressing percentage.

The carcass compositions of broilers fed the control, diet, all the beniseed containing diets or all the *Moringa* containing diets were as shown in Table 4.11. *Moringa* leaf meal diets gave significantly better live weights than the beniseed diets ( $P < 0.05$ ). Although live weight for the *Moringa* diets was slightly higher than for the control diet, the difference between the two were not significant ( $P > 0.05$ ). This result was in agreement with that of Ray *et al.* (2006) who reported that broilers fed on *Moringa* leaf meal diets had improved growth performance.

Carcass characteristics for birds on the beniseed diets compared with the results for those on the *Moringa* leaf meal diets were as presented in Table 4.12. Birds on beniseed diets showed slightly higher dressing percentage than those on the *Moringa* diets. The result was in agreement with Aduku and Olukosi, (2000) reported that smaller animals tend to have higher dressing percentage when compared to larger animals.

The deep yellow colouration of the shank and the skin of birds on the *Moringa* leaf meal diets could be attributed to the presence of xanthophylls and carotenoid pigments contained in the *Moringa* leaves as reported by Austic and Neishem, (1990). Similar results were also obtained by Kakengi *et al.*, (2007).

## CHAPTER SIX

### 6.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The proximate analyses showed that roasted beniseed contained 23.13% crude protein, 2.77% crude fibre, 50.34% ether extract, 9.48% ash and 14.28% nitrogen free extract. For the raw *Moringa* leaf meal it was found to contain 25.25% crude protein, 9.02% crude fibre, 11.48% ether extract, 5.09% Ash and 49.18% nitrogen free extract, while the cooked *Moringa* leaf meal contained 22.44% crude protein, 10.62% crude fibre, 8.70% ether extract, 6.67% ash and 51.57% nitrogen free extract.

Amino acid composition of the roasted beniseed showed that it contains 0.87% methionine, 0.99% cystine, 1.6% lysine and 2.16% arginine among the critical amino acids. Raw *Moringa* leaf meal on the other hand contained 0.26% methionine, 0.17% cystine, 1.29% lysine and 1.36% arginine. It was however observed that *Moringa* leaf meal had lower values of the essential amino acids per unit weight than the beniseed.

The feeding of raw *Moringa* leaf meal in experiment 1 showed that there was no lethal effect of antinutritional factors on the growth and on the health status of broiler chicks. Therefore raw *Moringa* leaf meal may be included in broiler diets up to 6% dietary level without any adverse effect on the growth performance. It is therefore unnecessary to cook *Moringa* leaf meal before feeding it in broiler diets. *Moringa* leaf meal at 6% dietary level in experiment 2 resulted in better performance of broiler birds in terms of final weight and average daily

gain than observed for broilers fed on the control or on the beniseed based diets. 6% *Moringa* leaf meal diet without supplemental methionine performed equally well as the control diet and significantly better than the beniseed based diets ( $P < 0.05$ ). Broilers on 6% beniseed diets performed significantly ( $P < 0.05$ ) lower than the broilers on the control diet in terms of final weight, weight gain and average daily gain. Carcass characteristics at 9 weeks of age showed no significant ( $P > 0.05$ ) differences in choice parts of the carcass (breast, thighs and drumsticks). *Moringa* leaf meal at 6% dietary level was also observed to impart a deep yellow colouration of the shanks and skin of the broilers.

It was concluded that raw *Moringa* leaf meal at 6% dietary level is sufficient in meeting the methionine requirement of broiler chicks both for the starter and finisher phases. Roasted beniseed based diets at the 6% dietary level could not meet the methionine requirement of the broiler chicks despite its higher contents of methionine than the raw *Moringa* leaf meal. This could only mean that the methionine in raw *Moringa* leaf meal is more readily available in the diets than the methionine in the roasted beniseed. It is therefore recommended that raw *Moringa* leaf meal at 6% could be used in the diets of broilers provided it can be obtained at economical prices.

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