EFFECT OF DIETARY INCLUSION LEVELS OF MORINGA (*Moringa oleifera)* LEAF MEAL ON PERFORMANCE CHARACTERISTICS AND BLOOD METABOLITES OF BROILER CHICKENS

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APRIL, 2019

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METABOLITES OF BROILER CHICKENS

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A DISSERTATION SUBMITTED TO THE DEPARTMENT OF ANIMAL SCIENCE, BAYERO UNIVERSITY, KANO, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF MASTER IN ANIMAL SCIENCE

APRIL, 2019

DECLARATION

I hereby declare that this work is a product of my research efforts undertaken under the supervision of Dr. N.B. Rano and has not been presented anywhere for the award of degree or certificate. All sources have been duly acknowledged.

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CERTIFICATION

This is to certify that the research work for this dissertation and the subsequent write-up (Sadiq Madaki, SPS/14/MAS/00006) were carried out under my supervision.

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APPROVAL

This dissertation has been examined and approved for the award of Masters in Animal Science.

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ACKNOWLEDGEMENTS

All praises be to almighty Allah for sparing our life and gave me the ability to undertake this research, in summary Alhamdulillah!, Alhamdulillah!!, Alhamdulillah!!!. I must acknowledge the contribution of my supervisors; Dr. N.B. Rano and Dr. M. Baba for their tireless effort in correction, supervision and guidance from the beginning of the program up to this moment. I also appreciate the contribution of all my lecturers in the Department of Animal Science, Bayero University, Kano and all deanery personnel of the faculty of Agriculture, Bayero University, Kano. May Almighty Allah bless them abundantly, amen.

I acknowledge the contribution of the management of Kano University of Science and Technology, Wudil and the entire staff of Animal Science Department, Kano University of science and Technology, Wudil for their support, encouragement and prayers throughout the period of this study and also to Sovet International Limited. My sincere appreciation goes to my families and friends for their prayers and support towards successful completion of this study. May Allah bless all of them here and hereafter, amen.

DEDICATION

I dedicated this research work to my beloved parents Alhaji Aliyu Mustapha (Madakin Tsangaya) and Hajia Safiya Ibrahim.

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Abstract

A feeding trial was conducted to determine the effects of dietary inclusion levels of *Moringa oleifera* leaf meal (MOLM) on the performance characteristics and blood metabolites of broiler chickens. The study was conducted at Teaching and Research Farm of the Department of Animal Science, Faculty of Agriculture, Bayero University, Kano. Two hundred and twenty-five day old broiler chickens (Cobb strain) were distributed randomly into five treatments with tree replicates and each contained fifteen birds in a completely randomized design. Birds were managed on deep litter system. MOLM was used as leaf protein supplement at varying levels 0, 2, 4, 6, and 8% designated as treatments A, B, C, D and E respectively. The diets were formulated to contain 22% CP, 2800ME Kcal/kg and 20% CP, 3100 ME Kcal/Kg for broiler starter and finisher respectively. Parameters measured included growth performance, nutrient utilization, carcass characteristics, haematology and blood serum chemistry. There were no significant (P>0.05) difference in growth performance at starter phase except in FCR and feed cost with better performance obtained in treatment C and diet A was significantly higher in cost of feed/kg. There were significant (P<0.05) differences in growth performance at finisher phase for all parameters measured with best result obtained in birds fed diet C. Similarly, blood metabolites results revealed significant (P<0.05) differences for all parameters measured except for potassium and chloride contents. There were significant (P<0.05) difference in nutrients utilization and carcass characteristics. However, no significant (P<0.05) differences were observed in carcass parts and organ weight except in wings, liver, and empty small intestine. It was observed that better performances were recorded in birds offered 4%MOLM-based diet. It could be recommended that varying levels of MOLM can be included in the diet of broiler chickens as leaf protein supplement up to 8% inclusion level without any harmful effect.

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND INFORMATION

The future of poultry enterprise depends on the availability of feedstuff for a balanced diet. This is because the production potentials of poultry depend mainly on feed. These potentials cannot be fully attained unless balanced rations are provided. These should be provided in sufficient quantity and quality to supply energy needed for normal performance of the birds, contain protein, minerals and vitamins in sufficient quantities to ensure proper growth and maintenance and not hazardous to the animals (Egbewende, 2012). Feed accounts for 60-70% of the total production cost in modern poultry production. Poultry enterprise competes with humans for grains thus, making the enterprise expensive in terms of feeding (Smith, 1990). It is also estimated that feed contributes about 60-80% of the total cost of production in intensive poultry production system (Ehtesham & Chowdhury, 2002). One of the possible options to solve the present high cost of feedstuff is the substitution of the conventional feedstuff with non-conventional types in poultry enterprise (Olerede & Longe, 1999).

The protein from leaves can be fed to poultry in the form of leaf protein concentrate or leaf meal, (Farinu, Ajiboye & Ajao, 1992). For instance, leaf meals made from shrubs have been useful to small-scale farmers (World Agro forestry Center, WAC, 2006). Various leaf meals have been used in poultry diets, including those of *Leucaena leucocephala*, *Amaranthus spp.* etc. (Farinu *et al.*, 1992). One such non-conventional feedstuff, which could be of value for poultry feeding is the leaves of *Moringa* (Zanu, Asiedu, Tampuori, Asada & Asante, 2012). *Moringa oleifera* is a widely grown crop in India, Ethiopia, the Philippines and Sudan. The tree is being grown in West, East and South Africa and in tropical Asia, Latin America, the

Caribbean, Florida, and the Pacific Islands (Fahey, 2005). English common names of Moringa include; Drumstick tree (describing the shape of its pods), Horseradish tree (describing the taste of its roots) and it were utilized by the ancient Romans, Greeks and Egyptians. *Moringa oleifera*, or the horseradish tree, is a tropical species that is known by such regional names as Benzolive, Drumstick tree, Kelor, Marango, Saijhan and Sajna (Fahey, 2005). It is widely grown and cultivated in the northern part of Nigeria where it is locally called *Zogale* (among the Hausa speaking people).

It is considered one of the world's most useful trees, as almost all parts of this plant have been used for various treatments of diseases/ailments. Several parts of *Moringa oleifera* have been reported to show antitumor, anti-inflammatory and antipyretic effects (Sodamade, Bolaji & Adeboye, 2013). It is considered as one of the world's most useful trees, as almost every part of the Moringa tree can be used for food, medication and industrial purposes (Khalafalla *et al.,* 2010). People use its leaves, flowers and fresh pods as vegetables while others use it as livestock feed (Anjorin, Ikokoh & Okolo, 2010). This tree has the potential to improve nutrition, boost food security and foster rural development, all parts of this tree can be used in a variety of ways. Moringa is full of nutrients and vitamins and is good in food of humans as well as in the feed of animals. Moringa seed is use in water purification and is a useful source of medicines. It provides lots of leafy material when using alley cropping systems (Hsu, 2006). The result of proximate analysis of *Moringa oleifera* leaves conducted by Sodamade, Bolaji and Adeboye (2013) revealed that *Moringa oleifera* contains 9.0% moisture, 6.0% ash, 2.43% ether extract, 5.43% crude fibre, 39.13% crude protein, and 38.21% nitrogen free extract. Olugbemi *et al*., (2010b) obtained the following values; 28.0% crude protein, 2.5% calcium, 23.20 mg/kg potassium, 214.00 mg/kg sodium, 187.00 mg/kg iron, 5.0 mg/kg phosphorous, and

2978 metabolizable energy kcal/kg. Makkar and Becker (1997) reported that *Moringa oleifera* has low levels of anti-nutritional factors and can therefore serve as a valuable non-conventional feedstuff in poultry feeds and if grown in sufficient quantities will lower the cost of animal feeds and can reduce the pressure on the conventional feedstuff (Oludoyi & Toye, 2012). Feed supplements are materials that are incorporated to the animal feed to enhance the effectiveness of nutrients and exert their effects in the gut or on the gut wall cells (McDonald *et al.*, 2010). Information on the requirements for energy and protein in broiler chickens is richly available (Jegede, Adeyeye & Agbede, 2016). The levels approved for broiler during starter and finisher phases are 22 to 24% and 18 to 20% crude protein with the same energy base of ME 2800 Kcal/kg and 3200 ME Kcal/kg respectively (NRC, 1994).

Blood is an important index of physiological and pathological changes in organism (Abdulazeez, Adamu, Igwebulke, Gwayo, & Muhammad (2016). The primary functions of blood are to transport oxygen from the respiratory organs to body cells (Noah, 2015), distribute nutrients and enzymes to cells and carry away waste product from the body (Robert, 2016). The various functions of the blood are carried out by the individual and collective action of its constituents; these are cells and plasma (Akinmutini, 2004). Haematological tests have been widely used for the diagnosis of various diseases and nutritional status of an animal (Afolabi, Akinsoyinu, Alajide & Akinyele, 2010). The information obtained from blood parameters would substantiate the physical examination and together with medical history provide excellent basis for medical decision (Weater, Burkish & Daniel, 1987). It will also help to determine the extent of tissue and organ damage, the response of defense mechanism of the patient and aid in the diagnosis of the problem (Addas, Midau & Babale, 2010).

Carcass is an important factor for evaluating the ability of an animal to transform feed into edible product (Mecedo, Sequeire & Martins, 2000). Factors including age, sex, breed, birth weight, type of feed etc. have effects on carcass weight and dressing percentage (Perez, 2002). Genes and environmental factors dictate the amount of growth and development of an individual organism. Dressing percentage is important in carcass grade evaluation (Irshad *et al.,* 2012).

1.2 PROBLEM STATEMENT

High feed cost is reducing the expansion and development of poultry enterprise and resulting in animal protein deficiency among Nigerians, especially the low income earners leading to malnutrition (Adebayo, Agunbiade, Adeyemi & Banjoko, 2008; Abu & Suetan, 2009). It was reported that feed supply remains a major constraint in animal production due to high cost of conventional feedstuffs and the competition between man and animals (Ahamefule, Obua, Ukweni, Oguike & Amaka, 2008). Generally, inadequate supplies of feeds, nutritionally unbalanced rations, and adulterated ingredients are some of the factors responsible for low productivity of livestock in Nigeria (Ogundupe, Abeke, Sekoni, Dafwang & Adeyinka, 2003).

1.3 JUSTIFICATION OF THE STUDY

The demand for broiler (*Gallus gallus domesticus*) chickens is rising as consumer's interest in meat is gradually shifting from red meat to white meat. However, to satisfy the demand of white meat by meat consumers, evaluation of locally available and unconventional feed resources might be the solution (Smith, 1990). It is evident that the conventional sources of feed can no longer adequately supply the needs of the fast growing livestock industry (Abubakar, 2008). Despite the large number of legume grains in Nigeria only soybean, cotton seed cake and groundnut cake are mainly used in livestock feeding. Several other locally available species that exhibit remarkable adaptation to tropical conditions have been underutilized and underexploited for livestock feeding (Apata & Ologhobo, 2004). Alternative or unconventional plant protein sources are therefore, been identified to be adapted in new feeding scheme (Omole and Ajayi, 2006). Recently, researchers have increasingly been paid attention to Moringa. *Moringa oleifera* a member of the family *Moringaceae* is a fast growing plant and widely available in the tropics and subtropics with much economic values.

Moringa is widespread, drought-tolerant tree with negligible amount of tannins, trypsin and amylase inhibitors (Becker, 1995; Makkar & Becker, 1997; Gidamis, Panga, Sarwatt, Chove & Shayo, 2003). *Moringa* can also be dried and used in the form of Moringa leaf meal (Zanu *et al.* 2012). It is also a natural source of protein with great potentials. The leaves contain magnesium, potassium, and all of the essential amino acids like histidine, arginine, methionine, lysine, phenylalanine, leucine, isoleucine and valine. *Moringa* leaves are probably ranked as the best of all the vegetables in the tropics. Its leaves are eaten by sheep, pigs, cattle, goats and rabbits, the leaves are also used to feed fishes. They contain very strong concentration of vitamins A, C and B-complex, iron, protein, zinc and selenium which are usually of plant origin (FAO, 1997). In addition *Moringa oleifera* leaf meal (MOLM) has been reported to have antimicrobial properties, natural digestive enzymes (Greg, 2008), blood boosting properties and medicinal properties (Fuglie, 1999).

1.4 OBJECTIVES OF THE STUDY

The objectives for the study were:

I. To determine the growth performance of broiler chickens fed diets containing varying levels of *Moringa oleifera* leaf meal

II. To determine the hematological indices and serum chemistry of broiler chickens fed diets with varying levels of *Moringa oleifera* leaf meal.

III. To examine the nutrient utilization of broiler chickens fed diets containing inclusion levels of *Moringa oleifera* leaf meal.

IV. To assess the effect of feeding varying levels of *Moringa oleifera* leaf meal on carcass characteristics of broiler chickens.

V. To compare the cost of feeding broiler chickens with the experimental diets.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 MORINGA FOR POULTRY DIETS

Moringa oleifera is a widely grown crop in India, Ethiopia, the Philippines, and Sudan. The tree is grown in West, East, and South Africa and in tropical Asia, Latin America, the Caribbean, Florida, and the Pacific Islands (Fahey, 2005). *Moringa oleifera* is native to Northwest India (Foidl, Makkar & Becker, 2001). Currently it is widely distributed in the tropics throughout the Pacific region, Aregheore, (2002), West Africa (Lockett, Calvert & Grivetti, 2000) as well as Central America and the Caribbean (Foidl, *et al.,* 2001). English common names include Drumstick tree (describing the shape of its pods), Horseradish tree (describing the taste of its roots), and it was utilized by the ancient Romans, Greeks and Egyptians. It is a typical multipurpose tree of significant economic importance because there are several industrial and medicinal uses and various products to be used as food and feed which can be derived from its leaves and fruits. Moringa is one of the most useful tropical trees. The relative ease with which it propagates through asexual means and its low demand for soil nutrients and water after being planted makes its production and management easy. Introduction of this plant into a farm which has a biodiversed environment can be beneficial for both the owner of the farm and the surrounding ecosystem.

2.1.1 Morphology and Physical Characteristics of Moringa

Moringa is a fast growing, perennial tree which can attain a maximum height of 7-12m and a diameter of 20-40cm at chest height (Morton, 1991).

Stem and branch

The stem is normally straight but occasionally poorly formed. The tree grows with a short straight stem that reaches a height of 1.5-2m before it begins branching but can reach up to 3.0m. The extended branches grow in a disorganized manner and the canopy is umbrella shaped (Morton, 1991).

Leaves

The alternate twice or thrice pinnate leaves grow mostly at the branch tips. They are 20-70 cm long, grayish, smooth when young long petiole with 8-10 pairs of pinnae each bearing two pairs of opposite elliptic or obovate leaflets and one at the apex all 1-2 cm long with glands at the bases of the petioles and pinnae (Morton, 1991).

Flowers

The flowers which are pleasantly fragrant and 2.5cm wide are produced profusely in axillary drooping panicles 10-25 cm long. They are white or cream colored and yellow-dotted at the base. The five reflexed sepals are linear-lanceolate. The five petals are slender spatulate. They surround the five stamens and five staminodes and are reflexed except for the lowest (Morton, 1991).

Fruits and seeds

The fruits have three lobed pods which hang down from the branches and are 20-60 cm in length. When they are dry they open into 3 parts. Each pod contains 12 to 35 seeds. The seeds are round with a brownish semi-permeable seed hull. The hull itself has three white wings that run from top to bottom at 120-degree intervals. Each tree can produce between 15,000 - 25,000 seeds/year. The average weight per seed is 0.3g and the kernel to hull ratio is 75:25 (Makkar & Becker, 1997).

2 .1.2 Uses of Moringa (*Moringa oleifera)* Tree

It is considered as one of the world's most useful trees, as almost every part of Moringa tree can be used for food, medication and industrial purposes (Khalafalla, *et al.,* 2010). People use its leaves, flowers and fresh pods as vegetables while others use it as livestock feed **(**Anjorin, Ikokoh, & Okolo, 2010). This tree has the potential to improve nutrition, boost food security and foster rural development, all parts of this tree can be used in a variety of ways. Moringa is full of nutrients and vitamins and is good in human's food as well as in the feed of animals. Moringa seed is use in water purification and is a useful source of medicines. It provides lots of leafy material when using alley cropping systems (Hsu, 2006).

One of the most important industrial applications is the use of Moringa seeds for water purification purpose (Kalogo, Bassigui´eS´eka, & Verstraete, 2001; Broin *et al.,* 2002). Oil obtained from Moringa seeds is used for cooking and was found to contain high levels of unsaturated fatty acids (Lalas & Tsaknis, 2002).

2.1.3 Nutritive Value of Moringa Plant

Leaves and seeds of Moringa represent an important source of nutrients for rural populations in certain areas of India and West Africa (Lockett, Calvert & Grivetti, 2000). Most reports indicate that Moringa leaves are rich in protein and present an amino acid composition, which is suitable for human and animal nutrition (Makkar & Becker, 1996). High biomass production of Moringa of over 100 tons of dry matter/hectare can be achieved under intensive farming conditions (Foidl *et al.,* 2001). Therefore, there is a need to make proper use of the protein-rich residual materials from plantations and from the extraction of carotenes or growth promoting components. Moringa may contain certain amounts of anti-nutritional factors like tannins and saponins (Makkar and Becker, 1997; Oliveira, Silveira, Vasconcelos, Cavada & Moreira, 1999). Recently, a high degree of renewed interest was placed on the nutritional properties of Moringa in most countries where it was not native (Reyes, Sporndly & Ledin 2006; Oduro, Ellias & Owusu, 2008). This could be due to the claims that it increases animal productivity as it has nutritional, therapeutic and prophylactic properties (Fahey, 2005). Studies from other countries indicate that the leaves have enormous nutritional value such as vitamins, minerals and amino acids (Anwar, Sajid, Muhammad & Anwar, 2007). As such, the leaves have been used to solve problem of malnutrition, especially among infants and nursing mothers.

2.1.4 Effect of Moringa in Animal Production

The digestibility of dry matter, crude protein and neutral detergent fiber increased significantly in the diets supplemented with Moringa compared to *B. brizantha* hay alone (Nadiar, 2006). Sarwatt, Kapange and Kakengi, (2002) studied the effect of substituting *Moringa oleifera* Leaf meal (MOLM) for cottonseed cake on milk yield and composition of cross bred cows fed Napier grass (*Pennisetum purpureum*) as basal diet. They recorded that when cottonseed cake was substituted with MOLM milk yield was significantly increased. There were no effects of substituting cottonseed cake with MOLM on total solids, fat, milk protein and ash contents of the milk. MOLM had higher dry matter (820 g/kg) than cottonseed cake (697g/kg dry matter). Dry matter degradability of MOLM was higher than cottonseed cake. It is concluded that up to 1.65 kg dry matter of MOLM could substitute for 1.23kg cottonseed cake in dairy cow diets without affecting the milk yield. For best performance a combination of the two with lower levels of MOLM gave higher milk yield than another protein source fed alone.

Adeniji (2012) studied effects of replacing groundnut cake with *Moringa oleifera* leaf meal (MOLM) in the Diets of grower rabbits at 0, 20, 40, 60, 80 and

100%. He reported enhanced weight gain of rabbits at 60% inclusion. Profit, gross profitability and feed cost efficiency increased as more *Moringa oleifera* replaced Groundnut cake in the diets. There was high nitrogen digestibility among the treatment although was not significantly different.

Some plant leave and Moringa leave have been used as feed stuffs for poultry and rabbit as a supplement or partial substitute for the conventional cereal grains and forages. Olugbemi, Mutayoba & Lekule (2010b) studied the effect of adding Moringa and cassava leaves meal on broiler performance and assessment of growth and blood chemistry when fed at graded levels of (0, 5, 10, and 15%). The authors concluded that the *Moringa oleifera* can be added up to 5% can be used in finisher diet without any adverse impact on the growth, blood chemistry or carcass characteristics.

Melesse, Bulang & Kluth (2009) investigated the effects of *Moringa stenopetala* leaf meal (MSLM) on nutrient intake and weight gain of chicks. The experimental diets contained MSLM at a rate of 2, 4, and 6% of the diets to replace 3, 5.9 and 8.8% of the crude protein levels of the diets respectively. The results on daily feed, dry matter and crude protein intake of the broiler chicks fed MSLM diets were significantly higher than those fed the control diet. Chicks fed 6% MSLM showed significantly higher average live weight gain than those on 0, 2 and 3% MSLM. Feed efficiency ratio and protein efficiency ratio were also higher for chicks fed MSLM based diets. MSLM elicited no deleterious effects in the birds. The results indicated that MSLM is a potential plant protein supplement and could be included up to 6% in the diet of grower chicks to substitute expensive conventional protein sources. Gadzirayi, Masamha, Mupangwa, and Washaya (2012) tested the effects of supplementing soyabeans with *Moringa oleifera* leaf meal as a protein source in poultry production. The experimental diets contained (0, 25, 50, 75 & 100% MOLM).

The authors reported that inclusion of *Moringa oleifera* leaf meal as protein supplement in broiler diets at 25% inclusion level produced broilers of similar weight and growth rate compared to those fed under conventional commercial feeds. Banjo, (2012) determined the impact of adding the Moringa leaf meal in broiler diets at varying levels (0, 1, 2 & 3%). He reported enhanced weight gain at 2% inclusion levels while feed intake and feed conversion where not affected.

2.2 ANTI-NUTRITIONAL FACTORS IN ANIMAL FEED

Anti-nutrients or anti-nutritional factors may be defined as those substances generated in natural feedstuffs by the normal metabolism of species and by different mechanisms (for example inactivation of some nutrients, diminution of the digestive process or metabolic utilization of feed) which exerts effect contrary to optimum nutrition (Cheeke & Shull, 1985). Anti-nutritional factors are substances which either by themselves or through their metabolic products interfere with feed utilization and affect the health and production of animal or which act to reduce nutrient intake, digestion, absorption and utilization and may produce other adverse effects (Akande & Fabayi, 2010). There is a wide distribution of biologically active constituents throughout the plant kingdom, particularly in plants used as animal feeding stuff and in human nutrition (Igile, 1996). Many plant components and seeds of legumes and other plant sources contain in their raw state wide varieties of anti-nutrients which are potentially toxic (D'Mello, 2000).

The knowledge that these compounds elicit both toxic and advantageous biological responses has given rise to several investigations in recent times as to their possible physiological implications in various biological systems (Igile, 1996). Some of these chemicals are known as secondary metabolites and they have been shown to be highly biologically active and most of these secondary metabolites elicit very harmful biological responses, while some are widely applied in nutrition and as pharmacologically active agents (Soetan, 2008). There are several anti-nutritional factors that are very significant in plants used for human foods and animal feeds and some most common ones with their mechanism of toxicity and impact on animal health and productivity are discussed hereunder.

2.2.1 Tannins

Tannin is an astringent, bitter plant polyphenolic compound that either binds or precipitates proteins and various other organic compounds including amino acids and alkaloids. Tannins are the most widely occurring anti-nutritional factors found in plants. These compounds are present in numerous tree and shrub foliages, seeds and agro-industrial by-products (Dube, Reed & nNdlovu, 2001). Tannins have a property of binding to protein to form reversible and irreversible complexes due to the existence of a number of phenolic hydroxyl groups. Tannins are water soluble phenolic compounds with molecular weight greater than 500. Tannins is divided into two; Hydrolysable tannins and condensed tannins (Smitha, Alagundagi & Salakinkop 2013). The two types differ in their nutritional and toxic effects. The condensed tannins have more profound digestibility-reducing effect than hydrolysable tannins, whereas, the latter may cause varied toxic manifestations due to hydrolysis in rumen (Akande & Fabayi, 2010).

Tannins are heat stable and they decreased protein digestibility in animals and humans, probably by either making protein partially unavailable or inhibiting digestive enzymes and increasing fecal nitrogen. Tannins are known to be present in food products and to inhibit the activities of trypsin, chemotrypsin, amylase and lipase, decrease the protein quality of foods and interfere with dietary iron absorption. Tannins are known to be responsible for decreased feed intake, growth rate, feed efficiency and protein digestibility in experimental animals. If tannin concentration in the diet becomes too high, microbial enzyme activities including cellulose and intestinal digestion may be depressed. Tannins also form insoluble complexes with proteins and the tannin protein complexes may be responsible for the anti-nutritional effects of tannin containing foods (Habtamu & Nigussie, 2014).

2.2.2 Saponins

Saponins are secondary compounds that are generally known as non-volatile, surface active which are widely distributed in nature, occurring primarily in the plant kingdom. They are structurally diverse molecules and consist of non polar aglycones coupled with one or more monosaccharide moieties. This combination of polar and non-polar structural elements in their molecules explains their soap-like behavior in aqueous solutions. The structural complexity of saponins results in a number of physical, chemical, and biological properties, which include sweetness and bitterness, foaming and emulsifying , pharmacological and medicinal, haemolytic properties, as well as antimicrobial, insecticidal activities (Habtamu & Ngusse, 2014). Saponins reduce the uptake of certain nutrients including glucose and cholesterol at the gut through intra-lumenal physicochemical interaction. Hence, it has been reported to have hypo cholesterolemic effects. In chickens saponnin have been reported to reduce growth, feed efficiency and interfere with the absorption of dietary lipids and vitamins A and E (Jenkins & Atwal, 1994). Saponins are among several plant compounds which have beneficial effects. Among the various biological effects of saponins are antibacterial and antiprotozoal (Avato *et al.,* 2006).

2.2.3 Cyanogens

Cyanogens are glycosides of a sugar or sugars and cyanide containing aglycone. It can be hydrolysed to release Hydrogen cynide by enzymes that are found in the cytosol. Damage to the plant occurs when the enzymes and glycoside form Hydrogen cynide. The hydrolytic reaction can take place in the rumen by microbial activity. Hence, ruminants are susceptible to Cynide toxicity than non- ruminants (Smitha *et al.,* 2013). The Hydrogen cynide is absorbed and is rapidly detoxified in the liver by the enzyme rhodanese which converts Cynide to thiocyanate. Excess cyanide ion inhibits the cytochrome oxidase. This stops ATP formation, tissues suffer energy deprivation and death follows rapidly. The lethal dose of Hydrogen cynide for cattle and sheep is 2.0 - 4.0 mg per kg body weight (Sarah, 2007).

2.2.4 Oxalate

Strong bonds are formed between oxalic acid, and various other minerals, such as Calcium, Magnesium, Sodium, and Potassium. This chemical combination results in the formation of oxalate salts. Oxalate is an anti-nutrient which under normal conditions is confined to separate compartments. However, when it is processed or digested, it comes into contact with the nutrients in the gastrointestinal tract. When released, oxalic acid binds with nutrients, rendering them inaccessible to the body. If feed with excessive amounts of oxalic acid is consumed regularly, nutritional deficiencies are likely to occur, as well as severe irritation to the lining of the gut. In ruminants oxalic acid is of only minor significance as an anti-nutritive factor since ruminal microflora can readily metabolize soluble oxalates (Habtamu & Nigusse, 2014).

Various tropical grasses contain soluble oxalates in sufficient concentration to induce calcium deficiency in grazing animals. These include buffel grass (*Cenchrus ciliaris*), pangola grass (*Digitaria decumbens*), setaria (*Setaria sphacelata*) and kikuyu grass (*Pennisetum clandestinum*). Oxalates react with calcium to produce insoluble calcium oxalate, reducing calcium absorption. This leads to a disturbance in the absorbed calcium: phosphorus ratio resulting in mobilization of bone mineral to alleviate the hypocalcemia. Prolonged mobilization of bone mineral results in nutritional secondary hyperparathyroidism or osteodystrophy fibrosa.

Cattle and sheep are less affected by degradation of oxalate in the rumen. However, cattle mortalities from oxalate poisoning due to acute hypocalcemia have occurred on setaria pastures and sheep have been poisoned while grazing buffel grass. Levels of 0.5 per cent or more soluble oxalate in forage grasses may induce nutritional hyperparathyroidism in horses. Levels of 2 per cent or more soluble oxalate can lead to acute toxicosis in ruminants. The oxalate content of grasses is highest under conditions of rapid growth with concentrations as high as 6 per cent or more of dry weight (Cheeke & Shull, 1985).Young plants contain more oxalate than older plants. During early stages of growth, there is a rapid rise in oxalate content followed by a decline in oxalate levels as the plant matures. It was observed that the oxalate content of napier grass can be manipulated by varying the harvesting interval, and that oxalate content declined as the harvest interval increased (Smitha *et al*. 2013).

2.2.5 <u>Nitrates</u>

Nitrate toxicity of cattle was noted as early as 1895 with corn-stalk poisoning. However, nitrate was not recognized as the principle toxicant during that period. In the late 1930s, after an outbreak of oat-hay poisoning in the high plains region, an indictment of nitrate was finally made. Some of the fodder crops such as Sudan grass, pearl millet and oats can accumulate nitrate at potentially toxic levels. Nitrate poisoning is better described as nitrite poisoning (Tadele, 2015). When livestock consume forages, nitrate is normally converted in the rumen from nitrate to nitrite to ammonia to amino acid to protein. When forages have an unusually high concentration of nitrate, the animal cannot complete the conversion and nitrite accumulates. Nitrite is absorbed into the bloodstream directly through the rumen wall and converts haemoglobin (the oxygen carrying molecule) in the blood to methaemoglobin, which cannot carry oxygen. The blood turns to a chocolate brown color rather than the usual bright red. An animal dying from nitrate (nitrite) poisoning actually dies from asphyxiation, or lack of oxygen (Tadele, 2015). Factors affecting the severity of nitrate poisoning are the rate and quantity of consumption, type of forage, energy level or adequacy of the diet (Tadele, 2015).

2.2.6 Protease Inhibitors

Protease inhibitors are widely distributed within the plant kingdom, including the seeds of most cultivated legumes and cereals. Protease inhibitors are the most commonly encountered class of anti-nutritional factors of plant origin. The inhibitors have the ability to inhibit the activity of proteolytic enzymes within the gastrointestinal tract of animals. Due to their particular protein nature, protease inhibitors may be easily denatured by heat processing although some residual activity may still remain in the commercially produced products. The antinutrient activity of protease inhibitors is associated with growth inhibition and pancreatic hypertrophy (Chunmei, Hongbin, Zewei & Guixn, 2010).

2.2.6 Alkaloids

Alkaloids are one of the largest groups of chemical compounds synthesised by plants and generally found as salts of plant acids such as oxalic, malic, tartaric or citric acid. Alkaloids are small organic molecules, common to about 15 to 20 per cent of all vascular plants, usually comprising several carbon rings with side chains, one or more of the carbon atoms being replaced by nitrogen. They are synthesized by plants from amino acids. Decarboxylation of amino acids produces amines which react with amine oxides to form aldehydes. The characteristic heterocyclic ring in alkaloids is formed from Mannich-type condensation from aldehyde and amine groups. The chemical type of their nitrogen ring offers the means by which alkaloids are sub classified: for example, glycoalkaloids (the aglycone portion) glycosylated with a carbohydrate moiety. They are formed as metabolic byproducts. Insects and hervibores are usual1y repulsed by the potential toxicity and bitter taste of alkaloids.

Alkaloids are considered to be anti-nutrients because of their action on the nervous system, disrupting or inappropriately augmenting electrochemical transmission. For instance, consumption of high tropane alkaloids will cause rapid heartbeat, paralysis and in fatal case, lead to death. Uptake of high dose of tryptamine alkaloids will lead to staggering gate and death. Indeed, the physiological effects of alkaloids have on humans are very evident (Habtamu & Nigusse, 2014).

2.2.7 Phytate

Phytate, which is also known as inositol hexakisphosphate, is a phosphorus containing compound that binds with minerals and inhibits mineral absorption. The cause of mineral deficiency is commonly due to its low bioavailability in the diet. The presence of phytate in feeds has been associated with reduced mineral absorption due to the structure of phyate which has high density of negatively charged phosphate groups which form very stable complexes with mineral ions causing non-availability for intestinal absorption (Walter, Funny, Charles & Christian, 2002). Phytates are generally found in feed high in fibre especially in wheat bran, whole grains and legumes.

2.2.8 Mycotoxins

Mycotoxins are those secondary metabolites of fungi that have the capacity to impair animal health and productivity (D’Mello, 2000). The diverse effects precipitated by these compounds are conventionally considered under the generic term *Mycotoxicosis*, and include distinct syndromes as well as nonspecific conditions. Mycotoxin contamination of forages and cereals frequently occurs in the field following infection of plants with particular pathogenic fungi or with symbiotic endophytes. Contamination may also occur during processing and storage of harvested products and feed whenever environmental conditions are appropriate for spoilage fungi. Moisture content and ambient temperature are key determinants of fungal colonization and mycotoxin production. It is conventional to subdivide toxigenic fungi into field (or plant pathogenic) and storage (or saprophytic/spoilage) organisms. *Claviceps, Neotyphodium, Fusarium* and *Alternaria* are classical representatives of field fungi while *Aspergillus* and *Penicillium* exemplify storage organisms. Mycotoxigenic species may be further distinguished on the basis of geographical prevalence, reflecting specific environmental requirements for growth and secondary metabolism. Thus, *Aspergillus flavus, A. parasiticus* and *A. ochraceus* readily proliferate under warm, humid conditions, while *Penicillium expansum* and *P. verrucosum* are essentially temperate fungi. Consequently, the *Aspergillus* mycotoxins predominate in plant products emanating from the tropics and other warm regions, while the *Penicillium* mycotoxins occur widely in temperate foods, particularly cereal grains. *Fusarium* fungi are more ubiquitous, but even this genus contains toxigenic species that are almost exclusively associated with cereals from warm countries.

2.3 THE CHICKEN (*Gallus gallus)*

The chickens *(Gallus gallus)* are domesticated fowl, a sub-species of red jungle fowl, they are the most common and widespread domestic animals. Chickens are the most numerous birds in the world. The chicken is believed to have been domesticated nearly 5000 years ago from wild birds in Southeast Asia. Human first domesticated chickens for the purpose of cock fighting in Asia, Africa, and Europe. Example of chickens includes; domestic fowl, turkey, geese, pheasant, pigeons and doves. (Ngawu, 2002)

2.3.1 Broiler Chicken *(Gallus gallus domesticus)*

Broilers are chickens *(Gallus gallus domesticus)* breed, raised specifically for meat production. Chickens are one of the most common and widespread domestic animal. Typical broiler have white feathers and yellowish skin, most commercial broilers bred for meat reach slaughter weight at between 5-7 weeks of age. In the United State in 2011 the average feed conversion efficiency of a broiler was 1.91pounds of feed per pound of live weight. Livestock industry in Nigeria provides employment and essential nutrients to majority of the population. The industry comprises of over 16 million cattle, 33million sheep, 54 million goats and 175 million poultry (FAO, 2010). The profession has assumed greater importance in improving the employment opportunity and animal food production in Nigeria. Poultry have contribute significantly to the national economy; report showed that about ten percent of the Nigerian are engage in poultry production, mostly on subsistence and small or medium size farms. Poultry is important because of the divergent roles it plays; sale of eggs in urban and rural markets is perhaps the only source of cash earnings available to rural families. Chickens are also used in traditional curving ritual, as gift and in cementing marriage and friendships. In communities where food shortage is uncommon chickens are kept to supplement the meals or to honor a guest. Indigenous poultry production i.e. a low input venture is an appropriate system that makes the best use of locally available resources (Ngawu, 2002).

2.4 POULTRY PRODUCTION SYSTEM IN NIGERIA

Which method of poultry keeping you adopt will depend on a number of factors, notably your own space, time, finances and inclination, and the need of the hen themselves. The two extremes are the back to Nature Bridge who let hen's wanders and scratch wherever they want around the farm and the battery-intensive farmers who cram all the birds in cages. Hens kept in the former manner will destroy every vestige of a flower or vegetable garden, lay eggs in inaccessible places and probably be carried off by foxes. The battery cage system of poultry management system is an obscene practice which is illegal in some countries and which many people condemn however, since its' undoubtedly true that the hens respond with good production records. Large-scale commercial enterprise will no doubt continue to keep poultry in this way (Katie and Fraser, 1986). There are four system of housing generally found in practice among the poultry keepers. The types of housing adapted depend to a large extant on the availability of land and the capital available.

2.4.1 <u>The Free Range System</u>

This is suitable for those with a lot of land and field of pasture who would let the chicken graze the stubble after harvest. The birds gleaned much of their food in this way as well as ridding the field of insect pests and weed seeds. A hen house was provided in the field and when time to move on to a new field the house would be transferred as well. The system had much to recommend it for most of the year the birds found their own feed, and feeding cost were thereby greatly reduced. Where they followed grazing cattle, they did useful work in scratching up and spreading cow pats which together with their own dropping, helped to build up the fertility of the soil. They also got rid of parasites. There were disadvantages of cause, the losses by foxes and other predators were higher and eggs were often laid in hidden nest, rather than in the houses. In cold winters many hens died and egg production dwindled to nothing (Katie & Fraser, 1986). The major advantage of range rearing is that the birds acquire parts of their diet by scavenging for herbage seeds and insect and that they usually remain very healthy. A simple building in which the birds can be enclosed at night is required, the right accommodation, even if simply constructed should possess adequate space, good ventilation, perches for roosting and proper protection against predators and inclement weather. Most housing on small poultry farms does not attain minimum standards of adequacy.

Feed and water containers should be available both on range and in the house. The birds should be moved at regular intervals to a different area in order to avoid a major build up of internal parasite and diseases organisms. An alternative method of rearing on range is the fold system.

2.4.2 Semi-Intensive System

The semi-intensive system requires a permanent house often a converted barn or farm building with access to two plot of grazing area. The hen have access to each plot in turn, while the other is rested and the numbers of birds you can keep depends on the amount of land available. The floor of the house is kept covered with straw and in the event of really bad weather the hens are not let out but are given their scratch feeds in the straw (Katie & Fraser, 1986). This is the most common system used by small producers and it is often used by the smaller breeders. The poultry have access to outside runs where they live during the day and to houses where they sleep at night. It is preferable that each house should possess two or more outside runs, so that one or more can be rested while the other being used, it is also good practice to spread lime over the land in the pen that has just been vacated and if there are grasses the pen can be grazed by other species such as calves, sheep or goats. The semi-intensive system requires more land and labor than most of the other systems and the capital cost is quite high, (Payne & Wilson, 1999).

2.4.3 Fold system

This is a semi-intensive system of utilizing range groups of 25-50 birds depending on their size the birds are confined in a moveable wired-in iron with attached housing that is sufficiently large to accommodate them at night. The unit is moved to fresh ground at frequent intervals, preferably each day. This system allows the orderly uses of land which decreases the possibilities of worm infestation and ensures the even distribution of poultry dropping (Payne & Wilson, 1999).

2.4.4 Intensive system

This is normally a well-ventilated deep litter house, in most regions of the tropics the house does not required conventional walls but there must be some device which cold and driving rain can be prevented from entry during the rainy season. Available space feeding trough, perching facilities and so on, should be provided, (Payne & Wilson, 1999).

Deep litter system

This is a more intensive system than the previous one because the hens are not let outside at all. They are housed in a single large room with a straw-or-litter covered floor, and electric lightning. The litter build up is round once a year and provide valuable compost for vegetables. It is particularly suitable for people with little land although there are those who would condemn it on ground that is un-natural. It is however more humane than the battery system where individuals birds are confined in cages. The hens are free to walk around and peck in the litter, while the year-round protection from cold and rain together with artificial lightning does ensure a high level of egg production, (Katie & Fraser, 1986). The housing for this system is simple to build and operate. The floor can be constructed of rammed earth or concrete. But in the wet tropics it is preferable to use concrete. A variety of different type of litter can be used, nesting boxes and a broody coop are required in the house as water and feeding troughs are best suspended above the litter if runs are provided it can be used as semi-intensive house (Payne & Wilson 1999).

Battery cage

This is probably the most efficient system of egg production, feed conversion efficiency are higher when fowl are housed in battery cases. Little land is required, recording is simple and battery can be labor saving if they are equipped with automatic feeding, watering and cleaning devices. They are particularly useful where lights breed are utilized, land is expensive and laborers relatively expensive. Batteries do however, have disadvantages, they are relatively costly to install, (Payne & Wilson 1999). This is the system which is use commercially and involve keeping hens in doors in individual cages within a large controlled environment, dropping fall straight in the in the cage floors, and food and water are available automatically on demand. Each time an egg is laid, it rolls on to a collection trough. Smaller versions are available for the small poultry keeper and there is no doubt this system produce a high number of eggs (Katie & Fraser, 1986).

2.5 CHICKENS NUTRIENTS REQUIREMENT

2.5.1 Water Requirement

The body of a bird is made up of 70% water and eggs are approximately 65% water. Poultry must have a continuous supply of clean fresh water so that nutrients can be absorbed and toxic materials removed from the body. This is especially vital for young chicks. A lack of water will reduce feed intake, seriously retarding growth and impairing egg production. This is particularly true in hot climates, where deprivation can rapidly lead to death. Water is also essential for birds to control their body temperatures in hot weather. Birds need a lot more water at high temperatures than at low temperatures, and lack of water quickly leads to death by overheating. It is undesirable to restrict any bird's water intake, particularly in the tropics. Even a 10% restriction in the amount of water available can reduce the growth rate and feed conversion efficiency (amount of feed needed per kg growth) of broilers. With layers, the effect is even more devastating. Short periods of deprivation can result in moulting and the cessation of egg production (Eekeren, Maas, Saatkamp & Verschuur, 2006).

2.5.2 Energy Requirement

The energy intake means the calories that are taken in by the chicken with its feed. The amount of energy contained in feedstuffs is normally expressed in units of metabolisable energy (ME) per unit weight. The metabolisable energy refers to the feed energy that is available to the bird for maintenance of vital functions and the production of meat and eggs. It is expressed in e.g. calories per gram (cal/g) or kilocalories per kg (kcal/kg). 1 kcal equals 4.2 kJ. The energy requirement of poultry can be expressed in terms of metabolisable energy per day (kcal/d). Dietary energy comes mainly from carbohydrates but also from fat and protein. Chickens are usually given free access to feed and allowed to consume as much as they wish. They usually consume enough feed to meet their nutrient requirements. This control of intake is based primarily on the amount of energy in the diet. Birds eat to satisfy their energy requirements. Thus, increasing the concentration of energy in the diet will result in a decrease in intake, and vice versa, as long as intake is not limited by problems of bulk, texture, inaccessibility or palatability. Levels of nutrients in a diet are therefore often stated in terms of energy content. It was reported by Eekeren, Maas, Saatkamp and Verschuur, (2006) that the recommended energy levels in poultry diets are about 2,800 kilo calorie per kilogram for layers and about 3000 kcal/kg for broilers. When chickens reduce their intake because of heat stress, it is advisable to use more concentrated diets, so that they get enough nutrients in spite of the lower intake.

2.5.3 Protein Requirement

Protein is made up of amino acids, and birds obtain these amino acids from their feed to build up their own proteins in the body. Priority always goes to maintenance, and any surplus is used for growth or egg production. High protein feed is expensive, so rations which are too high in protein are wasteful. The excess protein is broken down and used as an energy source, and the excess nitrogen is excreted as uric acid. The synthesis of protein in the body tissues requires an adequate supply of about twenty different amino acids in the proper proportions. Ten of these cannot be synthesized by the bird's metabolism and must therefore be supplied by the diet. These are called essential amino acids, the main ones being lysine and methionine. A shortage of essential amino acids will limit production (Eekeren, Maas, Saatkamp & Verschuur, 2006). The quality of feed protein can be described in terms of the amino acids it supplies. However, it is useful to specify total requirements for crude protein in addition to requirements for the main essential amino acids. There should be enough crude protein to supply the required amounts of these amino acids. In most nutrient requirement tables, only the percentages of lysine and methionine are given, and these percentages should be regarded as an indication that there are enough of the other essential amino acids too (Eekeren, Maas, Saatkamp & Verschuur, 2006).

2.5.4 Vitamins Requirement

Vitamins play a role in the enzyme systems and natural resistance of poultry. They are only needed in very small quantities, but are vital to sustain life. Vitamin deficiency can lead to serious disorders. Natural vitamins are found in young and green plants, seeds and insects. When birds are confined in poultry houses, they are entirely dependent on the vitamins present in the compounded feed. All vitamins may be purchased in a synthetic form at a commercial price, and may be added to the mixed feed as a premix. Without extra vitamins, rations may not be balanced enough to support high productivity (Eekeren, Maas, Saatkamp & Verschuur, 2006).

2.5.5 Minerals Requirements

Minerals, especially calcium (Ca) and phosphorus (P), are essentially needed for the bones to be stronger. Enzyme systems are also often dependant on trace elements of certain minerals, such as iron, copper, zinc and iodine. The mineral requirements of poultry are defined in terms of the separate mineral elements, although minerals are always added to diets in the form of compounds. It is useful to know the proportion of each element in these compounds, so that the correct amount of this element can be added to the diet (Eekeren, Maas, Saatkamp & Verschuur, 2006).

Calcium and phosphorus

Calcium and phosphorus both primarily add to the structure and maintenance of the chicken bones. The skeleton accounts for about 99% of the calcium and 80% of the phosphorus in the body. The two minerals interact with each other, both before and after their absorption from the digestive tract. Over-supply of either mineral can interfere with the utilization of the other. During egg production, calcium needs are more than doubled. Poultry's calcium and phosphorus requirements are influenced by the amount of vitamin D in the diet, increased as the level of vitamin D decreases and vice versa (Eekeren, Maas, Saatkamp & Verschuur, 2006). For growing birds, the ratio of Ca: P should be between 1:1 and 2:1. However, laying birds need a ratio of up to 6:1, and they need about 4.0 g of calcium per day for eggshell formation. Supplements like steamed bone-meal are added to chick and grower diets to provide extra calcium and phosphorus. For laying birds, the extra calcium requirement is provided by oyster-shell grit fed separately or by limestone flour added to the diet. The main criteria for determining a laying hen’s requirements of calcium and phosphorus are egg production and shell thickness. Calcium requirements should be specified in terms of amount of calcium per day rather than percentage in diets. This is particularly important in the tropics, where reduced intake due to heat may result in too little calcium being consumed each day (Eekeren, Maas, Saatkamp & Verschuur, 2006).

Other ingredients in chicken diets

So far, we have considered the energy, amino acid, vitamin and mineral content of chicken diets, vitamins and minerals can be added as premixes to the diets of laying hens and broilers. Other ingredients to be considered include coccidiostats as preventive medicine and antioxidants as preservative. A prophylactic dose of a coccidiostat should be added to every broiler diet, following the manufacturer’s directions. The dose can be withdrawn towards the end of the fattening period. As coccidiosis may occur in flocks treated with a coccidiostat at prophylactic levels, it is advisable to have a concentrated coccidiostat available for medicating the water at a curative level. Commercial feed preparations may also contain an antioxidant, especially when there is additional fat in the feed mixture (Eekeren, Maas, Saatkamp & Verschuur, 2006).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 STUDY SITE

The research was conducted at the Poultry unit of Teaching and Research Farm, Department of Animal Science, Faculty of Agriculture, Bayero University, Kano. Kano is located within the longitude $9^{o}30''$ and $12^{o}30''$ E and the latitude $9^{o}30''$ and $8^{o}42''$ N at an altitude of 403m above the sea level (Olofin, 2007). The minimum and maximum temperatures are 13^{o}C and 43^{o}C respectively; high temperatures are recorded during the months of March to May and lowest temperature between December and January. Relative humidity is between 20 to 40% in January, and rose to about 40 to 60% in July and August (Olofin, Nabegu & Danbazau, 2008). The region is characterized by tropical wet and dry climate. The rainy season starts May to September and dry season starts October to April. The annual rainfall ranges from 787-960mm (KNARDA, 2006)

3.2 SOURCES OF EXPERIMENTAL FEED INGREDIENTS

Moringa leaf for the research was obtained from the Department of Forestry, Fisheries and Wildlife Orchard, Faculty of Agriculture and Agricultural Technology, Kano University of Science and Technology, Wudil, Kano. Other feed ingredients such as sorghum, soybean meal, fish meal, wheat offal, bonemeal, limestone, vitamin/mineral premix, methionine, lysine and salt were purchased at Sovet International Limited located at Tarauni L.G.A, Kano state.

3.3 EXPERIMENTAL DIETS

The Moringa (*Moringa oleifera*) leaf was dried under shade for five days and was milled using hammer mill in order to obtain the leaf meal. The diets were compounded at Sovet International Feed Mill located at Ladanai, Eastern bypass

Kano. The experiment consisted of five diets for the two phases (starter and finisher) of broiler chickens growth. *Moringa oleifera* leaf meal (MOLM) was tested at five varying levels of inclusion; 0, 2, 4, 6 and 8% which were designated as diets A, B, C, D and E respectively. The composition of the experimental diets is presented in Tables 1 and 2 for broiler starter and broiler finisher respectively.

Table 1: Composition of the Experimental Diets Fed to Broiler Chickens at Starter Phase

Ingredients	Inclusion levels of MOLM				
	A (0%)	B (2%)	C (4%)	D (6%)	E (8%)
Sorghum (*Kaura)*	55.45	53.45	52.20	51.20	50.00
Soybean Meal	26.80	26.80	26.05	25.05	24.25
MOLM	0.00	2.00	4.00	6.00	8.00
Fish Meal	5.00	5.00	5.00	5.00	5.00
Wheat offal	8.00	8.00	8.00	8.00	8.00
Limestone	2.00	2.00	2.00	2.00	2.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10	0.10
Lysine	0.15	0.15	0.15	0.15	0.15
Salt	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Calculated analysis					
ME(Kcal/kg DM)	2802	2808	2801	2827	2803
Crude Protein (%)	22.30	22.01	22.45	22.83	22.05
Ether Extract (%)	4.30	4.30	4.20	3.90	3.80
Crude Fibre (%)	3.60	3.50	3.26	3.60	3.30
Lysine (%)	0.80	0.80	0.80	0.90	0.90
Methionine (%)	0.30	0.40	0.36	0.30	0.33
Calcium (%)	1.80	1.70	1.74	1.70	1.80
Phosphorous (%)	0.50	0.50	0.46	0.60	0.60

MOLM: Moringa oleifera Leaf Meal, ME: Metabolizable Energy, DM: Dry Matter, Kcal/kg: Kilo calorie per kilogram.

Table 2: Composition of the Experimental Diets Fed to Broiler Chickens at Finisher Phase

Ingredients	Inclusion levels of MOLM				
	A (0%)	B (2%)	C (4%)	D (6%)	E (8%)
Sorghum (*Kaura)*	58.70	57.50	56.20	55.20	54.20
Soybean Meal	23.55	22.75	22.05	21.05	20.00
MOLM	0.00	2.00	4.00	6.00	8.00
Fish Meal	5.00	5.00	5.00	5.00	5.00
Wheat offal	8.00	8.00	8.00	8.00	8.00
Limestone	2.00	2.00	2.00	2.00	2.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10	0.10
Lysine	0.15	0.15	0.15	0.15	0.15
Salt	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Calculated analysis					
ME(Kcal/kg DM)	3033	3049	3065	3004	3075
Crude Protein (%)	20.27	20.08	20.09	20.05	20.15
Ether Extract (%)	4.30	4.30	4.20	3.80	3.80
Crude Fibre (%)	3.43	3.41	4.20	3.69	3.37
Lysine (%)	0.82	0.82	0.82	0.90	0.87
Methionine (%)	0.36	0.36	0.36	0.33	0.32
Calcium (%)	1.74	1.74	1.74	1.76	1.76
Phosphorous (%)	0.46	0.46	0.46	0.59	0.59

MOLM: Moringa oleifera Leaf Meal, ME: Metabolizable Energy, DM: Dry Matter, Kcal/kg: Kilo calorie per kilogram.

3.4 EXPERIMENTAL TREATMENTS AND DESIGN

The experiment was conducted using five treatments A, B, C, D and E with inclusion levels of *Moringa oleifera* leaf meal at 0, 2, 4, 6, and 8 percent respectively, in a completely randomized design (CRD).

3.5 EXPERIMENTAL BIRDS AND THEIR MANAGEMENT

Two hundred and twenty five day-old broiler chicks (Cobb strain) were purchased from Sovet International Limited, Tarauni L.G.A, Kano state. The experimental birds were randomly allocated to five treatments (A, B, C, D & E) and each treatment contained forty-five birds, with three replicates per treatments and fifteen birds per replication. The experimental birds were managed on deep litter system with wood shavings as litter material. Kerosene stove, 200watts electric bulbs were used to provide heat to the chicks during brooding. Feed and water were provided *ad libitum*. Experimental birds were vaccinated against Newcastle Viral Disease and Infectious Bursal Disease using Lasota and Gumboro vaccines respectively. The vaccines were administered orally via drinking water at a dose rate of 225 doses in $2\frac{1}{4}$ liters of water providing one dose for each bird. Meanwhile, standard bio-security measures were taken to guard against microbial infections. During the starter phase the birds were fed broiler starter mash. Feed trays and conical drinkers were used at starter phase, while at finisher phase they were fed broiler finisher mash. Feed trays and conical drinkers were replaced with adult feeders and drinkers. The time frame for the research was eight weeks, which was divided into two phases (starter and finisher) and each phase lasted for four weeks.

3.6 PROXIMATE ANALYSIS

Proximate composition of the Moringa (*Moringa oleifera*) leaf meal, experimental diets and bird's droppings were determined in the Department of

Animal Science Laboratory, Bayero University, Kano. The proximate components examined were crude protein, crude fibre, ether extract, ash and nitrogen free extract which was determined by difference according to AOAC (2005) procedures. Metabolizable energy was calculated from the proximate composition components result according to the procedure described by Pauzenga (1985).

$$\text{ME} = 37 \times \%\text{CP} + 18 \times \%\text{EE} + 35.5 \times \%\text{NFE}$$

3.7 BLOOD METABOLITES ANALYSIS

The blood metabolites analyses (Haematology & Serum chemistry) were conducted at Microbiology Laboratory, Aminu Kano Teaching Hospital, Kano.

3.7 DATA COLLECTION

3.7.1 Determination of Growth Performance

Feed intake

Feed intake was measured on daily basis. It was obtained by subtracting the left over from the feed offered. The feed intake was obtained mathematically using formula as follows;

$$\text{FI} = \text{FO} - \text{LO}$$

Where; FI = feed intake, FO = feed offered and LO = left over.

Live weight gain

Initial live weight was measured using sensitive weighing scale on arrival. Thereafter at weekly interval, birds were selected randomly from each replication and weighed using weighing scale up to the termination of the experiment (8 weeks). It was obtained mathematically;

$$\text{Live weight gain} = \text{Final live weight} - \text{Initial live weight}$$

Feed conversion ratio

Feed conversion ratio was determined by dividing the total feed intake by the average weight gain for each treatment. Mathematically;

$$\text{Feed conversion Ratio} = \frac{\text{Feed intake}}{\text{Weight gain}}$$

Mortality

Mortality was monitored every day and recorded against each replicate for the determination of percentage mortality (if any) of the birds in each treatment.

$$\text{Percentage Mortality} = \frac{\text{Number of birds died}}{\text{Number of birds stocked}} \times 100$$

3.7.2 Determination of Nutrient Utilization

At the end of the feeding trial, three birds from each treatments, one from each replicate were selected on the basis of their average weight transferred into battery cage and allowed three days for adaptation and were fed with their respective experimental diets. Droppings were collected for four days with the aid of nylon bag tied beneath the cage units of each treatment. Daily droppings from each replicate were collected and thoroughly mixed. Four days droppings collected for each treatment were then pooled together. Samples of 100g for each treatment were taken to the laboratory and oven dried at 60^0C for 16 hours. The dried samples for each treatment were ground using pestle and mortar, and kept in an airlock plastic vessel at 4^0C before proximate analysis. The percentage nutrients utilization was calculated using the formula below;

$$\text{Nutrients utilization} = \frac{\text{Nutrient intake} - \text{Nutrient output}}{\text{Nutrient intake}} \times 100$$

Where: Nutrient intake = Dry feed intake × Nutrients in the diet

Nutrient output = Dry fecal output × Nutrients in the diet

3.7.3 Determination of Blood Metabolites

At the end of the feeding trial, three birds per treatment(one from each replicate) were selected and 10ml blood sample was drawn through wing vein using sterilized hypodermic needle and syringe as described by (Coles, 1986). Five milliliter (5ml) of blood sample was placed into a carefully labeled sample bottles containing ethylenediamine tetracetic acid (EDTA) as anticoagulant, which was used for the determination of hematological parameters such as, packed cell volume (PCV), haemoglobin (Hb), white blood cell (WBC), red blood cell (RBC), mean corpuscular haemoglobin concentration (MCHC), mean corpuscular haemoglobin (MCH) and mean corpuscular volume (MCV), platelet count, neurophils, lymphocytes, and monocyte. The remaining 5ml was placed into a labeled sample bottles without anticoagulant, and was used for the determination of the following serum chemistry parameters; blood urea nitrogen, sodium, potassium, hydrogen carbonate, chloride, glucose, creatinine, total cholesterol, albumin, total protein, globulins and alkaline phosphate using cobas integral 400 plus chemistry analyzer, manufactured by Roche Diagnostics Ltd., Switzerland.

3.7.4 Determination of Carcass Characteristics

At the end of feeding trial, three birds from each treatment, one from each replication were fasted overnight and slaughtered by severing the jugular vein. Each carcass was scalded, de-feathered, singed and eviscerated, cut-up into parts and they were measured in grams. Carcass weight, carcass parts (breast muscle, drumstick, thigh & wings), gut weight (proventriculus, empty gizzard, empty small and empty large intestines), and organs weight (heart, liver, lungs & spleen). Dressing percentage was determined using the formula below:

$$\text{Dressing Percentage} = \frac{\text{Dressed weight}}{\text{Live weight}} \times 100$$

Carcass parts and organs weight were determined on the basis of percentage body weight using the formula below:

$$\text{Percentage body weight} = \frac{\text{Carcass part/Organ weight}}{\text{Live weight}} \times 100$$

3.7.5 Cost of Feeding

Cost of all feed ingredients were recorded in relation to prevailing market prices and used for computation of the cost of feed incurred throughout the experimental period, taking into consideration individual ingredient cost per kilogram (₦/kg).

3.8 DATA ANALYSIS

The data generated were subjected to analysis of variance (ANOVA) using SAS statistical software package, version 9.1 (2002), using general linear model at 5% probability level, where significant differences existed, means were separated using least significance differences (LSD).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 RESULTS

4.1.1: Proximate Composition of the *Moringa oleifera* Leaf Meal

Result of the proximate composition of the *Moringa oleifera* leaf meal used in the research is presented in Table 3. The result showed that *Moringa oleifera* leaf meal contained the following values presented in table 3 below.

Table 3: Proximate Composition of the *Moringa oleifera* Leaf Meal

Parameter (%)*	Percentage compositions (%)
Dry matter	92.58
Moisture	7.42
Crude protein	26.70
Ether Extract	3.60
Crude fibre	7.10
Ash	6.08
NFE	49.10
ME (Kcal/kg)	2795.36

NFE: Nitrogen free extract, SEM: standard error of mean, ME: Metabolizable Energy, Kcal/kg: Kilo calorie per kilogram. *Unless otherwise stated.

4.1.2: Proximate Composition of the Experimental Diets Fed Broiler Chickens Dietary Inclusion Levels of *Moringa oleifera* Leaf Meal Fed at Broiler Starter Phase

Result of the proximate composition of the experimental diets fed to broiler chickens at starter phase is presented in Table 4. The result showed dry matter ranged from 91.02-94.77%, diet A had the highest value while diet E presented the lowest value for dry matter. The trend indicated that dry matter decreased at increasing inclusion levels of MOLM. Moisture content values ranged from 5.23-8.98% with diet E and A having the highest and lowest value respectively. The moisture contents increased with increasing inclusion levels of MOLM. Values for crude protein ranged from 21.03- 24.50%, ether extract ranged from 3.00-4.23%, crude fibre ranges from 3.49-5.02% and ash contents ranged from 2.27-5.32%. Diet E had the highest values and diet A present the lowest values for the above proximate components. The trend for the above proximate components increased with increasing levels of MOLM. However, values for nitrogen free extract across the treatments means showed downward trend in which values decreased as the inclusion level of MOLM was increased. The result shows no differences in the amount of metabolizable energy (Kcal/kg) among the diets.

Table 4: Proximate Composition of the Experimental Diets Fed Broiler Chickens Dietary Inclusion Levels of *Moringa oleifera* Leaf Meal Fed at Broiler Starter Phase

	Inclusion levels of MOLM				
Parameter (%)*	A (0%)	B (2%)	C (4%)	D (6%)	E (8%)
Dry matter	94.77	93.34	92.98	91.93	91.02
Moisture	5.23	6.66	7.02	8.07	8.98
Crude protein	21.03	22.05	23.36	24.11	24.50
Ether Extract	3.00	3.47	3.67	4.00	4.23
Crude fibre	3.65	3.49	4.49	4.70	4.81
Ash	2.27	2.95	4.27	5.08	5.53
NFE	64.39	61.38	57.19	54.04	51.95
ME (Kcal/kg)	2850.35	2828.54	2885.50	2882.49	2828.37

MOLM: *Moringa oleifera* leaf meal, NFE: Nitrogen free extract, SEM: standard error of mean, ME: Metabolizable energy, Kcal/kg: Kilo calorie per kilogram. *Unless otherwise stated.

4.1.3: Proximate Composition of the Experimental Diets Fed Broiler Chickens Dietary inclusion Levels of *Moringa oleifera* Leaf Meal at Broiler Finisher Phase

Result of the proximate composition of the experimental diets fed to broiler chickens at finisher phase is presented in Table 5. The result showed dry matter values ranges from 88.65- 92.66%, diet B had the highest value and diet E had the lowest value among the diets. The trend in dry matter content indicates a decrease with increasing inclusion levels of MOLM. Values for moisture ranged from 6.45-11.35%, crude protein values ranged from 19.69-21.82%, ether extract values range from 3.48-4.26%, crude fibre values ranged from 3.80-6.43% and ash contents values ranged from 3.10-5.12%. The trends for these proximate components showed an increase with increasing inclusion levels of MOLM. Diet D had the highest value for crude protein, diet E had the highest value for ether extract, crude fibre and ash contents compared to other diets. Diet A had the lowest value for moisture, crude protein, ether extract and crude fibre contents. Diet B had the lowest value for ash content. However, diet A had the highest value for nitrogen free extract compared to other diets. The result shows no differences in the amount of metabolizable energy (Kcal/kg) among the diets.

Table 5: Proximate Composition of the Experimental Diets Fed Broiler Chickens Dietary Inclusion Levels of *Moringa oleifera* Leaf Meal at Broiler Finisher Phase

	Inclusion levels of MOLM				
Parameter (%)*	A (0%)	B (2%)	C (4%)	D (6%)	E (8%)
Dry matter	91.38	92.66	91.65	90.22	88.65
Moisture	6.45	7.23	8.35	9.78	11.35
Crude protein	19.69	20.33	21.76	21.82	21.62
Ether Extract	3.48	3.57	4.73	4.20	4.26
Crude fibre	3.80	4.11	4.20	4.89	4.91
Ash	3.62	3.10	3.82	4.42	5.12
NFE	62.96	61.66	57.14	54.89	52.74
ME (Kcal/kg)	3018.75	3000.90	2960.63	3053.95	3113.85

MOLM: *Moringa oleifera* leaf meal, NFE: Nitrogen free extract, SEM: Standard error of mean, ME: Metabolizable energy, Kcal/kg: Kilo calorie per kilogram. *Unless otherwise stated.

4.1.4: Effect of Dietary Inclusion Levels of *Moringa oleifera* Leaf Meal on Growth Performance of Broiler Chickens at Starter Phase

Table 6 contained the growth performance of broiler chickens fed dietary inclusion levels of Moringa leaf meal at starter phase. The result showed no-significant (P>0.05) differences in all the parameters measured, except for feed conversion ratio (FCR) and feed cost per kilogram which were significantly (P>0.05) different across the treatment means. Values for FCR showed that birds fed diet A had significantly (P<0.05) higher value compared to other treatments means. Birds in treatment D were statistically (P>0.05) similar with birds in treatment B. Values obtained for birds fed diet C and diet E were statistically similar and had significantly lower (P>0.05) values compared to other treatments means in feed conversion ability. Feed cost per kilogram values was significantly (P<0.05) different across all the experimental treatment means. Cost per kilogram of the diets values showed an increase at increasing level of *Moringa oleifera* leaf meal. There was no significant (P>0.05) difference in mortality among the treatments means.

Table 6: Effect of Dietary Inclusion Levels of *Moringa oleifera* Leaf Meal on Growth Performance of Broiler Chickens at Starter Phase

	Inclusion levels of MOLM					
Parameter	A (0%)	B (2%)	C (4%)	D (6%)	E (8%)	SEM
Initial live weight(g/bird)	35.00	35.00	35.00	35.00	35.00	0.00
Final live weight gain (g/bird)	440.3	482.7	639.2	539.4	529.4	71.28
Total live weight gain (g/bird)	405.3	447.7	604.2	504.4	494.4	71.43
Daily live weight gain (g/bird)	14.48	15.98	21.57	18.01	17.65	2.08
Total feed intake (g/bird)	968.7	917.7	936.5	974.5	865.8	106.64
Daily feed intake (g/bird)	34.60	32.78	33.44	34.80	30.92	3.05
FCR	2.3^{a}	2.1^{ab}	1.6^{b}	1.9^{ab}	1.8^{ab}	0.20
Feed cost/ kg diet(₦)	119.50^{e}	121.00^{d}	123.57^{c}	124.80^{b}	125.60^{a}	8.81
Mortality (%)	0.25	0.25	0.08	0.00	0.17	0.07

^{a,b,c,d,e} Means in the same row with different superscript are significantly different(P<0.05), MOLM: *Moringa oleifera* leaf meal, SEM: Standard error of mean, FCR: Feed conversion ratio.

4.1.5: Effect Dietary Inclusion Levels of *Moringa oleifera* Leaf Meal on Growth Performance of Broiler Chickens at Finisher Phase

Result obtained on growth performance of broiler chickens fed dietary inclusion levels of *Moringa oleifera* leaf meal at finisher phase is presented in Table 7. Significant (P<0.05) differences existed in all the parameter measured except for initial live weight gain which showed non significant (P>0.05) differences across the treatment means. Birds fed diet C were observed to have significant (P<0.05) higher values in mean initial live weight, mean final live weight gain, mean total live weight gain, mean total feed intake and mean daily feed intake. Similarly, birds fed the control diet (containing no MOLM) had lower values for all parameters measured except for FCR and percent mortality. Similarly, birds fed diet E had significantly (P<0.05) higher FCR values compared to other treatment. However, birds fed 4% MOLM in their diet recorded the least value (P>0.05) in feed conversion ability compared to other treatments. Additionally, there was no significant (P>0.05) differences in percent mortality among the treatments means. However, treatment A and B were observed to have higher values for percentage mortality compared to remaining treatments.

Table 7: Effect of Dietary Inclusion Levels of *Moringa oleifera* Leaf Meal on Growth Performance of Broiler Chickens at Finisher Phase

	Inclusion levels of MOLM					
Parameter	A (0%)	B (2%)	C (4%)	D (6%)	E (8%)	SEM
Initial live weight(g/bird)	440.3	482.7	639.2	539.4	529.4	71.28
Final live weight gain(g/bird)	1269.7^{b}	1504.5^{b}	1971.7^{a}	1654.2^{ab}	1601.6^{ab}	88.59
Total live weight gain (g/bird)	918.5^{b}	1021.80^{b}	1332.50^{a}	1114.80^{b}	1072.20^{b}	36.66
Daily live weight gain (g/bird)	29.62^{c}	36.42^{b}	47.59^{a}	39.81^{b}	38.29^{b}	1.05
Total feed intake (g/bird)	1931.3^{c}	2300.8^{b}	2619.6^{a}	2325.0^{ab}	2313.3^{b}	74.30
Daily feed intake (g/bird)	68.96^{c}	82.17^{b}	93.56^{a}	83.04^{b}	82.62^{ab}	2.17
FCR	2.3^{a}	2.2^{b}	1.9^{c}	2.1^{bc}	2.2^{b}	0.04
Feed cost/ kg diet(₦)	104.0^{e}	104.3^{d}	104.8^{c}	105.5^{b}	106.0^{a}	0.00
Mortality (%)	0.25	0.08	0.08	0.00	0.16	0.08

[a,b,c,d,e] Means in the same row with different superscript are significantly different(P<0.05), MOLM: *Moringa oleifera* leaf meal, SEM: standard error of mean, FCR: Feed conversion ratio.

4.1.6: Effect of Dietary Inclusion Levels of *Moringa oleifera* Leaf Meal on Haematological Indices of Broiler Chickens

Result on the effect of dietary inclusion levels of *Moringa oleifera* leaf meal on haematological indices of broiler chickens is presented in Table 8. The result showed that significant (P<0.05) differences were observed in all the parameters measured. Birds offered 4% MOLM presented significantly (P<0.05) higher values in haemoglobin content compared to other treatment means and the lowest value was obtained in treatment B birds. Birds in treatment A (control) had significantly (P<0.05) higher values in packed cell volume compared to other treatments means. Treatment C birds had significantly (P<0.05) higher values in red blood cells and white blood cells compared to other treatments means. However, birds fed diet B have non significant (P>0.05) lower values in red blood cell and white blood cell compared to other treatments. Birds offered 8% MOLM were observed to have significantly (P<0.05) higher values in mean corpuscular haemoglobin contents compared to other treatments and the lowest values was obtained in treatment C birds. Significantly (P<0.05) higher values for mean corpuscular volume was obtained in birds offered 4% MOLM (diet C) and the lowest values was obtained in birds offered 6% MOLM. Significant (P<0.05) differences were observed in the composition of platelets counts, neutrophils, lymphocytes and monocytes with highest values obtained in MOLM-based diets.

Table 8: Effect of Graded Levels of *Moringa oleifera* Leaf Meal Utilization on Hematological Indices of Broiler Chickens

	Inclusion levels of MOLM					
Parameter	A (0%)	B (2%)	C (4%)	D (6%)	E (8%)	SEM
Hb (g/dl)	7.12^{ab}	4.78^{d}	8.03^{a}	6.33^{bc}	5.51^{cd}	0.24
PCV (%)	24.10^{b}	17.99^{c}	30.23^{a}	23.10^{b}	16.00^{c}	0.94
RBC ($\times10^{6}$ml)	2.11^{a}	1.27^{c}	2.27^{a}	1.90^{b}	1.38^{c}	0.03
WBC($\times10^{6}$ml)	25.22^{b}	19.52^{c}	48.31^{a}	24.70^{b}	19.52^{c}	0.84
MCH(pg)	35.19^{b}	36.60^{b}	33.17^{b}	37.23^{b}	43.65^{a}	1.16
MCV(fl)	127.65^{b}	134.57^{a}	135.53^{a}	122.80^{b}	126.67^{b}	1.38
MCHC (g/dl)	25.73^{b}	26.63^{b}	24.03^{b}	30.30^{a}	32.42^{a}	0.87
Platelets count	38.38^{c}	31.06^{d}	50.71^{b}	54.03^{a}	30.68^{d}	0.49
Neutrophils (%)	0.09^{d}	1.87^{a}	0.99^{b}	0.18^{d}	0.83^{c}	1.06
Lymphocytes (%)	25.95^{b}	16.49^{c}	45.11^{a}	24.34^{b}	25.47^{b}	0.44
Monocytes (%)	$2.00a^{b}$	1.18^{b}	3.47^{a}	0.81^{b}	$2.18a^{b}$	0.52

^{a,b,c,d} Means in the same row with different superscript are significantly different(P<0.05), MOLM: *Moringa oleifera* leaf meal, SEM: standard error of mean. Hb: Hemoglobin, PCV: Packed cell volume, RBC: Red blood cell, WBC: White blood cell, MCH: Mean corpuscular hemoglobin, MCV: Mean cell volume, MCHC: Mean corpuscular hemoglobin concentration.

4.1.7: Effect of dietary inclusion Levels of *Moringa oleifera* Leaf Meal on Serum Chemistry of Broiler Chickens

The effect of dietary inclusion levels of *Moringa oleifera* leaf meal on serum chemistry of broiler chickens is presented in Table 9. The result showed that there were significant (P<0.05) differences in all the parameters measured except for potassium and chloride for which the treatments were not significantly (P>0.05) different. Based on the result obtained, treatment E (8% MOLM) had significantly (P<0.05) higher values for blood urea nitrogen and the lowest value was obtained in treatment A (0% MOLM). Birds in the control treatment had significantly (P<0.05) higher values for sodium compared to other treatments means and the lowest value was obtained in treatment C (4% MOLM). Hydrogen carbonate contents was significantly ($P<0.05$) higher in control treatment and lowest value was obtained in treatment B and D birds. Significantly ($P<0.05$) higher values for creatinine was obtained in treatment B (2% MOLM) however, birds in treatment C, D and E have the lowest values. Birds on treatment D had significantly ($P<0.05$) higher values for glucose and non significant ($P>0.05$) lower values was obtained in treatment C birds. Total cholesterol content was significantly ($P<0.05$) higher in treatment B and the lowest values was recorded in treatment D birds. Birds in control treatment had significantly ($P<0.05$) higher value in total protein compared to other treatments means. Birds fed diet B and C were statistically similar and they have the lowest values for total protein compared to other treatments. Treatment E birds had significantly ($P<0.05$) higher values for albumin contents compared to other treatments and non significant ($P>0.05$) lower values was obtained in treatment B birds. Composition of globulin and alkaline phosphate were significantly ($P<0.05$) higher in treatment D compared to other treatment means. However, the lowest values for globulin and alkaline phosphate were obtained in the control treatment (0% MOLM).

Table 9: Effect of Dietary Inclusion Levels of *Moringa oleifera* Leaf Meal on Serum Chemistry of Broiler Chickens

Parameter	Inclusion levels of MOLM A (0%)	B (2%)	C (4%)	D (6%)	E (8%)	SEM
BUN (mmol/L)	0.28^{c}	1.10^{ab}	0.43^{c}	0.97^{b}	1.18^{a}	1.16
Sodium (mmol/L)	139.00^{a}	133.33^{ab}	130.67^{b}	136.67^{a}	135.33^{ab}	1.45
Potassium(mmol/L)	4.45	4.40	4.57	4.57	3.90	0.30
Chloride(mmol/L)	101.33	101.00	98.83	100.50	101.33	0.85
HCO_3 (mmol/L)	24.00^{a}	20.33^{b}	21.67^{b}	20.33^{b}	23.83^{a}	0.40
Creatinine(mmol/L)	54.35^{b}	74.67^{a}	36.67^{c}	36.00^{c}	36.00^{c}	0.82
Glucose(mmol/L)	3.60^{bc}	4.05^{ab}	3.37^{c}	4.27^{a}	4.06^{ab}	0.16
T. Chol. (mmol/L)	6.10^{a}	6.28^{a}	5.40^{b}	5.11^{b}	5.44^{b}	0.16
Total protein (g/l)	201.33^{a}	101.27^{b}	101.00^{b}	103.00^{b}	110.00^{b}	2.26
Albumin	45.44^{c}	44.83^{c}	51.17^{b}	50.33^{b}	53.88^{a}	0.47
Globulin (g/l)	40.17^{d}	55.87^{ab}	50.78^{c}	59.00^{a}	54.67^{b}	0.78
ALP (u/l)	867.33^{d}	1066.67^{c}	1798.33^{b}	1942.67^{a}	1753.33^{b}	24.01

[a,b,c,d] Means in the same row with different superscript are significantly different($P<0.05$), MOLM: *Moringa oleifera* leaf meal, SEM: standard error of mean, BUN: Blood urea nitrogen, HCO_3: Hydrogen carbonate, ALP: Alkaline phosphate, T. Chol. : Total cholesterol.

4.1.8: Effect of dietary inclusion Levels of *Moringa oleifera* Leaf Meal on Nutrients Utilization of Broiler Chickens

Result of the proximate composition of the droppings used for nutrients utilization of broiler chickens fed dietary inclusion levels of *Moringa oleifera* leaf meal is presented in Table 10. There were significant ($P<0.05$) differences among all the parameters measured except for dry matter contents which was not significantly ($P>0.05$) different among the treatments means. Values obtained for birds in treatment C, D and E were statistically similar and significantly ($P<0.05$) different compared to other treatments in crude protein utilization and the lowest value was obtained in treatment A birds (Control). Nutrients utilization for ether extract was significantly

(P<0.05) higher in birds fed diet C and lowest value was recorded in treatment E birds. Birds in treatment C had significant (P<0.05) higher values for crude fibre utilization and no significant (P>0.05) lower values was recorded in treatment E birds. Ash utilization was significantly (P<0.05) higher in birds fed diet C and D. However, treatment B birds had no significant lower values for ash utilization. Birds on treatment A (control) had significantly (P<0.05) lower values for nitrogen free extract compared to other treatments, while the lowest value was recorded in birds fed diet E.

Table 10: Effect of Dietary Inclusion Levels of *Moringa oleifera* Leaf Meal on Nutrients Utilization by Broiler Chickens

	Inclusion levels of MOLM					
	A (0%)	B (2%)	C (4%)	D (6%)	E (8%)	
Parameter (%)						SEM
Dry matter	89.77^{a}	88.50^{a}	87.82^{ab}	88.10^{a}	63.10^{b}	3.83
Crude protein	68.25^{c}	70.00^{b}	85.27^{a}	78.58^{a}	75.03^{a}	1.14
Ether extract	70.27^{b}	80.09^{ab}	85.53^{a}	67.64b^{c}	57.38^{c}	1.42
Crude fibre	67.53^{c}	64.92^{d}	60.02^{a}	58.00^{b}	62.15^{e}	1.36
Ash	68.17^{bc}	58.00^{c}	87.85^{a}	89.67^{a}	78.47^{ab}	2.12
NFE	67.86^{a}	63.28^{b}	57.49^{c}	54.35^{d}	52.53^{d}	0.28

^{a,b,c,d,e} Means in the same row with different superscript are significantly different(P<0.05), MOLM: *Moringa oleifera* leaf meal, NFE: Nitrogen free extract, SEM: standard error of mean.

4.1.9: <u>Effect of Dietary Inclusion Levels of *Moringa oleifera* Leaf Meal on Carcass Characteristics of Broiler Chickens</u>

Result of carcass measurement of broiler chickens fed dietary inclusion levels of *Moringa oleifera* leaf meal is presented in Table 11. There were significant (P<0.05) differences in all the parameter measured except for dressing percentage which was not significant (P>0.05) among the treatment means. Birds on treatment C had significantly (P<0.05) higher values for live weight, bled weight, de-feathered weight, carcass weight and dressed weight compared to other treatments means. Birds on treatment A (control) had significantly (P>0.05) lower values for live weight, bled weight, de-feathered weight, carcass weight and dressed weight. There was no significant (P>0.05) difference in dressing percentage across the treatments means. Birds fed diet E had the highest value for dressing percentage compared to other treatments.

Table 11: Effect of Dietary Inclusion Levels of *Moringa oleifera* Leaf Meal on Carcass Characteristics of Broiler Chickens

	Inclusion levels of MOLM					
	A (0%)	B (2%)	C (4%)	D (6%)	E (8%)	
Parameter (g)*						SEM
Live weight	1733.30^{c}	2183.30^{ab}	2300.00^{a}	2066.70^{ab}	1900.00^{bc}	74.16
Bled weight	1683.30^{b}	2088.30^{ab}	2260.00^{a}	1895.00^{ab}	1858.00^{ab}	103.46
Defeathered Weight	1653.30^{b}	2013.30^{b}	2233.30^{a}	1870.00^{ab}	1829.00^{ab}	104.02
Carcass weight	1608.30^{b}	1953.30^{b}	2150.00^{a}	1791.70^{ab}	1760.70^{ab}	101.71
Dressed weight	1393.30^{b}	1653.30^{b}	1700.00^{a}	1571.70^{ab}	1445.70^{ab}	99.84
Dressing Percentage (%)	80.38	75.72	73.91	76.04	76.09	0.47

^{a,b,c,} Means in the same row with different superscript are significantly different (P<0.05), MOLM: *Moringa oleifera* leaf meal, SEM: standard error of mean. *Unless otherwise stated.

4.1.10: Effect of Dietary Inclusion Levels of *Moringa oleifera* Leaf Meal on Carcass Parts and Organs Weight Measurements of Broiler Chickens

Table 12, contained the results obtained for carcass parts and organs weight measurement of broiler chickens fed diets with inclusion levels of *Moringa oleifera* leaf meal. The results showed no significant (P>0.05) differences in all the parameters measured except for wing, liver and empty small intestine weight which were significantly (P<0.05) different. In terms of wings weight, birds fed diet B, C, and D were statistically similar and they were significantly (P<0.05) higher compared to other treatments. Birds fed diet A had significant (P>0.05) lower value for wings weight compared to MOLM-based diets. Significantly (P<0.05) higher value for liver weight was obtained in birds fed diet E and the lowest value was recorded on birds fed diet A. Empty small intestine weight was significantly (P<0.05) higher in birds fed diet C (4% MOLM), while the lowest value was obtained in birds fed diet A (control).

Table 12: Effect of Dietary Inclusion Levels of *Moringa* Leaf Meal on Carcass Parts and Organs Weight of Broiler Chickens Based on Percentage Body Weight

	Inclusion levels of MOLM					
	A (0%)	B (2%)	C (4%)	D (6%)	E (8%)	
Parameter (%)						SEM
Drumstick	3.86	3.83	4.30	5.22	3.90	1.48
Thigh	4.79	4.83	4.83	5.62	4.63	1.52
Breast muscle	15.41	15.26	21.01	22.58	18.42	3.44
Wing	2.24^{c}	3.43^{ab}	3.34^{ab}	4.38^{a}	3.43^{ab}	1.78
Lungs	0.35	0.27	0.34	0.32	0.23	0.21
Heart	0.27	0.24	0.26	0.31	0.21	0.12
Liver	1.47^{b}	1.47^{b}	1.35^{b}	1.77^{b}	3.77^{a}	0.21
Empty gizzard	1.32	1.23	1.63	1.62	0.51	0.38
Spleen	0.14	0.08	0.07	0.06	0.06	0.04
Proventriculus	0.30	0.27	0.29	0.33	0.27	0.06
E. small intestine	1.37^{b}	1.38^{b}	1.69^{a}	1.69^{a}	1.67^{a}	0.37
E. large intestine	2.95	2.12	2.29	2.26	2.73	0.51

^{a,b,c,d} Means in the same row with different superscript are significantly different($P<0.05$), MOLM: *Moringa oleifera* leaf meal, SEM: standard error of mean, E: Empty.

4.2 DISCUSSION

The proximate composition of the *Moringa oleifera* leaf meal (Table 3) revealed that *Moringa oleifera* leaf meal (MOLM) contained an appreciable amount of crude protein, ether extract, crude fibre, ash, and metabolizable energy. The presence of appreciable quantity of these nutrients especially crude protein in Moringa means that Moringa leaf protein concentrates could be used as nutritionally valuable ingredient to improve protein deficiency in animal diet, specifically monogastric animals. The result obtained was lower than the value obatained by Sodamade, Bolaji and Adeboye, (2013); Bamishaiye, Olayemi, Awagu and Bamishaiye, (2011) this difference could be due to variation in the location of sample collection. The amount of crude protein, ash and metabolizable energy obtained shows MOLM is a potential leaf protein supplement capable of supporting the life of monogastric animals. Similarly the values for dry matter, crude protein, ether extract, and ash obtained are in conformity with finding of Zanu, Asiedu, Tampuori, Asada and Asante (2012).

Proximate composition of the experimental diets for broiler starter (Table 4) shows that there was a decrease in the amount of dry matter at increased inclusion levels of MOLM. The values obtained are in agreements with finding of Iyabode, Edith, Daniel and Emmanuel (2014) the authors investigated the reproductive response of rabbit does to diets containing graded level of horse radish (MOLM). However the amount of moisture increased as the level of MOLM was increased in this research was not similar to the finding of Iyabode *et al.,* (2014) perhaps due to the hygroscopic nature of MOLM which tend to absorb moisture from the atmosphere. Similarly, the crude protein, ether extract, and ash contents of the diets also followed the same trend. However, the nitrogen free extract content decreased as the inclusion levels of MOLM were increased this also agrees with the finding of Iyabode *et al*.. (2014). The metabolizable energy, crude protein and crude fibre values obtained were within the range recommended by (National Research Council, NRC, 1994) for broiler starter and can support the life of broiler chickens.

The proximate composition of experimental diets for broiler finisher (Table 5) indicated that dry matter content decreased as the levels of MOLM was increased. All the parameters including moisture, crude protein, ether extract, crude fibre, and ash increased as the level of the MOLM were increased. The trend of these proximate components differs with the finding of Gadzirayi, Masamha, Mupangwa and Washaya (2012) these differences could be due to variation in the sample collection location of experimental test material. The metabolizable energy, crude protein and crude fibre contents obtained in this study were within the range recommended by NRC (1994) for broiler finisher.

Growth performance of broiler chickens fed diets with inclusion of varying levels of MOLM (Table 6) at broiler starter phase revealed that there was an improved performance in birds fed MOLM-based diets. Higher mean total live weight gain values obtained in birds fed diet C (4% MOLM) perhaps could be because MOLM at 4% level of inclusion is the optimum level required for broiler chickens to efficiently metabolize and utilize the nutrients for better performance. Under or over-supply of nutrients can interfere with the utilization of the other. The result is in agreement with the finding of Ebenebe, Umegechi, Aniebo and Nweze (2012) in their research comparison of hematological parameters and weight changes of broiler chickens fed different levels of MOLM diet. Similarly, Onu and Aniebo (2011) obtained higher value in birds fed MOLM-based diet compared to control diets. The increased in live weight gain of birds fed MOLM could be as a result of the optimum crude protein content of the diets which were efficiently metabolize and utilized for growth by the birds. The lower values obtained in birds fed diet D and E compared to birds on diet C (4% MOLM) despite the higher crude protein content probably due to the negative effects of anti-nutritional factors present in MOLM. Kakengi, Kaijage, Sarwatt, Mutayoba, Shem and Fujihara (2007) reported *Moringa oleifera* contained 1 to 23g tannin in every 1 kilogram of leaves. Birds on treatment D (6% MOLM) consumed higher amount of feed compared to other treatment. The trend shows an increment in feed consumption with increasing in the amount of MOLM, this follow similar trend with the result of Onu and Aniebo (2011) in their work influence of *Moringa oleifera* leaf meal on the performance and blood chemistry of broiler starter. However, there was reduced feed intake in birds fed diet E (8% MOLM) this could be as a result of reduced palatability of the diet due to increase in the quantity of the graded levels of MOLM which might result in reduced palatability of the diet, (Kakengi *et al.,* 2007). Previous authors; Onu and Aneibo (2011); Tesfaye *et al.* (2012) stated that reduced palatability nature of a feedstuff would consequently prevent chicks from consuming adequate amount of feed. In present study no significant differences were observed in mortality across the experimental treatments, this indicate that inclusion levels of MOLM in the diet of broiler chickens had no effect on mortality.

There were significant differences in the feed conversion ability of the birds used in the experiment. The best feed conversion ability was obtained in birds fed MOLM-based diets and the best result was obtained in birds fed diet C. This was probably because birds fed MOLM-based diets properly utilized the nutrients consumed compared to those in the control treatment. The result is in line with the finding of Safa and El-Tazi (2012) the authors reported that broilers fed MOLM-based diets had higher weight gain, higher feed intake and best feed conversion ability. Cost of feed per kilogram diet indicate an increased in the cost/kg with an increased in inclusion levels of MOLM with highest value obtained for diet E (8% MOLM) and the lowest in diet A (0% MOLM) the trend disagree with work of Oyewole, Olarewaju and Dafwang (2013) and with the values reported by Iyabode *et al.* (2014). The latter author reported a decreased in the cost of feed per kilogram diet as the levels of MOLM were increased which he attributed to the increased demand of the MOLM between livestock and human population for nutritional purposes.

Effect of dietary inclusion levels of MOLM on growth performance of broiler chickens at finisher phase (Table 7) revealed significant differences in mean total weight gain in birds fed MOLM-based diets, where best performance was recorded in birds fed diet C (4% MOLM) this is probably due to influence of MOLM in the diet. This is in agreement with the finding of Oyewole, Olarewaju, and Dafwang (2013) in their work performance of broiler fed premix prepared from locally sourced materials, where they reported higher values for MOLM-based diets compared to control treatment. Mean total feed intake was higher in birds fed MOLM-based diets. However, there was a depressed feed intake in birds fed diet E which is probably due to reduced palatability of the diet as a result of increased quantity of the inclusion levels of MOLM as reported by Kakengi *et al.*, (2007). There was an improved performance in feed conversion ability of the birds fed MOLM based diet. The least value for feed conversion ratio was observed in birds fed diet C (4% MOLM). Meanwhile, the lower values in feed conversion ratio indicate better feed conversion ability of the birds. This indicates birds fed 4% MOLM (diet C) were able to properly utilize the nutrients they consumed. Cost of feed per kilogram diet showed a steady increment with increase in the inclusion levels of MOLM. Diet E was more expensive compared to other treatments. This statement disagrees with the finding of Iyabode *et* *al.* (2014) where they observed a decrease in the cost of feed when the levels of MOLM were increased. The increment in the cost/kg was probably due to increased demand of the *Moringa oleifera* by the growing human population and the livestock industries. Non significant differences were observed in mortality across the experimental treatments, thus, indicated that inclusion of MOLM in the diet of broiler chickens had no effect on mortality of the birds.

Effect of dietary inclusion levels of MOLM utilization on hematological indices of broiler chickens (Table 8) shows a significant (P<0.050) differences in the amount of haemoglobin among the treatments observed, birds in treatment C presented the highest value however, the values obtained are lower than the reported values obtained by (Onu & Aniebo, 2011; Ebenebe, Umegechi, Aniebo & Nweze 2012; Zanu, *et al.*, 2012). The highest value obtained in treatment C birds may be attributed to the influence of inclusion levels of MOLM as protein supplement. Similarly, birds on treatment C were observed to have the highest value in packed cell volume which could also be as a result of the effect of MOLM inclusion in the diet. This is similar to the finding of Ebenebe *et al*., (2012) who observed remarkable significant in the parked cell volume of the birds fed MOLM-based diets. The values obtained for red blood cells in this experiment were lower than the value obtained by Onu and Aniebo (2011) in their paper titled influence of MOLM on the performance and blood chemistry of broiler chickens at starter phase. Red blood cell is responsible for the transportation of oxygen and carbon dioxide in the blood as well as manufacture of haemoglobin which enhance the better state of health of the birds (Olugbemi, Mutayoba, and Lekule, 2010b). The values for red blood cells obtained was higher than the value obtained by Onu and Aneibo (2011) the highest value was obtained in birds fed diets with inclusion levels of MOLM-based diets. This suggest that the animals fed diets with inclusion levels of MOLM were healthier because decrease in the number of white blood cells below the normal range could be an indication of allergic condition, anaphylactic shock and certain parasitism or presence of foreign body in circulating system (Ahamefule, Obua, Ukweni, Oguike & Amaka 2008). Value for mean corpuscular hemoglobin in treatment C birds was within the normal range. However, the values observed in treatments A, B, D, and E were above the normal range. Similarly, the values for mean corpuscular volume were above the normal range across the treatments observed, this agrees with the finding of Zanu *et al.* (2012) in their study possibilities of using MOLM as a partial substitute for fish meal in broiler chickens diets where they obtained highest values in birds fed MOLM-based diets compared to control diet. However, only values obtained in treatment E was within the normal range in the amount of mean corpuscular haemoglobin volume compared to other treatment. The remaining treatments have values lower than the normal range. The result obtained agrees with value obtained by Onu and Aniebo (2011) in their work influence of MOLM in the performance and blood chemistry of broiler starter chicks. Values obtained for monocytes were lower than the values obtained by Hassan *et al.,* (2017). However, the values obtained for neutrophils were higher than the values obtained by Hassan *et al.* (2017). Lymphocytes values obtained in this study were lower than the values obtained by Nuhu (2010) who obtained highest values recorded in birds fed MOLM-based diets compared to control diet.

There was a significant difference in blood urea nitrogen across all the treatments observed with highest value obtained in treatment A followed by treatment D and the least was treatment B. This agree with finding of Annongu *et al.,* (2013) and Ghomsi *et al.*, (2017) in their work changes in metabolic nutrients utilization and alterations in biochemical and haematological indices in broiler fed graded levels of dietary *Moringa oleifera* leaf meal. The highest values recorded in MOLM based diet is probably due to problems associated with quality of the protein as a result of the increasing quantity of the MOLM, Aregheore (2012). Similarly, the amount of sodium in blood serum follows similar trend with blood urea nitrogen. There were no significant differences in the composition of blood serum potassium and chloride contents. This agrees with the findings of Nuhu (2010) in his work effect of MOLM on nutrients digestibility, growth performance, carcass and blood indices of weaner rabbits. This suggests that the experimental diets did not influence the composition of the potassium and chloride of the experimental birds. There was significant differences in the composition of cretinine contents with higher values recorded in MOLM based diets, with highest value in treatment B (2% MOLM). This agrees with the finding of Hassan *et al.,* (2016), who reported higher values in MOLM-based diets. However, values obtained by Tijjani, Akanji, Agbalaya, and Onigemo (2016) were higher than the value obtained in this study, however lower than the values obtained by Annongu *et al.,* (2013). There were significant differences in the serum total protein with highest value recorded in MOLM-based diets. This agrees with the findings of Onu and Aneiebo (2011) who obtained highest values in MOLM-based diets. The higher value for serum total protein obtained in treatment E (8% MOLM) could be a reflection of the protein quality of the diet. However, disagree with finding of Hassan *et al.,* (2017) who obtained lower values compared to findings of this study.

Values obtained for albumin in this study was higher than the values obtained by Hassan *et al.,* (2017) in their work serum biochemistry and haematology of broilers fed baobab and MOLM as premix. Values recorded for total cholesterol was significantly lower than the value obtained by Abousekken (2015) who reported a higher value. However, lower than the values obtained by Zanu *et al.,* (2012).There were significant differences in globulin contents in birds fed diets with inclusion of MOLM compared to control diet, this is contrary to the finding of Annongu *et al.,* (2013), the authors obtained higher values of globulin in the control diet compared to those fed MOLM-based diets. Similarly, Annongu *et al.,* (2013) got higher values for alkaline phosphate in birds fed control diet compared to those fed MOLM-based diets. In summary, values for blood urea nitrogen, globulin and alkaline phosphate were below and above the normal range as reported by Clinical Diagnostic Division, (1990). Nevertheless, the values obtained for serum potassium, chloride, bicarbonate, creatinine, glucose, total cholesterol, total protein and albumin contents were within the normal range.

Effect of dietary inclusion levels of MOLM on percentage nutrient utilization of broiler chickens (Table 10) the values on percentage nutrients utilization obtained in this research shows that dry matter, crude protein, ether extract, crude fibre, ash and NFE were higher than the value obtained by Eustace, Iyayi, Oluwakemi and Odueso (2003); Iyeghe-Erakpotobor, Aliyu and Uguru (2006). This is probably as a result of the higher digestible nature of the Moringa. There was significant differences in the percentage nutrient utilization on bird fed MOLM-based diets. Higher percentage of crude protein utilization was recorded in birds fed diet C (4% MOLM) this is contrary to report of Tijjani *et al.,* (2016). The authors obtained non significant differences among the experimental treatments including the control treatment, in their work effect of moringa leaf meal on performance, nutrient digestibility and carcass quality of broiler chickens. However, similar with finding of Nuhu (2010) who obtained higher values in MOLM-diets compared to control diet. The higher percentage crude protein utilization by birds in treatment C (4% MOLM) was probably because MOLM enhances nutrient utilization of the diet. Fahey, Zakmann, and Talalay (2001) reported that MOLM is an outstanding indigenous source of highly digestible protein. There was significant differences in percentage crude fibre utilization in birds fed diet 3 (4% MOLM) compared to control diet. This agrees with finding of Nuhu (2010) in his work effect of MOLM on nutrient digestibility, growth, carcass and blood indices of weaner rabbits. The author reported an increased in percentage nutrients utilization when the amount of graded level of MOLM was increased. There was no significant differences in percentage ether extract utilization among the treatments studied. This is in line with the findings of Tijjani *et al.*, (2016). However, disagree with the finding of Nuhu (2010) who obtained significant differences in percentage of ether extract utilized by the birds used in the experiment. There was significant differences in percentage of ash utilization in birds fed MOLM based diet compared to control diet with highest value obtained in treatment D birds, this disagree with finding of Annongu *et al.* (2013); Tijjani *et al.*, (2016). The reduction in percentage nutrients utilized by birds fed diet D (6% MOLM) and diet E (8% MOLM) despite the higher crude protein of the diet was probably because of the higher inclusion levels of MOLM and by implication higher concentration of anti-nutritional factors in the diet interfere with nutrient utilization by the birds.

Effect of dietary inclusion levels of MOLM on carcass yield of broiler chickens revealed significant differences in birds fed MOLM-based diets compared to birds on control diet on live weight, bled weight de-feathered weight, carcass weight, dressed weight and dressing percentage, with highest value recorded in birds fed diet C (4%MOLM) this agrees with the finding of Safa and El Tazi (2012) but disagrees with the finding of Zanu *et al.*, (2012). The authors observed no significant differences between the MOLM-based diets and the control diet. The highest significant differences obtained in birds fed MOLM diet was as a result of the influence of the diets which were properly metabolized for growth.

Effect of dietary inclusion levels of MOLM on carcass parts and organs weight of broiler chickens revealed no significant differences in all the parameters observed. The result showed an increasing trend as the levels of MOLM increased, this result agrees with the finding of Ologhobo, Akangbe, Adejumo and Adeleye (2014) in their research effect of *Moringa oleifera* leaf meal as a replacement for oxytetracycline on carcass characteristics of broiler chickens. The authors reported higher mean values for carcass parts and organs weight of birds fed MOLM-based diets compared to those fed the control diet which had the lowest mean value.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

A feeding trial was conducted to determine the effect of dietary inclusion levels of *Moringa oleifera* leaf meal on performance and blood metabolites of broiler chickens. The research was conducted at Poultry unit, Teaching and Research Farm, Faculty of Agriculture, Bayero University, Kano. A total of two hundred and twenty-five day old broiler chickens (Cobb strain) were used for the experiment, the birds were randomly distributed into five treatments and each treatment was replicated thrice, with 45 birds per treatment and 15 birds per replication in a completely randomized design. Drumstick (*Moringa oliefera*) was used as leaf protein supplement. The Moringa leaf meal was tested at five varying levels of inclusions; 0, 2, 4, 6, and 8 percent inclusion levels designated as treatments A, B, C, D and E respectively. The diets were formulated to contain 22% CP, 2800ME Kcal/kg and 20% CP, 3100 ME Kcal/kg for broiler starter and finisher phases respectively. Performance parameters comprised growth performance, nutrients utilization and carcass characteristics, while blood metabolites comprised haematology and serum chemistry.

The result showed no significant ($P>0.05$) differences in growth performance at the starter phase in all parameters measured except for FCR and feed cost/kg which were significant. However, there were significant ($P<0.05$) differences in growth performance at finisher phase in all the parameters measured with best performance obtained in birds fed MOLM-based diets compared to control diet. There was significant ($P<0.05$) difference in haematological indices and serum chemistry for all the parameters measured except for Chloride and Potassium contents which were significant. There were significant differences in nutrients utilization of birds fed diets with inclusion levels of MOLM compared to control diet. Similarly, carcass characteristics were significantly ($P<0.05$) higher in birds fed MOLM-based diets compared to control diet. However, it was observed that inclusion levels of MOLM as leaf protein supplement did not influence changes in the carcass parts and organs weight of broiler chickens for all the parameters measured except for wings, liver and empty small intestine which were significant.

5.2 CONCLUSION

It was concluded that effect of inclusion levels of MOLM on growth performance had no influence on broiler chickens at broiler starter phase. However, it influenced the growth performance of broiler chickens at finisher phase. Meanwhile, effect of dietary inclusion levels of MOLM on carcass characteristics and blood metabolites of broiler chickens was better in birds fed diet C (4% MOLM).

Yellow pigmentation was observed on the beak, shank and skin of broiler chicken, the yellow colouration increased as the inclusion levels of *Moringa oleifera* leaf meal was increased this could be attributed due to the presence of vitamin-A in the MOLM.

5.3 RECOMMENDATION

Based on this research it is recommended that *Moringa oleifera* leaf meal can be incorporated in the diet of broiler chickens as protein supplement up to 8% without any deleterious effect. Meanwhile, further research should be conducted in order to examine the effect of *Moringa oleifera* leaf meal on yellow pigmentation on the various parts of broiler chickens.

REFERENCES

Abdulazeez, H., Adamu, S.B., Igwebulke, J.U., Gwayo, G.J. and Muhammad, A.I. (2016). Haematology and Serum Biochemistry of Broiler Chickens Fed Graded Level of Baobab (*Adonsonia digitata)* Seed Meal. *Journal of Agriculture and Veterinary Science*, 9 (10&11):48 - 53

Abubakar, M. M. (2008). Utilization of Unconventional Feedstuff for Sustainable Livestock Production. Inaugural Lecture Series No.9, Abubakar Tafawa Balewa University, Bauchi

AbouSekken M.S.M., (2015). Performance, Immune Response and Carcass Quality of Broilers Fed Low Protein Diets Contained either *Moringa oleifera* Leaves Meal or its Extract. *Journal of American Science*, 11(6): 153 - 164

Abu, O. A. and Suetan, K. O. (2009). SWOT Analysis on the Application of Biotechnology in Livestock Improvement in Nigeria. Proceeding of 14th Annual Conference of Animal Science Association of Nigeria. September 14th – 17th LAUTECH, Ogbomosho, Nigeria. Pp. 215 - 217

Addas, P.A., Midau, A. And Babale, D.M. (2010). Haemato-Biochemical Findings of Indigenous Goat in Mubi, Adamawa State, Nigeria. *Journal of Agriculture and Social Sciences*, 6:14 - 23

Adebayo, M. O., Agunbiade, J.A, Adeyemi, O. A and Banjoko, O. S. (2008). Enhancing Nutrient Utilization of Cheap, Bulky Feed Ingredients Fed to Pullets by the Use of Exogenous Enzymes. Procedings of 33rd Annual Conference Nigerian Society of Animal Production. March, 17th - 20th 2008. Pp. 367 - 372

Adeniji L., (2012). Effects of Replacing Groundnut Cake with *Moringa oleifera* Leaf Meal in the Diets of Grower Rabbits, *International Journal of Molecular Veterinary Research*, 2(3): 8 - 13

Afolabi, K. D., Akinsoyinu, A.O., Alajide, R. and Akinyele, S.B. (2010). Haematological Parameters of Nigerian Local Grower Chicken Fed Varying Dietary of Palm Kernel Cake. In: Proceeding of 35th Annual Conferences of the Nigerian Society for Animal Production held at University of Ibadan, Nigeria

Ahamefule, F.O., Obua, B.E., Ukweni, I.A., Oguike, M.A and Amaka, R.A. (2008). Hematological and Biochemical Profile of Weaner Rabbits Fed Raw or Processed Pigeon Pea Seed Meal Based Diets. *African Journal of Agricultural Researc*h, 3(4):315-319

Akande K. E. and E. F. Fabayi, (2010). Effect of Processing Methods on some Anti-nutritional Factors in Legume Seeds for Poultry Feeding. *International Journal of poultry Science*, 9 (10):996 - 1001

Akinmutim, A. H. (2004). Evaluation of Sword Beans (Canavalia gladiate) as Alternative Feed Resources for Broiler Chickens (Unpublished Doctoral Thesis). Michael Okpara University of Agriculture, Umudike, Nigeria

Anjorin,T.S., Ikokoh.P, and Okolo.S (2010). Mineral Composition of *Moringa oleifera* Leaves, Pods and Seeds from Two Regions in Abuja, *Nigeria. International Journal of Agricultural Biology*, (12):431 - 434

Annongu A.A, Toye A.A, Karim O.R, Sola-Ojo F.E, Ashi S., Olasehinde K.J., O. A. Adeyina A.O and Aremu J.O (2013). Changes in Metabolic Nutrients Utilization and Alterations in Biochemical and Hematological indices in Broilers Fed Graded Levels of Dietary *Moringa oleifera*, *Bulletin of Environment, Pharmacology and Life Sciences*, 2 (10): 14 - 18

Anwar .H.G, Sajid. L, Muhammad .A and Anwar. F (2007). *Moringa oleifera*: A Food Plant with Multiple Medicinal Uses. *Phytother. Resource*, (21): 17 - 25

AOAC (2005). Association of Official Analytical Chemist. Official Methods of Analysis (18th edition) AOAC Inc. Arlington, Virginia, USA. 1094 pp

Apata, D. F and Ologhobo, A. D. (2004). Biochemical Evaluation of Some Nigerian Legume Seeds. *Journal of Food Chemistry*, (49):333 - 338

Aregheore, E.M. (2012). Intake and Digestibility of *Moringa oleifera* and Batiki Grass Mixtures by Growing Goats. *Small Ruminant Research*, 46: 23-38

Aregheore, E.M., (2002). Intake and Digestibility of *Moringa oleifera* and Batiki Grass Mixtures by Growing Goats. *Small Ruminant Resource*, (46): 23 - 28

Avato P, Bucci R, Tava A, Vitali C. Rosato A, Bialy Z, Jurzysta M, (2006). Antimicrobial Activity of Saponins from *Medicago spp*,: Structural Activity Relationship. *Phytother. Resource.* (20):454 - 457

Bamishaiye E.I, Olayemi F.F, Awagu E.F and O.M. Bamshaiye (2011). Proximate and Phytochemical Composition of *Moringa oleifera* Leaves at Three Stages of Maturation. *Advance Journal of Food Science and Technology*, 3(4): 233 - 237

Banjo,O.S.(2012). Growth and Performance as Affected by Inclusion of *Moringa oleifera* Leaf Meal in Broiler Chicks Diet. *Journal of Biology, Agriculture and Healthcare*, 2(9):

Becker K, (1995). Studies on Utilization of *Moringa oleifera* Leaves as Animal Feed. *Institute of Animal Production in Tropics and Subtropics*, 480:15

Broin, M., Santaella, C., Cuine, S., Kokou, K., Peltier, G., Jo¨et, T., (2002). Flocculent activity of a recombinant protein from Moringa oleifera Lam. seeds. *Applied Microbiology and Biotechnology*, (60): 114 - 119

Cheeke, P. R. and L. R. Shull, (1985) Tannins and Polyphenolic Compound. In: Natural Toxicants in Feeds and Poisonous Plants. AVI Publishing Company, USA

Chunmei G., P. Hongbin, S. Zewei and Q. Guixn, (2010) Effect of Soybean Variety on Antinutritional Factor Content, and Growth Performance and Nutrients Metabolism in Rat. *International Journal* of *Molecular Science*, (11): 1048 - 1056

Clinical Diagnostic Division (1990). Veterinary Reference Guide. Eastman Kodak Company, Rochester, New York

Cole, E.H. (1986). *Veterinary Clinical Pathology*, 4th edition, N.B Sanders Company, Harcourt Brace Jovanovich Inc.

D'Mello, J.P.F., (2000) Anti-nutritional Factor and Mycotoxins. In: *Farm Animal Metabolism and Soybeans,* CAB International Wallingford, UK, pp: 383 - 403

Dube, J. S., Reed, J. D. and nNdlovu, L. R., (2001), Proanthocyanidins and Other Phenolics in Acacia Leaves of Southern Africa. *Animals Feed Science and Technology*, (91):59 - 67

Ebenebe, C.L. Umegechi C.O, Aniebo and Nweze B.O (2012). Comparison of Haematological Parameters and Weight Changes of Broiler Chicks Fed Different Levels of Moringa oleifera Diet. *International Journal of Agriculture and Bioscience Science*, 1 (1): 23 - 25

Eekeren van, N., Maas A., Saatkamp H.W., Verschuur M., (2006) Small Scale Chicken Production. *World's Poultry Science Association*, Printed by: Digigrafi,Wageningen, Netherlands. Pp 33 - 39

Egbewande, O.O. (2012). Effect of Vitamin C, Baobab Pulp, Amaranthus and Tiger Nut on the Performance of Broiler and Egg-type Pullet. A Ph.D. Thesis. Department of Theriogenology and Animal Production, Faculty of Veterinary Medicine, Usman Danfodio University, Sokoto, Nigeria, (Unpublished)

Ehtesham, A. and Choudhory, S. D (2002), Response of Laying Chickens to Diet Formulated by Different Feeding Standards. *Pakistan Journal of Nutrition*, 1(3): 127 - 131

Eustace, A., Iyayi, O., Oluwakemi, O. and Odueso, M. (2003). Response of Some Metabolic and Biochemical Indices in Rabbits Fed Varying Levels of Dietary Cyanide. *African Journal of Biomedical Research*, 6(1): 43 - 47

Fahey, J.W., Zakmann, A.T. and Talalay, P. (2001). The Chemical Diversity and Distribution of Glucosinolates and Isothiocyanates among Plants. Corrigendum: *Journal of phytochemistry*, (59): 200 - 237

Fahey, J.W., (2005). Moringa oleifera: A Review of the Medical Evidence for Its Nutritional, Therapeutic, and Prophylactic Properties, Part1. *Trees for Life Journal*, 1(5)

FAO (1997).Human Nutrition in the Developing World. Latham M.C. FAO Food and Nutrition, 29

FAO, (2010). Country Statistics: Nigeria Retrieved November 10, 2011, From FAOSTAT/Liveanimals: http//faostart.fao.org/site/573/Default.aspx

Farinu G.O, Ajiboye S.O and Ajao S. (1992). Chemical Composition and Nutritive Value of Leaf Protein Concentrate from *Leucaena leucocephala*. *Journal of Science and Food Agriculture*, (59):127 - 129

Foidl, N., Makkar, H.P.S. and Becker, K. (2001). The Potential of *Moringa oleifera* for Agricultural and Industrial Uses. In: Proceedings of International Work shop. Theme: What Development Potential for Moringa Products. October 29th to November 2nd 2001. Dar Es Salaam, Tanzania.

Fuglie LJ. (1999). The Miracle tree: *Moringa oleifera*: Natural Nutrition for the Tropics. Dakar: Church World Service; Pp172

Gadzirayi C.T, Masamha B, Mupangwa J.F and Washaya S. (2012). Performance of Broiler Chickens Fed on Mature *Moringa oleifera* Leaf Meal as a Protein Supplement to Soybean Meal. *International Journal of Poultry Science*, 11 (1): 5 - 10

Ghomsi M.O.S, Enow J.T, Etchu K.A, Tientcheu B.L, Enamou G., Chouengouong T.M, Mongo B.G, and Bayemi P.H (2017). Effect of *Moringa Oleifera* Leaf Meal (MOLM) on the Growth, Carcass, Heamatology and Biochemical Parameters of Rabbits. *Standard Journal of Veterinary Sciences*, 3(1):1 - 5

Gidamis A, Panga J, Sarwatt S, Chove B, Shayo N, (2003). Nutrients and Anti-nutrients Contents in Raw and Cooked Leaves and Mature Pods of *Moringa oleifera* Lam. *Journal of Ecological Food Nutrition*, (42):1 - 123

Greg M.E, (2008). Effect of Enzymes on Cellulose. *European Journal of Applied Microbiology and Biotechnology*, (40):167 - 171

Habtamu Fekadu and Negussie Ratta, (2014). Antnutritional Factos in Plant Food: Potential Health Benefits and Adverse Effects. *International Journal of Nutrition and Food Sciences*, 3(4): 284 - 289

Hassan A. U., Sakaba A. M., Harande I. S., Isgogo S. M., Danbare B. M., Maiyama F. A. and Bagudo A. M. (2017). Serum Biochemistry and Hematology of Broilers Fed Baobab and Moringa Leaf Meal as Premix. *Asian Research Journal of Agriculture*, 7(3): 1 - 6

Hassan H.M.A., El-Moniary M.M., Hamouda Y., Eman F. El-Daly, Amani W. Youssef and Nafisa A. Abd El-Azeem (2016). Effect of Different Levels of *Moringa oleifera* Leaves Meal on Productive Performance, Carcass Characteristics and Some Blood Parameters of Broiler Chicks Reared under Heat Stress Conditions. *Asian Journal of Animal and Veterinary Advances*, (11): 60 - 66

Hsu, N.C. (2006). *Moringa oleifera* Medicinal and Economic Uses. International Course on Economic Botany, National Herbarium, Leiden. The Netherlands. Nutrient Utilization and Cost Implications of Feeding Broiler Finishers Conventional or Underutilized Resources. *Applied Tropical Agriculture*, (2): 57 - 62

Igile G.O. (1996). Phytochemical, and Biological Studies on Some Constituents of Vernonia *amygdalina* (compositae) Leaves. Ph.D thesis, Depaetment of Biochemistry, Unversity of Ibadan, Nigeria. Ikemefuna.

Irshad, A., Kandeepan, G., Kumar, S., Ashish, K.A., Vishnuraj, M.R. And Shukla, V.C. (2012). Factors Influencing Carcass Composition of Livestock: A Review: *Journal of Animal Production Advances*, 3(5):177-186

Iyabode C.A, Edith A.O, Daniel N.T, Emmanuel L.S (2014). Reproductive Response of Rabbit Does to Diets Containing Varying Levels of Horseradish (*Moringa oleifera*) Leaf Meal. *Journal of Biology, Agriculture and Healthcare*, 4(19): 62 - 68

Iyeghe-Erakpotobor, G.T, Aliyu, R. and Uguru, J. (2006). Evaluation of Concentrate, Grass and Legume Combinations on Performance and Nutrient Digestibility of Grower Rabbits under Tropical Conditions. *African Journal of Biotechnology*, 4 (20): 2004 - 2008

Jegede, O.O., Adeyeye, S.A And Agbede, J.O. (2016). Influence of Varying Level of Water Supply and Dietary Protein on Performance and Carcass Characteristic of Broiler Chicken. In: Proceeding of 41st Annual Conference of Nigerian Society for Animal Production Held at Federal University of Agriculture, Abeokuta, Nigeria.

Jenkins, K.J. and A.S. Atwal, (1994). Effect of Dietary. Saponins on Faecal Bile Acids and Neutral Sterol and Availability of Vitamins A and E in the Chicks. *Journal of Nutritional Biochemistry*, (5):134 - 13

Kakengi, A.M.V., Kaijage J.T., Sarwatt S.V, Mutayoba S.K, Shem M.N and Fujihara T., (2007). Effect of *Moringa oleifera* Leaf meal as a Substitute for Sunflower Seed Meal on Performance of Laying Hens in Tanzania. *International Journal of Poultry Science*, (9):363 - 367

Kalogo,Y., M'Bassigui´eS´eka, A.,Verstraete,W., (2001). Enhancing the Strat-up of a UAS Breactor Treating Domestic Waste Water by Adding Extract of *Moringa oleifera* seeds. *Applied Microbiology and Biotechnology*, (55):644 - 651

Katie, T. and Fraser, A. (1986). The Computer Book of Keeping Livestock and Poultry, (Small Holder's Guides) Published by University Services Limited. Educational publishers, 38 Commercial Avenues.

Khalafalla, M.M., Abdellatef, E., Dafalla, HM., Nassrallah, A.A., Aboul-Enein, K.M., Lightfoot, D.A., El-Deeb, F.E., El-Shemy, H.A., (2010). Active Principle from *Moringa oleifera* Lam Leaves Effective against Two Leukemias and a Hepatocarcinoma. *African Journal of Biotechnology*, 9(49): 8467 - 8471

KNARDA (2006). Kano Agricultural and Rural Development Authority, Metrological Station Reports. Temperature Record Book and Management Unit No. (11): 1 - 3

Lalas, S., Tsaknis, J., (2002). Characterization of *Moringa oleifera* Seed Oil Variety. Journal of Food Composition Analysis. (15) 65 - 77

Lockett, C.T., Calvert, C.C., Grivetti, L.E.,(2000). Energy and Micronutrient Composition of Dietary and Medicinal Wild Plants Consumed During Drought. Study of Rural Fulani, Northeastern Nigeria. *International Journal of Food Science and Nutrition.* (51):195 - 208

Macedo F.A.F., Sequeire, E. R. and Martins, E.N. (2000). Qualidde De Carcacas De Cordeiros Corriedele Puros E Mesticos Terminados Em Pastagem E Continamento. R. Bras. Zootec., 29(5):1250 - 1257

Makkar, H.P.S., Becker, K. (1996). Nutritional Value and Antinutritional Components of whole and Ethanol Extracted *Moringa oleifera* Leaves. *Journal of Animal Feed Science and Technology*, 63 (1 - 4):211 - 228

Makkar, H.P.S., Becker, K. (1997). Nutrients and Antiquality Factors in Different Morphological Parts of the *Moringa oleifera* Tree. *Journal of Agricultural Science*. (128):311-322

McDonald, P. Edwards R.A, Greenhalgh J.F.D, Morgan L.A Sinclair C.A, and Wilkinson R.G (2010). *Animal Nutrition*. Seventh Edition. Pp. 714

Melesse A., Bulang, M., Kluth, H., (2009). Evaluating the Nutritive Values and Invitro Degradability Characteristics of Leaves, Seeds and Seedpods from *Moringa stenopetala*. *Journal of Science of Food and Agriculture*. (89):281 - 287

Morton, J.F. (1991). The Horseradish Tree, *Moringa pterygosperma* (Moringaceae) A Boom to Arid Lands. *Economic Botany*, (45):318 - 333

Nadir, R.S. (2006). Moringa oleifera and Cratylia argentea: Potential Fodder Species for Ruminants in Nicaragua Doctoral Thesis Swedish University of Agricultural Sciences

Noah, L. (2015). Enhancing Oxygen and Carbon Dioxide. Merck Sharp and Dohme Corp., a Subsidiary of Merck and Co. Inc., Kenilworth, NJ., USA. 275Pp

NRC, (1994), National Research Council. *Nutrients Requirements of Poultry*. 9th Revised Edition. National Academic Press. Washington, DC, USA. Pp. 209

Nuhu F. (2010). Effect of Moringa Leaf Meal (MOLM) on Nutrient Digestibility, Growth, Carcass and Blood Indices of Weaner Rabbits. MSc, Faculty of Agriculture and Natural Resources, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana, Pp. 122

Nwagu B.I (2002), Production and Management of Indigenous Poultry Species, Poultry Research Programme, NAPRI, ABU Zaria

Oduro, I., Ellias, W.O., Owusu, D.(2008). Nutritional Potential of Two Leafy Vegetables: *Moringa oliefera* and *Ipomoea batatas* Leaves. *Journal of Scientific Research and Essay*, 3(2): 57 - 60

Ogundupe, S.A., Abeke, F.O., Sekoni, A.A, Dafwang, I.I., and Adeyinka, A.I (2003). Effect of Duration of Cooking on the Utilization of *Lablab purpureus* by Pullet Chicks. In: Proceeding of the 28th Annual Conference of the Nigeria society for Animal production, Held at Ibadan, Nigeria. Pp. 233 - 235.

Olerade, B.R and Longe, O.G (1999). Growth, Nutrition Retention, Heamatology and Serum Chemistry of Pullet Chickens Fed Shear Butter Cake in the Humid Tropics. *Journal of Animal Science*, (49): 44 - 444

Oliveira, J.T.A., Silveira, S.B.,Vasconcelos, I.M., Cavada, B.S., Moreira, R.A., (1999) Compositional and Nutritional Attributes of Seeds from the Multipurpose Tree *Moringa oleifera* Lamarck. *Journal of Science, Food, and Agriculture*, (79): 815 - 820

Olofin, E.A. (2007). "Some Aspect of Physical Geography of Kano Region and Related Human Resources". Departmental Lecture Note Series Vol. 1 Pp.50, Geography Department, Bayero University, Kano

Olofin, E.A., Nabegu, A.B., Danbazau, A.M. (2008). Wudil in Kano Region: A Geographical Synthesis, 1st Edition, Adamu Joji Publishers, Kano state, Nigeria, Pp. 134 - 138

Ologhobo, A.D., Akangbe, E.I., Adejumo, I.O. and Adeleye, O. (2014). Effect of *Moringa oleifera* Leaf Meal as Replacement for Oxytetracycline on Carcass Characteristics of the Diets of Broiler Chickens. *Annual Research and Review in Biology*, 4(2):423 - 431

Oludoyi, I.A. and Toye, A.A. (2012). The Effects of Early Feeding of *Moringa oleifera* Leaf Meal on Performance of Broiler and Pullet Chicks. *Journal of Agrosearch*, (2): 160 - 172

Olugbemi, T.S., Mutayoba S.K and Lekule F.P. (2010b). Effect of Moringa (*Moringa oleifera*) Inclusion in Cassava Based Diets Fed to Broiler Chickens. *International Journal of Poultry Science* (9): 363 - 367

Omole, T. A and Ajayi, T. A. (2006). Evaluation of Brewers Dried Grain in the Diet of Growing Rabbits. *Tropical Animal Production Investigation*, (13):36 - 38

Onu, P.N. and Aniebo, A.O. (2011). Influence of *Moringa oleifera* Leaf Meal on the Performance and Blood Chemistry of Broiler Starter. *International Journal of Food Agriculture and Veterinary Science*, 1 (1):38 - 44

Oyewole B.O, Olarenwaju G. and Dafwang II (2013) Performance of Broilers Fed Premix Prepared From Locally Sourced Materials. *Standard Research Journal of Agricultural Sciences*, 1(2):17 - 20

Pauzenga, U. (1985) Feeding Parent Stock. *Zoo Technical International*. Pp. 22 - 24

Payne, W.J, and R. T. Wilson (1999) An Introduction to Animal Husbandry in the Tropics, fifth edition. University press. Cambridge.Pp 801

Perez, J. R. O. (2002). Ovinocultura: Alguns Conceitos. In: SEVETUnB, 4 Brasilia, Resumos, Brasilia: Pp.152

Reyes, S. N, Sporndly. E, Ledin I (2006). Effects of Feeding Different Levels of Foliage from *Moringa oleifera* to Creole Dairy Cows on Intake, Digestibility, Milk Production and Composition. *Journal of Livestock Science*, 101(1-3):24 - 31

Robert, S. S. (2016). Blood Biochemistry Encyclopedia Britannic, Inc.208Pp

Safa M.A. and El -Tazi (2012). Effect of Feeding Different Levels of *Moringa oleifera* Leaf Meal on the Performance and Carcass Quality of Broiler Chicks. *International Journal of Science and Research*, 3(5): 147 - 151

Sarah Robson, (2007) Prussic acid poisoning in livestock. www.dpi.nsw.gov.au/prime facts

Sarwatt, S.V., Kapange, S.S., Kakengi, A.M.V.,(2002). Substituting Sunflower Seed-cake with *Moringa oleifera* Leaves as a Supplemental Feed to Goat in Tanzania. *Journal of Agro forestry System*, (56): 241 - 247

SAS (2002). Statistical Analysis System. Guide for personal computer Version 9.1. SAS Institution Inc. Carry NC, USA

Smith, A.J., (1990). Poultry. In: The Tropical Agriculturist. First edition, Macmillan Publishers, Wageningen, Pp. 218

Smitha Patel P. A., S.C. Alagundagi and S. R. S Salakinkop. (2013). The Anti-nutritional Factors in Forages. A Review. *Current Biotica*,6(4):516 - 526, 2013, ISSN 0973-4031.

Sodamade, A., Bolaji, O. S. and Adeboye, O. O. (2013). Proximate Analysis, Mineral Contents and Functional Properties of *Moringa oleifera* Leaf Protein Concentrate. *Journal of Applied Chemistry*, 4(6):47 - 49

Soetan K. O. and O.E. Oyewole, (2008). The Need for Adequate Processing to Reduce the Anti- Nutritional Factors in Plants used as Human Foods and Animals Feeds: A Review. *African Journal of food science*. 3 (9):223 - 232

Tadele Yilkal (2015) Important Anti-Nutritional Substances and Inherent Toxicants of Feeds. *Food Science and Quality Management*, Volume.36

Tesfaye, E., G. Animut, M. Urge, and D. T. Tadelle. (2012). Effect of Replacing *Moringa oleifera* Leaf Meal for Soybean Meal in Broiler Ration. *Global Journal of Science Frontier Research*, (1):1 - 5

Tijani, L. A, Akanji, A.M, Agbalaya, K. and Onigemo, M. (2016). Effects of *Moringa oleifera* Leaf Meal on Performance, Nutrient Digestibility and Carcass Quality of Broiler Chickens. *Applied Tropical Agriculture*, 21 (1) 46 - 53

WAC, (2006). World Agro forestry Center, Spreading the Word about Leaf Meal, Spore, (125):6

Walter, H. L., L. Funny C., Charles & R., Christian (2002) Minerals and Phytic Acid Interaction: Is it a Real Problem for Human Nutrition. *International Journal of Food Science Technology*, (37):727-739

Wheater, P.R., Burkish, H. G. and Daniel, U.G. (1987). Functional Histology. ELBS Chuchill H.Q. Living Stone, Zambia. 280 - 320

Zanu, H.K., Asiedu, P. Tampuori, M., Asada, M., Asante, I. (2012). Possibilities of Using Moringa (*Moringa oleifera*) Leaf Meal as a Partial Substitute for Fishmeal in Broiler Chickens Diet. *Online Journal of Animal and Feed Resources*, 2(1):70 - 75