ANALYSIS OF DIFFERENT POULTRY FEEDS AND THEIR EFFECT ON SOME BLOOD PARAMETERS IN BROILERCHICKS

BY

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CERTIFICATION

I declare that this research was independently carried out by **Dennis-Eboh Uche** in the Department of Biochemistry, Faculty of Science Delta State University Abraka for the award of M.Sc. Degree in Biochemistry and has not been carried out by any one for the award of any Diploma or Degree.

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DEDICATION

This dissertation is dedicated to God Almighty who gave me the gift of life and health, for sustenance, love and understanding. To Him be the glory and honour forever.

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ABSTRACT

The research was conducted to evaluate four different commercial feeds used in Nigeria. The feeds are Rainbow Feed (A), Animal Care Feed (B), Top Feed (C) and Jakee Feed (D). A total of forty (40) cochin broiler chicks were used for the study which lasted for a period of two weeks. The forty (40) broilers were divided into four different groups and were fed with the four different feeds for a period of two weeks. Feeds and clean water was supplied twice daily. Proximate analysis for the four feeds were performed to ascertain the nutrient content and to compare with what was written on the feeds' label. The result of the proximate analysis showed that Rainbow Feed and Top Feed had the highest percentage crude protein, followed by Animal Care and the least was in Jakee Feed. The protein content of all the Feeds obtained in this study except Top Feed did not correspond to the manufacturers claimed values. The average weekly weight gains of the birds were not statistically different (p>0.05). The mean serum urea concentration of birds fed with Top Feed was significantly increased than those fed with Rainbow Feed and Animal Care (P< 0.05). There was no significant difference observed in the serum concentration of calcium for all the boiler chicks fed with the different feeds (P> 0.05). The serum activity of Aspartate aminotransferase (AST) concentration of birds fed with Jakee Feed was significantly increased than those fed with Rainbow Feed, Animal care feed and Top Feed (P< 0.05). The serum activity of Alanine aminotransferase (ALT) concentration of birds fed with Rainbow Feed was Significantly increased than those broiler chicks fed with Animal Care feeds and Jakee feed (P< 0.05).The nutritional analysis of the different feeds and their effect on some of the blood parameters in broiler chicks shows that these feeds met the requirement of the birds and does not have any adverse effect on the boiler chicks. Conclusively, all the four different commercial diet used in this study are good and recommended for broiler production.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Poultry has now turned into one of the most important division of agriculture throughout the world. Poultry industry is one of the fastest growing segments in agricultural sector and undoubtly, it plays an important role in Nigeria economy (Burker and Saeed, 2014).Poultry is basically a source of economical, palatable and healthy food protein (Mahasar *et al.,* 2010).Broilers are chicken (*Gallus domesticus*) bred and raised specifically for meat production (Kruchten, 2002). The behaviour repertoires of broiler chickens are similar to those of other gallinaceous birds since they are the same species as egg laying hens. Broiler chicks today are the most widely grown birds throughout the world as the fastest source of animal's protein (FAO 1994). In the light of the above, Oluyemi and Robert (1979) reported that broiler keeping has been recognized to provide a method by which rapid transformation of animal protein can be achieved. Broilers are best meat producers because of their ability to put on much weight in the shortest possible time. The short production cycle of boiler chicks is one of the special characteristics of poultry production that provides animal protein for human feeding (Edney *et al.,*2014). Broiler chicks are also easy and convenient to distribute over a wide territory. With the increasing human population, the consumption of meat is increasing in the world and intensive animal production has many more challenges to solve including environmental pollution and animal welfare (Ishibashi and Yonemochi*,* 2002).

The growth of poultry industry was very impressive from the 60's to the 80's. At 1986, Nigeria has the largest poultry contribution in black Africa and was substantial (Okunaiya, 1986). The poultry industry in Nigeria is gaining rapid recognition and attention due to the high demand of animal protein. Poultry products are among the most important food items in Nigeria that cut across all barriers of religions, race and age class all over the world. Due to the rapid growth of human population in Nigeria, there is need to build food strength to ensure socio-economic stability productivity of human life (Addass *et al.,* 2010). It is therefore important that poultry farming be carried out efficiently for high productivity and sustainability of the industry in Nigeria. It has been established that feeding constitutes over 70% of the total cost of egg and broiler production (Afolayan and Afolayan, 2008) which implies that efforts to increase poultry industry productivity should be directed towards improving the quality of the feed. However, countries like Nigeria where there is competition between human and animal, the proportion is higher (Fetuga, 1997; Larmorde *et al.*, 1981, Igboeli, 2000).

Poultry feed is food for farm poultry including chickens, ducks, geese and other domestic birds. Feed for poultry must consist of grain. The quality of feed and the nutritional requirement of feed depend on the weight and the age of the poultry as well as the season. The quality of feed has significant effects on growth and performance of poultry birds. Poultry feed consist of various macro and micro components. Poultry feed industry is closely connected to the primary agricultural production and forms an essential component of the food chain. These components are mostly supplied by different agricultural and industrial by products or wastes (Anjum and Naseem, 2000, Farhat and Mohammed, 2014). In the last two decades the number of poultry has been raised up to the level that it is not very easy to sustain the growth rate of fifteen percent per annum. In this view the major problem faced by the industry is the availability of quality feed. Furthermore proper storage facilities are insufficient which results to fungal contamination of poultry feed. In the developing countries it is one of the common trends that the high quality cereals and grains kept, stored are exported for human use while the low quality agricultural products are used for manufacturing animal feeds (Sarah *et al.*,2016).

Healthy poultry requires sufficient amount of protein and carbohydrate along with the necessary vitamins, dietary minerals and adequate supply of water, for optimum growth, maintenance, finishing work, reproduction and production (Addass *et al.*, 2010). It is frequently recognized that feed correspond to the major expenditure of the poultry production. Nazri (2003) reported that in poultry production the most important component is the ratio amongst the feed and egg/meat.

Enzymes are biochemical macro molecules that control metabolic activities of an organism. Therefore a variation in enzyme activity would affect the organism (Roy, 2000). As biological catalyst which helps to accelerate the activities of chemical reaction in organism's body aminotransferases (both the alanine amino-transferase and aspartate amino-transferase) function as links between carbohydrate and protein metabolism by the interconversion of strategic compounds like α - ketoglutarate and alanine to pyruvic acid and glutamic acid, a process known as transamination (Knox and Greenyard, 1965; Marking, 1992). It has also been observed that serum urea, total protein and creatinine contents depend on both the quality and quantity of protein supplied in the diet (Iyayi and Tewe, 1998). Calcium is one of the most important ions in the body as it is utilized in bone and structural organization, enzyme function, blood coagulation, in osmotic pressure and maintenance of fluid balances and is essential in muscle activity. Urea is formed in the liver and is mainly excreted in the kidneys.

1.2 Statement of the Problem

The quality of food nutrients has been known to be one of the correlational factors that determine animal health statues. Poultry feed nutrients has been reported to predict the quality of protein and essential nutrients in poultry feeds. Being aware that poultry products represents one of the most important food items in Nigeria that cut across all barriers of religions, race and age class all over the world, the problem of this study is hinged on determining the nutrient quality of poultry feeds and the effects of these feeds on certain serum biochemical parameters.

1.3 Objective of the Study

The objective of the present study was to analytically characterize different broiler poultry feeds commercially available in Nigeria, for their nutritional constituents.

1.3.1 Specific Objectives

The specific objectives of this study are as follows.

i. Determine the Protein content of selected poultry feeds.
ii. Determine the ash content of selected poultry feeds
iii. Determine the moisture content of selected poultry feeds.
iv. Determine the carbohydrate contents of selected poultry feeds.
v. Determine the fat and oil content of selected poultry feeds.
vi. Determine the effect of selected poultry feeds on some selected serum parameters.

1.4 Significance of the Study

This study will provide useful information as whether the feeds met the nutritional requirement of poultry feed under study and whether they are health friendly to poultry birds.

1.5 Justification of the Study

Different feeds give different results in terms of growth and egg production. To attain the exact quantities of nutrients, it is important to balance the ratio of diets. A small number of the feed mills are serious in sustaining the quality of feeds. In view of the inadequate accessibility and varying sources of diverse feed ingredients, the level of nutrients in the finished products may be different from what is in reality required (Addass *et al*., 2010). In evaluating these feeds, it is important to also check the effects of such feed resources on the health status of the livestock. Serum parameters have been shown to be major indices of physiological, pathological and nutritional status of an organism and changes in the constituent's compounds of blood when compared to normal values could be used to interpret the metabolic state of an animal as well as quality of feed (Babatunde *et al.,* 1992; Obikaonu *et al.,* 2012). With such evidences from research it becomes imperative that the quality of different feed products and their effects on certain serum biochemical parameters be assessed.

1.6 Scope of the Study

The scope of this study covers the assessment of selected poultry feeds (Rainbow feeds, Animal care feeds, Top feed and Jaakee feed) nutritional quality and the effects of these feeds on selected serum parameters.

CHAPTER TWO

LITERATURE REVIEW

2.1 Poultry Nutrition

Nutrition can be defined as the science involving various chemical and physiological activities which transform feed elements (nutrients) into body elements and activities. It is the process of anabolism, assimilating or transforming food into living tissue. It is called constructive metabolism or tissue building and the cells in the body are responsible for the transformation into different tissues. Nutrition can be defined as the sum of the processes whereby an organism provides itself or it is provided with the materials (nutrients) necessary for energy release, growth, repair, various secretions, storage, transport, maintenance of internal osmotic and pH environment. It involves the ingestion, digestion, transportation, absorption and assimilation of the various nutrients and their transportation to all body cells and the removal of unusable elements/by-products and waste products of metabolism (Leeson and summers, 2005).

Nutrition, in essence, aims at providing all essential nutrients in adequate amounts and in optimum proportions. In other words, nutrition is the scientific way of how feed is used by the body of man, rabbit and other farm animals. Nutrition is one of the major constraints to survival and satisfactory productivity of livestock in this country. Feeds and feeding constitute about 65-75% of total production cost in intensive livestock production (Oyediji, 2001)e.g. poultry and pig production, hence, the ability to judiciously manipulate feed ingredients to maximize productivity is therefore central to the maintenance of a stable poultry production enterprise(Fetuga,1997; Larmorde *et al*,1981, Igboeli 2000). The rapid success and expansion of the livestock industry, therefore depends on the availability of good quality, quantity and cheap compounded feeds. This is particularly true of the intensive livestock enterprises – poultry, pigs and rabbits, whose performance depends mainly on the use concentrate and balanced compounded feeds.

2.2 Poultry Diet in General

Poultry diets are made primarily from a mixture of several feedstuffs such as cereal grains, soybean meal, animal byproduct meals, fats, vitamin and mineral premixes (Long, 1984; Alimon and Hair-Bejo, 1995).They are known as complete feed since they contain all the necessarynutrient essential for proper health of the body, egg production and growth

(Bale et al., 2002). A poultry diet is expected to contain three essential nutrients of protein, vitamins, and minerals as well as provides adequate metabolizable energy. Energy is very critical in poultry feed, in fact, the more the energy loaded in the ration, the less feed the birds would consume (Larbeir and Leclercq, 1994). For broilers, diets of high energy content promote fast growth, and therefore their metabolizable energy (ME) contents should generally not be less than 12.2MJ/kg of the feeds (Whitehead,1985).

Broiler diet is the type of feed fed as a complete feed to meat – type birds. It may be in crumbles or pellet forms. The diet is usually given within the first 2 to 3 weeks to chickens. Higher energy and nutrient content, especially protein/ amino acids, are required. The diet may contain 3 to 5% added fat to increase the energy content and the protein content is adjusted to maintain an optimum protein: caloric ratio (NRC, 1994).

2.2.1. Qualities of a Good Poultry Feed

Some of the qualities of good poultry feed include,

A) Balanced nutrition: Increased weight gain and greater profit are realized with a balanced diet.

B) Diversified in feedstuffs: Different feedstuffs allow for diet balancing.

C) Succulent: Poultry consume more feed if it is fresh and appealing.

D) Palatable: Poultry consume more feed if it tastes good.

E) Temperature and density: bulk density of diet and ambient temperature can affect feed intake of the birds.

F) Economical: Low cost, high quality diets keep the producer in business.

G) Suitable for the animal: Livestock or ruminant animal feeds are not appropriate for poultry (NRC 1994).

2.2.2 Importance of Well-Balanced Diets in Poultry

Most poultry species are omnivores, which in nutritional terms means, that they have a simple digestive system with non-functional caeca. Exceptions to this general rule include geese and ostriches, which have well-developed functional caeca. The digestive tract of poultry has more organs but is shorter than that of other domestic animals. The unique features of this digestive tract include the crop, which is a storage organ, and the gizzard, which is a grinding organ. In fast-growing meat chickens, it takes less than three hours for feed to pass from mouth to cloaca and for nutrients to be digested and absorbed. To compensate for the relatively short digestive tract and rapid digesta transit time, high-performing birds need easily digested, nutrient-dense diets (Lesson *et al.,* 2009).

2.3 Nutrient Requirement

The nutritional requirements of the poultry animal are essential for good performance. However the qualities and proportion differ depending on the nature, purpose and age of the birds. The considerable percentage of ash, protein content etc. justify the feed types. The rates of genetic change in growth and feed efficiency over the years have also changed the physiology of the birds. Nutrient requirements and nutritional management have therefore changed to satisfy the genetic potential of the new strains. The high genetic potential of current poultry strains can only be achieved with properly formulated feeds that are protein and energy-dense. Poultry, especially growing birds, are unique among domestic animals in that any change in nutrition is reflected in bird performance almost immediately. This phenomenon has been successfully exploited by the commercial poultry industry to improve growth, carcass yield and egg production.Aletor and Daramola, (1989) reported the success of poultry production to depend largely on the quality of feeds, based on their nutritional formulation.

Historically, recommendations on nutrient requirements have been based on available literature and data from expert groups. Currently, however, because each specific genotype has its own requirements, most commercial feed formulations use minimum requirements recommended by the breeding companies that supply the chicks. Poultry require nutrients to maintain their current state (maintenance) and to enable body growth (weight gain) or egg production. Birds need a steady supply of energy, protein, essential amino acids, essential fatty acids, minerals, and vitamins and, most important, water. Poultry obtain energy and required nutrients through the digestion of natural feedstuffs, but minerals, vitamins and some key essential amino acids (lysine, methionine, threonine and tryptophan) are often offered as synthetic supplements(Ravindran *et al.*, 1991; 1992; 1993)

2.3.1 Sources and Importance of Energy

Poultry can derive energy from simple carbohydrates, fat and protein. They cannot digest and utilize some complex carbohydrates, such as fiber, so feed formulation should use a system based on available energy (Scott and Dean 1991). Metabolizable energy (ME) is the conventional measure of the available energy content of feed ingredients and the requirements of poultry. This takes account of energy losses in the faeces and urine. Birds eat primarily to satisfy their energy needs, provided that the diet is adequate in all other essential nutrients. The energy level in the diet is therefore a major determinant of poultry's feed intake. When the dietary energy level changes, the feed intake will change, and the specifications for other nutrients must be modified to maintain the required intake. For this reason, the dietary energy level is often used as the starting point in the formulation of practical diets for poultry.

Different classes of poultry need different amounts of energy for metabolic purposes, and a deficiency will affect productive performance. To sustain high productivity, modern poultry strains are typically fed relatively high-energy diets. The dietary energy levels used in a given situation are largely dictated by the availability and cost of energy-rich feedstuffs. Because of the high cost of cereals, particularly maize, the use of low-energy diets for poultry feeding is common in many developing countries. (Ravindran and Blair, 1991) Although, poultry try to control the consumptions of feed to achieve minimum energy intake from diets containing different energy levels, these adjustments are not always precise. From an experiment with large number of broiler chicken, the data showed that changes in feed intake were not inversely proportional to changes in dietary energy level especially when broilers were fed moderate to high energy diets (Fisher and Wilson, 1974). It was also shown that growing broilers and turkey consume more energy when feed high energy diets than those fed low to moderate energy diets (Sell, 1988; Owings and Sell, 1982). Broilers and laying hens can generally regulate the intake of energy more precisely when fed with relatively low-energy diets (Morris, 1968; Fisher and Wilson, 1974; Latshaw *et al.*, 1990).It has been reported that birds on high fibre diet are unable to completely satisfy their energy and protein intake due to limitation imposed by the fibre in the diet (Hocking 2006).

2.3.2 Carbohydrate

Dietary carbohydrates are important source of energy for poultry. Cereals grains such as corn, grain, sorghum, wheat and barley contribute most of the carbohydrate to poultry birds starch is readily digested by poultry (Moran 1985a) while polysaccharides such as cellulose, hemicelluloses, pentosans and oligosaccharides such as stachyose and raffinose, all of which are poorly digested by poultry. As a result, it has little contribution to energy requirement of poultry and some adversely affect the digestive processes of poultry when present in sufficient dietary concentration.

Bredford *et al*., (1991) showed that Pentosan's of rye and beta glucans of baley increase the viscosity of digesta and thereby interfere with nutrient utilization by poultry. Supplementation of rye or barley -containing diet with appropriate supplemental enzyme preparations improves nutrient utilization and growth of young poultry (Long *et al*., 1962; 1989; Friesen*et al.*, 1992).

2.3.3 Protein and Amino Acids

Protein is essential in all animal life. Protein makes up a large part of the muscle, skin beak feathers cartilage andinternal organ of animal. The dietary function of protein is to supply amino acids for maintenance, muscle growth and synthesis of egg protein (Ravindran and Bryden, 1999). The synthesis of muscle and egg proteins requires a supply of 20 amino acids, all of which are physiological requirements. Ten of these are either not synthesized at all or are synthesized too slowly to meet the metabolic requirements, and are designated as essential elements of the diet. These need to be supplied in the diet. The balance can be synthesized from other amino acids; these are referred to as dietary non-essential elements and need not be in feed formulations (NRC 1994).

From a physiological point of view, however, all 20 amino acids are essential for the synthesis of various proteins in the body. The essential amino acids for poultry are lysine, methionine, threonine, tryptophan, isoleucine, leucine, histidine, valine, phenylalanine and arginine An under supply of a single essential amino acidwill inhibit the responses to those in adequate supply (Alimon and Hair – Bejo 1995, Fanatico, 2010) In any protein the limiting amino acid is the one which is below the standard. For poultry, methionine is the first limiting amino acid while lysine is the second limiting amino acid. In addition, some consider glycine to be essential for young birds. Cysteine and tyrosine are considered semi-essential amino acids, because they can be synthesized from methionine and phenylalanine, respectively (NRC 1994). Of the ten essential amino acids, lysine, methionine and threonine are the most limiting in most practical poultry diets(Ravindran and Bryden, 1999).

Poultry do not have a requirement for protein per se. However, an adequate dietary supply of nitrogen from protein is essential to synthesize non-essential amino acids (Scenes *et al* 2004) This ensures that the essential amino acids are not used to supply the nitrogen for the synthesis of non-essential amino acids. Satisfying the recommended requirements for both protein and essential amino acids therefore ensures the provision of all amino acids to meet the birds' physiological needs (Ravindran and Bryden, 1999).

The amino acid requirements of poultry are influenced by several factors, including production level, genotype, sex, physiological status, environment and health status. For example, high levels of lean meat deposition require relatively high levels of lysine. (Scott and Dean 1991) High levels of egg output or feather growth require relatively high levels of methionine. However, most changes in amino acid requirements do not lead to changes in the relative proportions of the different amino acids. There is therefore an ideal balance of dietary amino acids for poultry, and changes in amino acid requirements are normally expressed in relation to a balanced protein or ideal protein (Ravindran and Bryden, 1999).

The crude protein and amino acid status of a dietinfluence the carcass composition of broilers with increased carcass protein and reduced carcass fat accompanying increase in dietary protein or essential amino acid content (Carbel *et al*., 1987). The positive benefits of using supplemental amino acids has been reported to include decreased nitrogen in manure, decreased ammonia emission into the air, decreased water consumption by the experimental birds and decreased manure volume up to 5%. When the CP is lowered the ability of the diet to supply essential amino acids in a ratio that the birds require is impaired (Iyayi *et al.*, 2014)

2.3.4 Importance of Fats and Fatty Acids

Poultry diets usually include fats to achieve the needed dietary energy concentration because of the greater energy density of fat compared with carbohydrates and protein. Fat accounts for about 3 to no more than 5 percent of most practical diets (Lesson and Summer 2005). Other benefits of using fats include better dust control in feed mills and poultry houses, and improved palatability of diets. Poultry do not have a specific requirement for fats as a source of energy, but a requirement for linoleic acid has been demonstrated (Rose 1997).

Linoleic acid is the only essential fatty acid needed by poultry, and its deficiency has rarely been observed in birds fed practical diets. Linoleic acid's main effect in laying birds is on egg size (Ensminger *et al.,* 1990).

2.3.5 Minerals

Minerals are needed for formation of the skeletal system, for general health, as components of general metabolic activity, and for maintenance of the body's acid-base balance (NRC, 1994). Calcium and phosphorus are the most abundant mineral elements in the body, and are classified as macro-minerals, along with sodium, potassium, chloride, sulphur and magnesium. Macro-minerals are elements required in the diet at concentrations of more than 100 mg/kg. Calcium and phosphorus are necessary for the formation and maintenance of the skeletal structure and for good egg-shell quality. In general, 60 to 80 percent of total phosphorus present in plant-derived ingredients is in the form of phytate-phosphorus

Under normal dietary conditions, phytate phosphorus is poorly utilized by poultry owing to the lack of endogenous phytase in their digestive enzymes (Lesson and Summer 2005). It is generally assumed that about one third of the phosphorus in plant feedstuffs is non-phytate and is biologically available to poultry, so the phosphorus requirement for poultry is expressed as non-phytate phosphorus, rather than total phosphorus (Lesson and Summer 2005).. A ratio of 2:1 must be maintained between calcium and non-phytate phosphorus in growing birds' diets, to optimize the absorption of these two minerals. The ratio in laying birds' diets is 13:1, because of the very high requirement for calcium for good shell quality.

Dietary proportions of sodium (Na), potassium (K) and chloride (Cl) largely determine the acid-base balance in the body for maintaining the physiological pH. If a shift occurs towards acid or base conditions, the metabolic processes are altered to maintain the pH, with the likely result of depressed performance. The dietary electrolyte balance is described by the simple formula ($Na^+ + K^+ - Cl^-$) and expressed as mEq/kg diet. Prevention of electrolyte imbalance needs careful consideration, especially in hot climates. Under most conditions, a balance of about 250 mEq/kg of diet appears satisfactory for optimum growth. The overall balance among these three minerals, and their individual concentrations are important. To be effective, their dietary levels must each be within acceptable ranges, not deficient and not excessive. Birds exposed to heat stress consume more water, and are better able to withstand heat when the water contains electrolytes. The replacement of part of the supplemental dietary sodium chloride with sodium bicarbonate has proved useful under these conditions (Lesson and summer, 2005).

Trace elements, including copper, iodine, iron, manganese, selenium, zinc and cobalt, function as components of larger molecules and as co-factors of enzymes in various metabolic reactions. These are required in the diet in only very small amounts. Practical poultry diets should be supplemented with these major and trace minerals, because typical cereal-based diets are deficient in them(Lesson and Summer, 2005). Organic forms of some trace minerals are currently available, and are generally considered to have higher biological availability than inorganic forms.

2.3.6 Vitamins

Vitamins are classified as fat-soluble (vitamins A, D, E and K) and water-soluble (vitamin B complex and vitamin C). All vitamins, except for vitamin C, must be provided in the diet. Vitamin C is not generally classified as a dietary essential as it can be synthesized by the bird. However, under adverse circumstances such as heat stress, dietary supplementation of vitamin C may be beneficial (Lesson and Summer, 2005). The metabolic roles of the vitamins are more complex than those of other nutrients. Vitamins are not simple body building units or energy sources, but are mediators of or participants in all biochemical pathways in the body.They enhance digestion, absorption,metabolism maintenance of weight and egg production.

2.3.7 Water

Water is the most important, but most neglected nutrient in poultry nutrition. Water has an impact on virtually every physiological function of the bird. A constant supply of water is important to:

i) The digestion of feed;

ii) The absorption of nutrients;

Iii) The excretion of waste products; and

iv) The regulation of body temperature. (NRC, 1994)

Water constitutes about 80 percent of the body. Unlike other animals, poultry eat and drink all the time. If they are deprived of water for even a short time, production and growth are irreversibly affected (Lesson and Summer, 2005). Water must therefore be made available at all times. Both feed intake and growth rate are highly correlated with water intake. Precise requirements for water are difficult to state, and are influenced by several factors, including ambient conditions, and the age and physiological status of the birds (Scanes *et al* 2004). Under most conditions, water intake is assumed to be twice the amount of feed intake.

Drinking-water temperatures should be between 10 and 25°C. Temperatures over 30°C will reduce consumption (Hunton, 1995). The quality of water is equally important. Quality is often taken for granted, but poor water quality can lead to poor productivity and extensive economic losses. Water is an ideal medium for the distribution of contaminants, such as chemicals and minerals, and the proliferation of harmful microorganisms. Water quality for poultry can be a major issue in arid and semi-arid regions where water is scarce. In particular, underground water in these areas can have high levels of salt. Saline drinking-water containing less than 0.25 percent salt is tolerated by birds, but can cause sodium toxicity if water intake is restricted (NRC 1994).

2.4.0 Main Ingredients Used In Poultry Feed Formulations

Feed represents the major cost of poultry production, constituting up to 70 percent of the total feed cost, about 95 percent is used to meet energy and protein requirements, about 3 to 4 percent for major mineral, trace mineral and vitamin requirements, and 1 to 2 percent for various feed additives. Poultry diets are formulated from a mixture of ingredients, including cereal grains, cereal by-products, fats, plant protein sources, animal byproducts, vitamin and mineral supplements, crystalline amino acids and feed additives. These are assembled on a least-cost basis, taking into consideration their nutrient contents as well as their unit prices (Kellems and Church, 2010).

Accurate prediction of energy intake is important to formulate diets for poultry during different stages of growth and production (Berura et al., 2016). Energy sources constitute the largest component of poultry diets, followed by plant protein sources and animal protein sources. Globally, maize (corn) is the most commonly used energy source, and soybean meal is a common plant protein source. However, other grains such as wheat and sorghum, and plant protein meals such as canola meal, peas and sunflower meal are also widely used in some countries. The main animal protein ingredients are fishmeal and meat meal.

Almost all developing countries are net importers of these ingredients; the poultry feed industries in Africa and Asia depends on imports, which are a drain on their foreign exchange reserves. Quite often, the semi-commercial and commercial sectors in these countries are forced to limit their output of compounded feeds of grains, particularly maize, from the animal feed market to ethanol production is a major recent development that has caused severe grain supply problems in the world market, with dramatic price increases. With government policies to promote the use of biofuels, the global production of ethanol has rapidly increased in recent years, and further large increases are expected in the future. Despite record prices, the import demand for main ingredients in developing countries continues to increase to meet the feed demands of an expanding poultry sector, putting further pressure on prices.

Paradoxically, the solution for the rocketing price of maize could come from the biofuel industry, through its major co-product – distillers' dried grains with soluble (DDGS) which has been shown to be a good source of available amino acids and energy. Worldwide, feed millers are showing keen interest in DDGS because of its cost-effectiveness and ready availability. Good-quality DDGS is a potentially useful feed ingredient, containing about 25 percent protein and 10 percent fat, and rich mineral and vitamin resources. The amino acid availability in DDGS is similar to that in soybean meal. This may be the only raw material whose supply is assured and will increase in the future (FAO, 2012).

2.4.1 Main Energy Source

The predominant feed grain used in poultry feeds worldwide is maize. This is mainly because its energy source is starch, which is highly digestible for poultry. In addition, it is highly palatable, is a high-density source of readily available energy, and is free of anti-nutritional factors. The metabolizable energy value of maize is generally considered the standard with which other energy sources are compared. In North America and Brazil, the feed industry has benefited from surplus maize, resulting from increased mechanization and the application of genetic and agronomic techniques to raise productivity. In the Asian and African regions, however, maize yield per hectare is low, and in most countries, production has never been sufficient to meet the needs of the growing human population. The net result is a continuing shortage of maize for feed use in these regions (FAO, 2012).

The other energy source that meets most of the same criteria as maize is low-tannin sorghum. Sorghum can be grown in low-rain fall areas and is a popular crop in hot, drought-prone regions. The high tannin content of many older sorghum varieties limits their use in poultry diets, but low-tannin varieties are now available and can be used in poultry diets without any limitation. The energy value of low-tannin sorghum is 90 to 95 percent that of maize (Kellems and Church, 2010).

2.4.2 Main Sources of Plant Protein

After energy-yielding raw materials, protein supplements constitute the largest component of poultry diets. Plant protein sources supply the major portion of dietary protein (or nitrogen) requirements. The plant protein source traditionally used for feed manufacture is soybean meal, which is the preferred source for poultry feed. Soybean meal contains 40 to 48 percent crude protein, depending on the amount of hulls removed and the oil extraction procedure. Relative to other oilseed meals, soybean protein has a good balance of essential amino acids, which can complement most cereal-based diets. The amino acid availability in soybean meal is higher than those for other oilseed meals. The metabolizable energy content is also substantially higher than in other oilseed meals (Kellems and Church, 2010).

Raw soybeans contain several anti-nutritional factors, including protease inhibitors, which can negatively affect protein digestion and bird performance. However, these inhibitors are destroyed by heat during the processing of soybean meal. Properly processed soybean meal is an excellent protein source for all classes of poultry, with no restrictions on its use. Soybean production has increased substantially over the past two decades to meet the rising demands for oil for the human food market and meal for the animal feed market. The major producers of soybeans are the United States, Brazil and Argentina, which are also the major exporters. More than 50 percent of the current crop is now genetically modified (GM), mainly for herbicide tolerance, and there is an ongoing debate and campaign to reject GM ingredients from animal diets. If GM sources are not accepted in the market place, the potential for further nutritional quality enhancement and increased productivity will be limited (FAO 2012). The prevailing scarcity and cost of conventional plant protein supplements such as full fat soybean meal and groundnut cake have resulted in the recent high cost of commercial feeds and poultry products in Nigeria (Ogbonna, 2000).

2.4.3 Main Sources of Animal Protein

With the notable exception of soybean meal, plant protein sources are generally nutritionally imbalanced in terms of essential amino acids, particularly lysine, and the first limiting amino acid in cereals. Unless supplemented with animal protein sources and crystalline amino acids, plant-based diets may not meet the requirements for critical amino acids for egg and meat production. Owing to their high prices, animal protein ingredients are normally used to balance the amino acid contents of diets rather than as major sources of protein. In many countries, feed manufacturers ensure that animal protein ingredients do not fall below minimum levels in poultry diets, especially for young birds whose amino acid requirements are high (Ensminger *et al.,* 1990). The requirements for essential amino acids are progressively reduced as the birds grow older, and it is possible to meet the needs of older birds with diets containing lower levels of animal protein and relatively higher levels of plant protein. Fishmeal and meat meal are the animal protein sources most widely used in poultry diets

2.4.3.1 Fish Meal

Fishmeal is an exceptionally good source of high-quality protein, and its price usually reflects this. It also provides abundant amounts of minerals (calcium, phosphorus and trace minerals), B vitamins and essential fatty acids. The presence of unidentified growth factors is another feature of fishmeal. Feed formulations therefore seek to ensure minimum levels of fishmeal in diets. Fishmeal consists essentially of dried, ground carcasses of fish. Good-quality fishmeal is brown, but the colour varies according to the type of fish used and the processing conditions. A very dark colour is indicative of overheating, which can destroy amino acids, reduce amino acid availability and substantially lower the protein quality (Ravindran and Blair, 1993).Fishmeal is an important – sometimes the only – source of animal protein ingredients in most developing countries.

It is either imported or locally produced. Local fishmeal typically contain between 40 and 50 percent crude protein, compared with more than 60 percent protein in imported fishmeal. Local fishmeal is generally of low quality owing to lack of control over raw fish quality, processing and storage conditions. They are often adulterated with cheap diluents, including poor-quality protein sources (dried poultry manure, oilseed meals), urea and non-nutritive diluents such as sand.

Some fishmeal may be objectionable because of putrefaction, impurities or excessive salt content. Samples containing as much as 15 percent salt are not uncommon (FAO, 2012).This situation underlines the lack of quality control measures in most developing countries. As salt has laxative and growth depressing effects, the salt content of fishmeal should be carefully monitored; it should be less than 3 percent for best results, but legally may be up to 7 percent. The correct quantity of fishmeal to include depends on the types of cereal and oilseed meals in the feed formulation. The cost of fishmeal is another important determinant.

In general, average inclusion levels may be up to 8 percent for young birds, and less than 4 percent for older meat birds and layers. Higher levels must be avoided in finishing and laying diets, as they may lend a fishy taint to meat and eggs. Use of fishmeal can compensate, to an extent, where husbandry conditions are less than ideal (Ravindran and Blair,1992).

Future expansion possibilities in fishmeal production are limited. Production does not seem to have increased over the past 20 years, and is unlikely to do so in the future, given the pressures on world fisheries. Fishmeal is included in the overall animal proteinban in Europe, and there is also an underlying concern about possible pollutant (e.g., dioxin) levels in fishmeal.

2.4.3.2 Meat Meal

Meat meal contains relatively high levels of protein, calcium and available phosphorus. Meat meal is the dry-rendered product from mammalian tissues, excluding hair, hooves, horns, hide trimmings, blood and stomach contents, except in such amounts as occur in good slaughterhouse practice. Meat meals are derived mainly from bones and associated tissues such as tendons, ligaments, some skeletal muscle, gastrointestinal tract, lungs and condemned livers. Variation in the proportions of these raw materials contributes to the large variations in meat meal quality.

Depending on the proportion of bone to soft tissue used in the manufacture, the finished product is designated as meat meal (containing more than 55 percent crude protein and less than 4.4 percent phosphorus) or meat and bone meal (containing less than 55 percent crude protein and more than 4.4 percent phosphorus) (Kellems and Church, 2010).Collagen is the major protein in bone, connective tissue, cartilage and tendon, and contains no tryptophan. In poor-quality meat meals, 50 to 65 percent of total protein may be collagen. Increasing the level of bone in meat meal lowers the nutritive value and the quality of its protein may vary greatly in terms of amino acid composition and digestibility. Protein quality is also affected by the temperature used to process the meat meal.

As a supplement to cereal-based diets, meat meal is of lower quality than fishmeal or soybean meal. Tryptophan is the first limiting amino acid in meat meal for poultry fed maize-based diets; lysine and methionine are also limiting (Kellems and Church*,* 2010). Normally, no more than 10 percent meat and bone meal is recommended for use in poultry diets, largely because phosphorus requirements are met at that level. In recent years, feed manufacturers have to cope with increasing safety concerns, exemplified by the bovine spongiform encephalopathy (BSE) crisis, associated with the feeding of meatmeal to ruminant animals. The use of meat meal in animal feed manufacture is now banned in some parts of the world, and the long-term future of this raw material seems uncertain (Kellems and Church, 2010; FAO, 2012).

2.4.3.3 Fibre

Fibre is a polymeric plant substance that is resistance to mammalian digestive enzymes and among nutrients constituting poultry feeds, the level of fibre inclusion in poultry feed is very low. Increasing the level of fibre may enhance performance (Sklan *et. al*., 2003).Dietary fibre in poultry feed helps to increase the retention time of the digesta in the upper part of the digestive tract i.e. from the crop to gizzard and stimulate proper gizzard production (Hetland*et. al.,* 2005). Fibres helps in the production of hydrochloric acid in the proventriculs, gastrointestinal motility, reducing gizzard P^H which will improve the solubility and absorption of mineral salt in gastrointestinal tract benefits the development he gastrointestinal ac improve he growth performance o he birds (Matoes *et al*., 2006, Moran, 2006).

2.4.3.3.1 Sources of Fibers

One of the major sources of fiber in Nigeria is wheatbran and it is also used in breakfast cereals thus increasing the cost of the poultry feed ingredients (Okon and

Olowoyin, 2007). Other sources used in livestock include millet chaff, millet bran, sorghum bran, corn cobs, brewerdried grain maize bran, cowpea shell e.t.c (Oluoku and Olalokun, 1999; Agunbiade *et al.,* 2003). The addition of different fibre sources in the poultry diet has the ability to improve lean carcass, lower production cost, promote bowel movement which aids digestion and supply nutrients such as vitamins, minerals and some unidentified factors which improve growth and reduce the cost of wheat barn (Ojewale *et al*., 2001 and Maidala and Bello, 2016).

2.5 Feed Supplements and Additives

The objective of feed formulation is to derive a balanced diet that will provide appropriate quantities of biologically available nutrients required by the bird. In addition to energy and protein, formulations contain supplements to provide minerals, vitamins and specific amino acids. These supplements must be added to all diets as they provide essential nutrients necessary for health and performance. Modern feed formulations also contain a diverse range of non-nutritive additives, which may not be essential but have an important bearing on performance and health. In many cases, the need for their inclusion is well understood: A major factor to be considered in selecting these additives is their efficacy. Feed supplements and additives are used in only small quantities, and it is particularly important that they are mixed carefully with the main ingredients so that they are evenly distributed (Ensminger *et al*., 1990).

2.5.1 Mineral Supplements

It is only part of birds mineral requirements is provided by the natural feedstuffs in their diets. Mineral supplements must therefore be included in feed formulations. Some sources of minerals include oyster shell and limestone which are both rich in calcium. Common salt can satisfy the bird's sodium chloride requirement. Trace mineral requirement are usually met by supplementation via the vitamin/ mineral premix.

2.5.2 Major Minerals

Poultry require relatively large amounts of some minerals, such as calcium, phosphorus and sodium. Calcium and phosphorus are needed for normal growth and skeletal development, and poultry have unusually high requirements for calcium during the period of egg production, for the formation of strong egg shells. The calcium supplements commonly used in poultry feeding are limestone, crushed sea shells or sea-shell flour. Limestone powder can be included at no more than 3 percent, because higher levels will lower feed intake. It is therefore necessary to provide the extra calcium needed by high-producing layers as shell grit or limestone grit (Scanes *et al.*., 2004). Calcium (Ca), Zinc (Zn), Magnesium (Mg) and Phosphorus (P) are responsible for healthy bones, skin, feathers development as well as strong egg shells and good hatching rate (Aganga *et al*., 2000).

To meet the phosphorus needs of poultry, formulations must be supplemented with inorganic phosphorus sources. In diets containing fishmeal and meat and bone meal, supplementation with inorganic sources may not be necessary. The inorganic phosphates used in poultry diets are dicalcium phosphate, bone meal, rock phosphate, defluorinated phosphate and tricalcium phosphate, all of which supply both calcium and phosphorus. It is important that the inorganic phosphates are obtained from reliable sources, as contamination with fluorine can be a problem in some regions.

Excess levels of fluorine in the phosphate source can adversely affect bird performance. A recent development in phosphorus nutrition has been the availability of commercial phytase enzymes, which assist the bird's digestion and utilization of the phosphorus bound in phytic acid. This enzyme improves the availability of phosphorus from plant materials and reduces the need for inorganic phosphates in feed formulations. This enzyme is a non-nutritive additive (Ensminger *et al.,* 1990)

Common salt is included in all diets as a source of sodium and an appetite stimulant. Salt is added in poultry diets at levels of 0.2 to 0.4 percent. Excessive salt increases water consumption and leads to wet excreta. The use of salt can be lowered or even omitted if more than 5 percent fishmeal is used in the diet. Most formulations also contain 0.2 to 0.3% sodium bicarbonate (common baking soda); inclusion of this substance is particularly important in hot climates. When environmental temperatures are high, birds increase their respiration rate to increase the rate of evaporative cooling, thereby losing excessive amounts of carbon dioxide. This may be reflected in reduced growth rate and a decline in egg-shell quality, often seen in high-producing layers. Under these conditions, the replacement of part of the supplemental salt with sodium bicarbonate is recommended.

2.5.3 Trace Minerals

These elements are required in the diet at concentrations in trace amounts, usually about 0.01 percent. Trace minerals (zinc, copper, iron, manganese, cobalt, selenium) are therefore usually added in the form of propriety premixes.

All vitamins, except vitamin C, must be provided in the diet. Vitamins are required in only small amounts, and are usually provided in propriety vitamin premixes, which can be purchased from commercial suppliers. Although vitamin premixes represent only 0.05 percent of the diet, they can have a large effect on bird performance.

2.5.4 Crystalline Amino Acids

Pure forms of individual amino acids are now commercially available. Currently the limiting amino acids in poultry diets – methionine, lysine, threonine and tryptophan (in that order) – can be purchased at reasonable cost and included in poultry diets to balance dietary amino acid levels. Amino acid supplements now play a very important role in improving protein utilization in animal feeding (Kellems and Church, 2010). Iyayi (2014) in his research concluded that reduction of crude protein content supplemented with lysine or methionine in broiler diets resulted in reduced feed intake and suboptimal body weight gain of the broilers.

2.6. Non-Nutritive Additives Used In Poultry Feed Formulations

Poultry formulations also contain an array of substances known as “feed additives”. These are non-nutritive substances usually added in amounts of less than 0.05 percent to maintain health status, uniformity and production efficiency in intensive production systems. These additives have now become vital components of practical diets. Table 1 presents a list of commonly used feed additives.

Two recent developments relating to feed additives deserve special mention. First, there is increased interest in the use of feed enzymes to improve the utilization of nutrients in raw materials and to reduce feed cost. Improvements in nutrient availability are achieved by one or more of the following mechanisms:

i) Degradation of specific bonds in ingredients not usually degraded by endogenous digestive enzymes;

ii) Degradation of anti-nutritive factors that lower the availability of nutrients;

iii). Increased accessibility of nutrients to endogenous digestive enzymes; and

iv). Supplementation of the enzyme capacity of young animals. Enzymes widely used in the poultry industry are the carbohydrases that cleave the viscous fibre components in cereals (Table 1) and phytases that target the phytic acid-complexes in plant ingredients (Kellems and Church, 2010).

More recently, technically successful enzyme preparations for use in maize-soybean diets have become available. Future advances in feed enzyme technology will involve the development of enzymes that can be used to target the anti-nutritive factors in non-traditional feedstuffs and improve their feeding value. The second development is the recent ban on the use of in-feed antibiotics in animal feeds in some countries. In other countries, the number of in-feed antibiotics available for use in poultry diets has been restricted. Antibiotics have been used in poultry diets for many years as protection against pathogens and sub-clinical diseases, and for the resulting improved growth (Lesson et al., 2009). The withdrawal of this preventive measure has serious implications for the productivity of birds, encouraging considerable research effort into finding potential alternatives for antibiotics, some of which are listed in Table 1.

TABLE 1: Non-Nutritive Additives Commonly Used In Poultry Feed Formulations

Additive	Examples	Reasons for use
Enzymes	Xylanases, ß-glucanases, phytase	To overcome the anti-nutritional effects of arabinoxylans (in wheat and triticale), ß-glucans (in barley) or phytate (in all plant feedstuffs); to improve the overall nutrient availability and feed value
Antibiotics1	Avilamycin,virginiamycin, zinc,bacitracin, avoparcintylosin,spiramycin	To control gram-positive, armful bacterial species in the gut; to improve production efficiency; as a prophylactic measure against necrotic enteritis
Coccidiostats	Monensin, salinomycin, narasin	To prevent and control the clinical symptoms of coccidiosis Pigments Xanthophyll (natural and synthetic) To increase yolk colour in eggs and to improve the skin colour and appearance of carcasses
Antioxidants	Butylated hydroxy toluene (BHT), butylated hydroxyl anisole (BHA), ethoxyquin.	To prevent auto-oxidation of fats and oils in the diet
Antifungals		To control mould growth in feed; to bind and mitigate the negative effects of mycotoxins
Antibiotic replacers2 i. Direct-fed microbials	Probiotics	To provide beneficial species such as lactobacilli and streptococci.
ii. Prebiotics	Fructo oligosaccharides (FOS), mannan oligosaccharides(MOS)	To provide beneficial species such as lactobacilli and streptococci. To bind harmful bacteria
iii. Organic acids	Propionic acid, diformate	To lower gut pH and prevent the growth of harmful bacteria
iv. Botanicals Herbs, spices, plant extracts,		To prevent the growth of harmful essential oilsbacteria
v. Antimicrobial Lysozyme, lactacin F		To prevent the growth of harmful proteins/ peptides lactoferrin, α-lactalbumin bacteria

1 The use of avoparcin, zinc bacitracin, spiramycin, virginiamycin and tylosin phosphate as animal feed additives was banned in the European Union in 1998.

2 Envisaging a total ban on in-feed antibiotic use, a multitude of compounds (individually and in combination) are currently being tested. (FAO 2012).

2.7 Animal Food Safety and Regulation

Animal feeds are routinely subject to contamination from diverse sources, which may have serious consequences on the safety of foods of animal origin. Thus, there is need for the regulation of feed due to problems like bovine spongiform encephalopathy (BSE), melamine and dioxin contaminations, outbreaks of food-borne bacterial infections, and potential microbial resistance to antibiotics which have affected the public in rescent years.

Given the direct links between feed safety and the safety of foods of animal origin, it is essential that feed production and manufacture procedures meet stringent safety requirements.

Some sources of feed contamination are high priorities in all production systems and countries:

i) Mycotoxins (or fungal toxins);

ii) PathogenicBiological agents; and

iii) VariousChemicals.

These agents may contaminate feed at any stage of production up to the point of feeding, and can result in hazards in food of animal origin. Biological agents and chemicals normally enter the feed supply under specific conditions. Mycotoxins are more widespread, however, particularly in developing countries, because of improper agricultural, storage and processing practices. Not only do mycotoxins represent a food safety issue, but they can also have serious consequences on poultry performance. (Sinha and Bhatnagar, 1998; Diaz, 2004; Weidenborner, 2008)

2.7.1 Disease-causing biological agents

Poultry feed may be the source of human illness resulting from the consumption of poultry products. The agent of major concern in poultry feeds is salmonella, which is associated with food poisoning in humans. The principal manifestation of human salmonellosis is gastroenteritis. Salmonella is widely distributed in nature, and animal feed is only one of many sources for farm animals. Feedstuffs of animal origin are particularly frequently contaminated with salmonella. Salmonella contamination can be avoided by sourcing and using salmonella-negative feedstuffs in diet formulation. Heat treatments of varying severity are commonly used to ensure the microbiological quality of animal feed. (Cliver and Rieman, 2002)

2.7.2 Chemical contamination

A wide range of chemicals can enter the feed production system, intentionally or unintentionally. Potential hazards include veterinary drugs, agricultural chemicals (e.g., pesticides, fungicides), industrial chemicals (e.g., dioxin), heavy metals (e.g., mercury, lead, cadmium) and adulterants (e.g., melamine). These chemicals can accumulate in animal tissues, or are excreted in milk or incorporated in eggs, and cause health problems in humans. Some veterinary drugs, such as antibiotics and coccidiostats, are routinely included in poultry feeds as additives.

In meat-producingbirds, the problem of drug residues in meat are overcome by providing a withdrawal diet containing no drugs for seven to ten days prior to slaughter. However, the possible development of microbial resistance due to the use of antimicrobials in animal diets has become a major public concern in recent years. As a result, the use of in-feed antibiotics is either banned or restricted in the poultry industries of developed countries.

Most other chemical contaminants enter feeds through plant materials, especially cereals and treated seeds. The levels of chemicals in plant materials are closely related to the levels of soil contaminants where they are grown. Similarly, animal fats used in formulations may contain high levels of lipid-soluble contaminants if they are produced from feed grown in polluted areas (Tollefson, 1999)

2.8 The Role of Poultry in Human Nutrition

Chicken meat and eggs provide not only high-quality protein, but also important vitamins and minerals. Worldwide, 2 billion people depend on rice as their staple food. Most eat polished white rice stripped of many essential fats, the B complex vitamins and several minerals. Other cereal grains are usually deficient in critical nutrients. For example, maize (corn) is a staple food in some regions, but the niacin it contains is unavailable. Maize consumption without supplements causes pellagra. Invariably the protein content of grains is low and of poor quality.

Net protein utilization (NPU) is an index of protein quality, calculated by multiplying protein digestibility by biological value. NPU of grains is generally less than 40. Rice is the exception, with NPU of about 60, but it is low in protein (7.5 percent). NPU of chicken eggs is 87. Generally, cereals lack the most important amino acids for humans – lysine, threonine, the sulphur-bearing amino acids (methionine and cysteine) and occasionally tryptophan.

Eggs and chicken meat are rich in these essential amino acids. Eggs are also high in lutein which lowers the risk of cataracts and macular degeneration, particularly among people living in developing countries. In the least developed countries, the projected increase in egg consumption between 2005 and 2015 is 26 percent, compared with only 2.4 percent in the most developed countries. Corresponding annual projections for poultry meat are 2.9 percent and 1.6 percent, respectively (FAOSTATS).

2.9 Advantages of Chicken Meat and Eggs Compared To Other Animal Proteins

In developing countries, the diet of people living in cities usually contains more animal protein than that of rural people, mainly because urban people are more prosperous, but also because they generally have access to a wider variety of foods at local markets. In low-income countries, commercially produced chicken meat is well placed to satisfy the demands of a rapidly increasing affluent, middle class who can afford to pay for broiler chickens. Facilities and infrastructure for producing broiler chickens can be established quickly and soon start generating. Not only is chicken meat seen as a healthy meat, but it is also the cheapest of all livestock meats. A major advantage of eggs and poultry meat as human food is that there are no major taboos on their consumption. In addition, a chicken provides a meal for the average family without the need for a refrigerator to store left-overs. Meat from other livestock such as pigs and cattle is kept mainly for special festive occasions and celebrations, partly because of a lack of storage facilities (no refrigerator or electricity supply). Eggs can be purchased relatively cheaply and in small numbers. One egg is almost a meal in itself and when hard-boiled will last for several weeks. It can be taken to school safely by children for lunch.

2.10 Aspartate Aminotransferase (AST) and Alanine Aminotransferase (ALT) in The Serum

A variety of static and dynamic markers of liver injury or function are widely used in the detection of assessment of injury form and severity, determination of functioning liver mass, prognosis and response to medical management. Each marker as inherent deficiencies in sensitivity and no single method appear capable of completely discerning the etiology, severity and prognosis associated with a given injury (Friedman *et al*., 1996, Kaplan., 1993). Serum or plasma concentrations of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) are commonly used to assess hepatic injury (Friedman *et al*.,1996). However, because the aminotransferases are not specific to the liver and can be released under other conditions, it is often difficult to ascribe small abnormalities in their plasma activities to hepatic damage. In addition, the aminotransferases, which are found mainly in periportalhepatocytes are relatively insensitive markers of damage to centrilobular hepatocytes, the cells most prone to damage by halothane, alcohol, toxins, and hypoxia.

Enzymes activities in birds are variable and originates from different organs.Aspartate aminotransferase (AST) is a widely distributed enzyme, which is found in many tissues and organs, with high activity in the liver (Zimmerman *et al*.., 1968; Brugere – picoux *eta*l.,1987). Increased AST activity in the serum is a sensitive marker of liver damage (Ahmed *et al*., 2013) but they provide only a static estimate of the amount of recent damage and no indication of residual functional capacity (Tygstrup,1990, Clermont and Chalmers.,1967). There are two main isoenzymes: mitochondrial and cytosolic, which prevails in the total concentration in the blood plasma because it has a longer half-life (Kramer and Hoffman, 1997; Rej, 1978). Activity of AST in horses is much higher than in other animals (Cornelius*et al*., 1958). In addition to species, breed and age, AST activity is influenced by muscle activity (Weightert*et al..,* 1980).

In primates, dog, cat, rabbit and rat, alanine aminotransferase (ALT) is a specific cytosol liver enzyme, and its increase in the blood plasma is specific for changes in the liver, but ALT activity in pigs, horses, goats, sheep and cattle is not specific for the liver, in order to have a diagnostic significance (Kramer and Hoffman, 1997). ALT activity in the blood plasma is influenced by age and muscle activity (Weightert *et al.,* 1980).Aminotransferases respond to any stress or altered physiological condition (Knox and Greengard, 1965). Depressed AST and ALT activities suggest a decrease in energy demand, metabolic pathway and amino acids. However, in other studies (Ayalogu, *et al*., 2001; Svoboda*et al*.., 2001; Tiwari and Singh, 2004) an increase in the activities of AST and ALT was recorded indicating that there was an increased demand for energy due to tissue impairment. Contrariwise, elevation of ALT and AST reflect hepatic disease, some inflammatory disease or injury to the liver-hepatic cellular damage (Ayalogu*et al*.., 2000; Svoboda*et al.,* 2001). Both the amino-transferases (alanine and aspartate) function as link between carbohydrate and protein metabolism by the interconversion of strategic compounds like α-ketoglutarate and alanine to pyruvic acid and glutamic acid, a process known as transamination (Knox and Greenyard, 1965; Marking, 1992).

2.11 Urea

Urea is formed in the liver and is mainly excreted by the kidneys. Consequently urea is useful in evaluating kidney function in conjunction with creatinine which originates from the muscle and is filtered by the kidney. The majority of the blood urea is synthesized in the liver from ammonia. Once formed, urea diffuses freely throughout all body fluids. The kidney is the most important route of urea excretion and as a result, urea has long been used as a barometer of renal function. Urea appears in the glomerular filtrate in the same concentration as is found in the blood. This filtration process does not require energy. Decreased glomerular filtration increases urea. Some urea is passively resorbed from the tubules back into the blood. The amount resorbed is inversely related to the rate of urine flow through the tubules the lower the urine flow rate the greater the tubular urea reabsorption resulting in an increased urea.

An increase in urea may be considered under three categories:

1. Prerenal - Fever, infection, tissue necrosis and corticosteroid administration and circulatory changes may all result in urea elevation. Increased protein digestion resulting from intestinal bleeding will likewise cause an increase. Anything that decreases glomerular filtration will increase urea. A high protein diet may also affect the urea concentration.

2. Renal - Increased urea values are seen when approximately 75% of the nephrons become non-functional. As such urea may reach much higher levels (greater than 36 mmol/L) than found in pre-renal uraemia but lower values may also be renal in origin.

3. Post-renal - Urea increases as a result of obstruction of the urinary tract and may reach very high values (90 mmol/L). The magnitude of the increase is dependent on the degree of the obstruction. Urinalysis, especially urine specific gravity, is useful in determining whether elevated urea is pre-renal, renal or postrenal. With pre-renal uraemia urine specific gravity generally is greater than 1.030 in the dog and 1.035 in the cat, while renal uraemia has a lower urine specific gravity.

2.12 Calcium

Calcium determinations are important in evaluating profiles. These evaluations should always be included in profiles evaluating animal health or disease processes. Calcium is one of the most important ions in the body. It is utilized in bone and structural organization, enzyme function, blood coagulation, in osmotic pressure and maintenance of fluid balances, and is essential in muscle activity. As such, calcium interrelates with any other system and has a close relationship to many enzymes and values measured in a profile.

One of the important requirements in the reproduction cycle of the female birds is the calcium element. This requirement has been reported by Gilbert and Wood-Gush (1971); Taylor *et al*. (1962). The plasma level of this element has been well established in the domestic fowl. In the guinea fowl, dietary calcium requirement (2.75%) is said to be higher than that for the lengths recorded for domestic fowl. Carew and foss, (1982), determined the thickness of the eggshell and found it to be 620µ. This is about 1.7 times that of the domestic fowl, which is estimated to be 300 to 430µ.

The majority of calcium in circulation exists as protein-bound and ionised calcium. Calcium in both forms is normally measured and reported as a total calcium value. When evaluating calcium, it is important to relate total calcium to the quantity of albumin in the serum and the acid-base status of the animal. The total calcium concentration can increase in hyperalbuminaemia and decrease in hypoalbuminaemia.

Acid-base changes alter the ratio of ionised to protein-bound calcium. Acidosis increases the ionised calcium fraction, whereas alkalosis increases the protein-bound fraction.

Therefore total calcium, albumin and bicarbonate levels are important in evaluating calcium concentrations and related diseases.

Primary renal failure may itself cause an elevation of total calcium (so called tertiary hyperparathyroidism), this being quite a common finding in young animals with congenital renal disease. Thus the presence of persistent hypercalcaemia should always prompt careful examination of renal parameters such as creatinine, urea and also phosphate. The calcium phosphorus product is particularly important in this respect since it determines the risk of calcium and phosphorus precipitating out in tissues and leading to renal damage through nephrocalcinosis.

Persistent hypercalcaemia in the absence of hyperalbuminaemia in the dog (and cat) is highly diagnostically significant since it immediately implicates one of a short list of possible underlying aetiologies. These are hypercalcaemia of malignancy (the most common cause in the dog), primary hyperparathyroidism, vitamin D toxicity, Addisons disease and tertiary renal hyperparathyroidism. The last is usually obvious due to advanced signs of renal failure. Hypercalcaemia of malignancy (HCM) is most frequently caused by lymphosarcoma (often cranial mediastinal) but may also be due to apocrine anal gland carcinomas and other diverse carcinomas. It has also been reported in cases of multiple myeloma. Most tumours causing HCM do so by releasing an embryonic growth factor called PTH-related peptide which binds to the PTH receptor and mimics its actions. With these inter-relationships, it is important to evaluate a complete profile to analyze why calcium might be altered.

2.13 Review of Some Proximate Chemical Analysis of Some Feeds

Addas *et al.* (2010), in their research conducted to evaluate the four most common commercial poultry feeds used in the environs of Adamawa State University (ADSU) Mubi,showed that the proximate chemical analysis of the four starter feeds indicated a crude protein range of 21.01 – 25%, crude fibre (4.00 - 5.10%), ash (2.00 - 2.5%) and NFE (6.2 - 61.0%). In this study significant ($p<0.01$) weekly feed intake and growth performance was recorded on each diet during brooding and finishing stages.

Nworgu *et al.*(2007) also showed that the broiler chicken diet used in their experiment met the requirement of the NRC standard (NRC 1994). It contains 22.12% crude protein, 3.50% crude fibre, 7% ash content and 62.92% NFE.

Onwurah *et al*., 2014, in their study to evaluate the effect of baker's yeast (Saccharomyces cerevisiae) inclusion in feed and in drinking water on performance of broiler birds,showed that thebroiler starter diet used during the starting period met the requirement of NRC recommendation. The proximate chemical analysis contains, Crude protein (%) 22.15, ether extract (%) 3.8, ash (%) 7.51, Crude fibre (%) 3.8, nitrogen free extract (%) 52.74 and metabolisable energy (MJ/KG) 14.45.

A similar research carried out in Parkista also showed that the proximate analysis of the starter broiler feeds used in a recent study by Mahasar *et al*., (2010) contained 7.54-10.38%moisture, 19.83-23.05%crude protein, 2.37-4.70% fat, 3.65-6.25 crude fiber, 4.66 - 10.91%ash, 50.27-57.05% total carbohydrate and 12.82-14.26MJ/kg, energy value. There was significant difference observed in all feed samples with regards to the nutrients concentration (Mahasar *et al.*, 2010).

Bukar and Saeed., 2014 in their studyto evaluate the proximate analysis of some heavy metals in selected poultry feeds in Kano metropolis, Nigeria, showed that moisture content ranged from 11.33 ± 4.48% - 04.98 ± 01.92%, ash content 20.47 ± 12.67% - 09.59± 2.95%, lipid content ranged between 06.91 ± 01.92% - 4.14 ± 1.90%, crude protein range from 2.26 0.4 – 16% ± 11.29%, crude fiber 15.90 16.46 ± 03.41- 0.01%, carbohydrate 50.70 ± 21.63 – 39.67 ± 10.68%

CHAPTER THREES

MATERIALS AND METHODS

3.1 Experimental Diet

For the determination of the proximate analysis of the poultry feeds, experiments were carried out by sampling some of the different poultry feeds used in Nigeria. Each experimental feed sample was purchased from poultry feed stores and these feeds were designated as being appropriate for broiler starter. Poultry feed samples used are Rainbow Feed, Animal Care Feed, Top Feed, and Jakee Feed. The proximate composition of experimental feed is shown in Table 2

Table 2: Proximate Composition of the different experimental Poultry Feeds Used in this research work as stated by the manufacturer

Parameter	Rainbow Feed	Animal Care Feed	Top Feed	Jaakee Feed
	Feed A	Feed B	Feed C	Feed D
Crude protein (%)	24.0	21.0	20min	21.68
Crude fibre(%)	5.5	4max	5max	4
Phosphorous(%)	0.85	0.45	0.50min	0.50
Calcium(%)	1.25	1.00	1.00	1.00
Fat/oil (%)	3.0	2.75	5min	3.43
Energy	2990 Kcal/Kg	2840Kcal/Kg.min	3100kcal/kg.min	2551kcal/kg

3.2 Proximate Analysis

Proximate analysis of experimental samples was carried out at Nigeria Institute for Oil Palm Research (NIFOR), Benin City, Edo State.

The basic nutrient composition of food in terms of protein, fats, crude fibre, ash(minerals), moistureand carbohydrate (nitrogen free extract – NFE), which is usually determined by difference after adding up protein, lipid(fat), ash, fibre and then subtracting the sum from 100. All units are in percentage. NFE = [100 – (lipid% + protein% + ash% + fibre%)]. It usually involved thorough grinding of and mixing of the materials before sample of the true mixture was used for the analysis. In most cases, analysis was carried out on dried sample, except for moisture determination. Result may be reported on either dried or wet matter basis. Here, proximate analysis determination was carried out on the different feed.

3.2.2 Determination of Crude Protein

The estimation of crude protein involved the determination of total nitrogen using the Kjeldahl method described by Nielsen (2003).The amount of crude protein was obtained by multiplying the nitrogen content by 6.25. This factor was based on assumption that all feed proteins contained 16% nitrogen and that all the nitrogen in the tissue was present as protein.

Procedure:

Half gram (0.5g) of the sample was mixed with 10ml of concentrated H_2SO_4 in a digestion flask. A tablet of selenium was added to catalyse the reaction and then heated under a fume cupboard until a clear solution was obtained. The clear solution was diluted to 100ml in a volumetric flask and used for the analysis. 10ml of the diluted solution was mixed with equal volume of 45% NaOH solution in a Kjeldahl distillation apparatus. The mixture was added into 10ml of 4% basic acid containing 3 drops of mixed indicator (bromocresol green and methyl red). A total of 50ml distillate was collected and titrated against 0.02N EDTA from green to a deep red end point. A reagent blank was also digested, distilled and titrated. The N_2 content and hence the protein content was calculated thus,

% protein = % N2 x 6.25

$$\%N_2 = \left(\frac{100}{W} \times \frac{N \times 14}{1000} \times \frac{V_t}{V_a}\right) T - B$$

Where W = weight of sample analyzed (0.5)

$\%N_2$ = Percentage Nitrogen Content

N =Normality of titrant (0.02N H_2SO_4)

Vt= Total digest volume (100ml)

Va = Volume of digest analyzed (10ml)

T = Sample titre value

B = Blank titre value

3.2.3 Moisture Determination

The moisture content of the feeds was determined according to the method described by the AOAC (1990). 5g of dried sample of the feed sample was weighed into a clean, washed, dried petri – dish. The sample was placed in an oven at a temperature for 30 min, transferred to a desiccator, cooled and weighed until fairly constant weight is obtained.

Moisture (%) = (loss of wt / wt of sample) × 100

3.2.4 Ash Content Determination

The ash content of the feed was determined according to the method described by AOAC (1990). 1g of feed sample was placed in muffle furnace at a temperature of 5000oC for 3 hours to ash. The ashed sample was transferred to a desiccator to cool and weighed.

Ash (%) = (wt of ash / wt of sample) × 100

In this process, all organic matter is burnt off. Then for percentage organic matter is (100 – ash %).

3.2.5 Lipid Or Fat Content Determination.

The lipid content of the feed was determined according to the method described by AOAC (1990). Ten grams (10g) of the ground sample was wrapped in an absorbent paper and placed in a soxhlet extract, with a reflux condenser. N- Hexane was used as the extracting solvent and a suitable quality was used to ensure a continuous extraction for 8 h. Before the commencement of the extraction, the weight of the empty clean dry flask was weighed. After 8 h of extraction, the solvent inside the extractor is cleaned and the system dismantled to discontinue the extraction. The sample residue was removed and the solvent removed. The flask was transferred to an oven at $105^{O}C$, heated to expel any hexane remaining in the flask and the flask was transferred to a desiccators, cooled and weighed.

Lipid (%) = [(wt of flask – oil – wt of flask) / wt of sample used] × 100

3.2.6 Fibre Determination

The fibre content of the feed was determined according to the method described by AOAC (1990). Two grams (2 g) of the feed sample was weighed into thoroughly washed and dried 1000ml cornical flask. 200ml of 5% sulphuric acid was added. 5 drops of antifoaming agent (n- octanol) was also added to prevent foaming and loss of sample. The sample was heated to boil in a sand bath for 30min. Distilled water from a washed bottle was used to wash down the sides of the boiling flask, adhering samples to the sides of the flask and maintain a constant volume.

The sample was filtered through a whatman filter paper using a vacuum pump. It was then washed with hot distilled water to neutrality, tested for acid with litmus paper. The sample was washed into a 1000ml conical flask with cold distilled water; 200ml of 5% potassium hydroxide was added and 5 drops of anti-forming agent. It was allowed to boil for 30min, using distilled water to wash down the sides. The sample was filtered through an ashless filter paper and bucknel funnel, with a vacuum pump. Few drops of 5% Hel was added; washed to neutrality with hot distilled water.

Finally, alcoholwas used to wash the sample into thoroughly washed, dried petri-dish. The sample was dried to a constant weight, cooled in a desiccator and weighed (wt2). The sample was then placed in a muffle furnace, and ashed at a temperature of 500OC for 3h. The furnace was cool and the sample finally transferred to a desiccators, cooled and weighed (wt3).

Crude fibre (%) = [(wt2 - wt3)/ wt1]× 100

Wt1 = wt of original sample used.

3.2.7 Determination of Carbohydrate (Nitrogen Free Extract)

The nitrogen free extract NFE referred to as soluble carbohydrate is not determined directly but obtained as a difference after adding up protein%, ash%, fibre% and lipid% (fat oroil) and then subtracting the sum from 100. All parameters are in percentage.

NFE = 100 – [lipid(%) + protein (%) + fibre %) + ash (%)]

3.2.8 Determination of Energy Contents

The energy contents of the feed were determined according to the formular described by AOAC, (1990).

Metabolizable energy (Kcal/Kg) = (crude protein x 37) + (crude fat x 81.8) + (35.5 x NFE)

After the proximate analysis was determined, the experiment was commenced using the feed samples in African Research Laboratories, Otorho-Agbon, Delta State.

3.3 Arrival of Experimental Birds and Design.

Fifty (50) Cochin broiler chicks were purchase at Obohor Agricultural enterprises, Otorho- Agbon, Delta State. The birds were randomly allocated to the four different feeds. Prior to the arrival of the chicks, all necessary sanitary measures were done, which include thorough washing, disinfection using detergent and izal. Three days before the arrival, fresh saw dust of 5cm deep was evenly spread in the poultry house. Lightening and heating equipment including lampterns, charcoal pots were used. Feeders and waterers of rubber boots and a white laboratory coat were used as uniform. Two days before chicks arrival everything was in place and tested. Three to four hours before chicks arrival, all heating and lightening systems were put on, fresh water and feed were also ready on arrival. The chicks were directly carried into the house near sources of heat and light which were randomly assigned to the five different types of diet. Ten birds per diet. Multivitamins in water was used as anti - stress for five days. All treatment and vaccination schedule were duly observed.

All necessary husbandry practices were also duly observed throughout the research period. The birds were weighed at the beginning of the trial and there after weekly. From day one to seven, chicks were fed 20g of feed after which 40g was fed in the second week. Feeding trial lasted for two weeks.

3.3.1 Data Collection

Data were collected on the growth performance and blood parameters. A weighed quantity of feed was fed daily. The birds were weighed at the start of the experiment and weekly: thereafter, percentage mean weekly gain was calculated by dividing the weight difference between day 1 and week1 by day 1 and then multiplied by 100.

3.3.2 Blood Collection and Analysis:

At the end of the experiment, 5 birds were randomly selected from each group and used for biochemical studies. Blood samples were collected with syringe and test tubes from five birds per group making five samples per treatment. Bleeding was done from the punctured wing vein with a 5ml scalp vein needle set. 2ml of blood was collected from each birds into a sterilized bottle and was allowed to stand for some hours to generate serum for biochemical analysis.

3.4 BIOCHEMICAL ASSAY

3.4.1 Determination of Serum Alanine Aminotransferase (Glutamic Pytuvic Transaminase).

The liver alanine aminotransferase measurement was done using a commercially available kit (Randox Laboratories, UK)(Reitman *et al.*, 1957). It is based on the reaction below:

$$\alpha\text{-oxoglutarate} + \text{L-alanine} \longrightarrow \text{L-glutamate} + \text{pyruvate}$$

ALT is measured by monitoring the concentration of pyruvate hydrazone formed with 2,4-dinitrophenylhydrazine

Procedure: 0.5ml of Reagent 1(R1) containing phosphate buffer, α-oxoglutarate and L-alanine was pipette into 2 test tubes containing 0.1ml of sample and 0.1ml of distilled water (blank) according to the manufactural instruction. After mixing and incubating for 30 minutes, 0.5ml of Reagent 2(R2) containing 2,4-dinitrophenylhydrazine was added to both tubes(reagent 1 reagent 2 were used as produced by the manufactural). Finally, after 20 minutes of incubation, 5.0ml of 0.4M sodium hydroxide was also added to the tubes. Thereafter the absorbance (A) of the sample was read against the blank using the spectrophotometer at a wavelength of 546nm after zeroing the spectrophotometer. The activity of ALT was obtained from the calculation table in the instruction manual.

3.4.2 Determination of Aspartate Aminotransferase

The liver aspartate aminotransferase measurement was done using a commercially available kit (Randox Laboratories, UK) (Reitman*et al.,* 1957). It is based on the reaction below:

α-oxoglutarate + L-aspartate $\longrightarrow$ L-glutamate + oxaloacetate

AST is measured by monitoring the concentration of oxaloacetate hydrazone formed with 2,4-dinitrophenylhydrazine

0.5ml of Reagent 1(R1) containing phosphate buffer, α-oxoglutarate and L-aspartate was pipette into 2 test tubes containing 0.1ml of sample and 0.1ml of distilled water (blank). After mixing and incubating for 30 minutes, 0.5ml of Reagent 2(R2) containing 2,4-dinitrophenylhydrazine was added to both tubes. Finally, after 20 minutes of incubation, 5.0ml of 0.4Msodium hydroxide was also added to the tubes. Thereafter the absorbance (A) of the sample was read against the blank using the spectrophotometer at a wavelength of 546nm after zeroing the spectrophotometer. The activity of AST was obtained from the calculation table in the instruction manual.

3.4.3 Determination of Urea

The urea measurement was done using a commercially available kit (Randox Laboratories, UK) (Weatherburn, 1967). It is based on the reaction below:

Urea + H_2O → $2NH_3 + CO_2$

NH_3 +Hypochlorite+ Phenol Indophenols (blue compound)

Urea in serum is hydrolyzed to ammonia in the presence of urease. The ammonia is then measured photometric ally by Berthelot` s reaction.

Procedure:

100ul of Reagent 1(R1) containing sodium nitroprusside and urease was pippete into a test tube containing 10ul of sample, standard and blank. After mixing and incubating at37^{0}C for 10 min, 2.50ml of Reagent 2(R2) and Regent 3(R3) containing phenol and sodium hypochlorite was added and mixed immediately and incubated at 37^{0}C for 15 min. Thereafter absorbance (A) of the sample and standard was read against the blank using the spectrophotometer at a wavelength of 546nm. The colour of the reaction was stable for at least 8h.The activity of urea was obtained from the calculation table in the instruction manual.

3.4.4 Determination of Calcium

Total calcium concentration was determined spectrophotometrically using reagent kit obtained from Randox Laboratories U.K. Reaction principle;

Calcium ions form a violet complex with O- Cresolphthaleincomplexone in an alkaline medium.

Procedure

0.5 ml of Reagent 1(R1) and Reagent 2(R2) containing 2-amino – 2- methyl- propan- l –ol and o-Cresolphthalein complexone respectively was pippete into a test tube containing 25ul of sample, standard and blank reagent. After mixing,the absorbance (A) of the sample and standard was read against the reagent blank after 5 to 50minutes using the spectrophotometer at a wavelength of 546nm.

Calculation

$$\text{Concentration (mg/dl)} = \frac{\text{Asample} \times \text{Astandardconc (mmol/l)}}{\text{Astandard}}$$

3.5 Statistical Analysis

Results were input into the computer and statistical analysis performed using the Statistical Package for Social Sciences (SPSS) software. The one-way analysis of variance

(ANOVA) was utilized in comparing the degree of significance of different parameters estimated and the difference between mean were considered significantly at $p < 0.05$.

CHAPTER FOUR

RESULTS

4.1 Proximate Analysis

Prior to the commencement of some biochemical parameters in the feeds, analysis of experimental samples was carried out to determine the biochemical components of Rainbow feed (A), Animal care feed (B), Top feed (C) and Jakee feed (D). The proximate analysis of the various feeds was analyzed to ascertain the proximate chemical composition (crude protein, moisture, ash, fat and carbohydrate) of each of the diet used in this study.

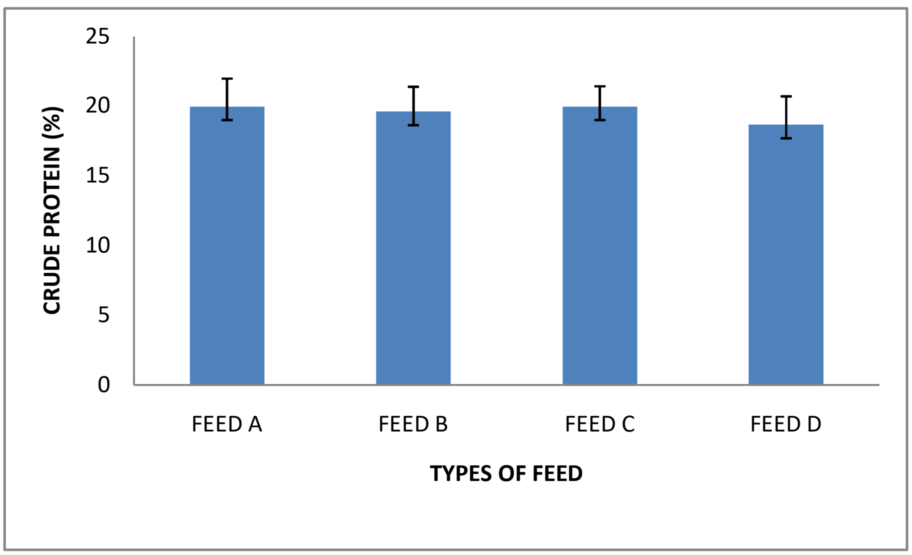


Figure 4.1.1 Crudeprotein content (%) of Rainbow Feed (FEED A), Animal Care Feed (FEED B), Top Feed (FEED C) and Jakee Feed (FEED D).

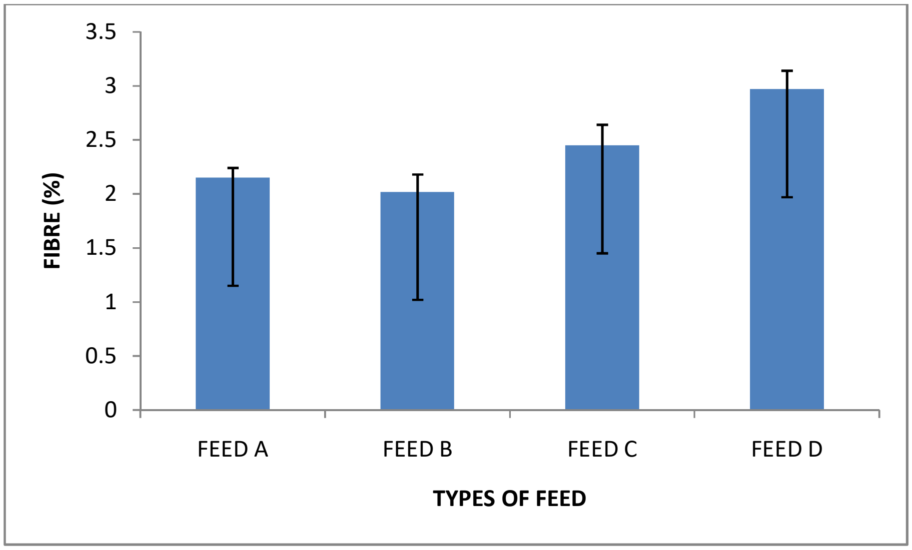


Figure 4.1.2. Crude fibre content (%) of Rainbow Feed (FEED A), Animal Care Feed (FEED B), Top Feed (FEED C) and Jakee Feed (FEED D).

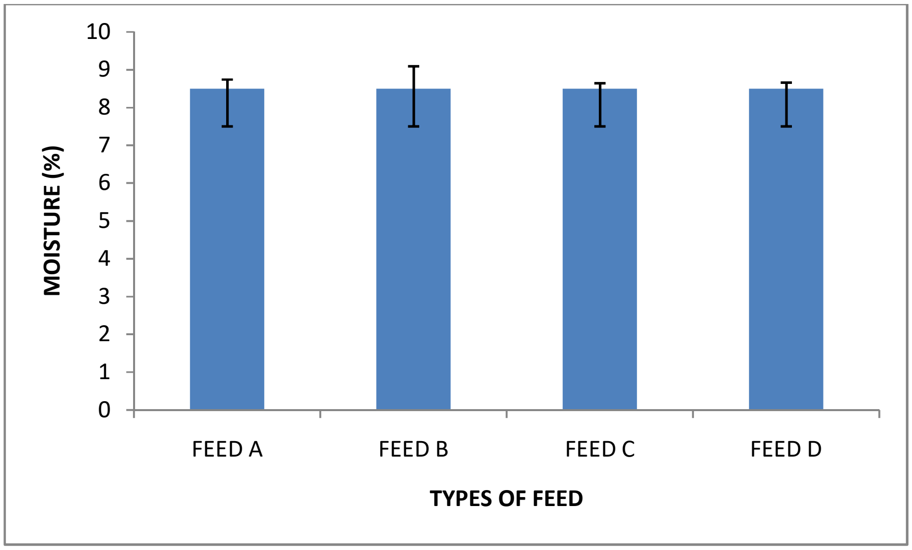


Figure4.1.3.Moisture content (%) of Rainbow Feed (FEED A), Animal Care Feed (FEED B), Top Feed (FEED C) and Jakee Feed (FEED D).

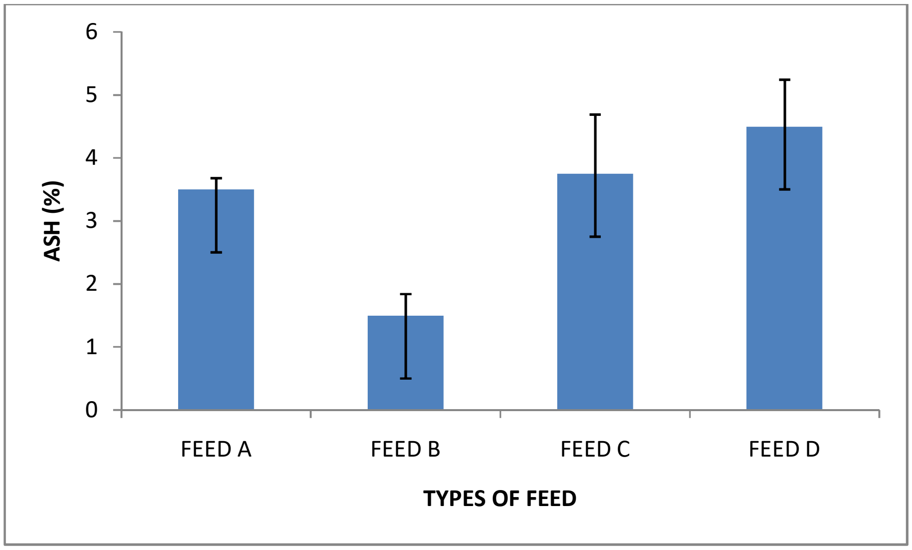


Figure 4.1.4 Ash content (%) of Rainbow Feed (FEED A), Animal Care Feed (FEED B), Top Feed (FEED C) and Jakee Feed (FEED D).

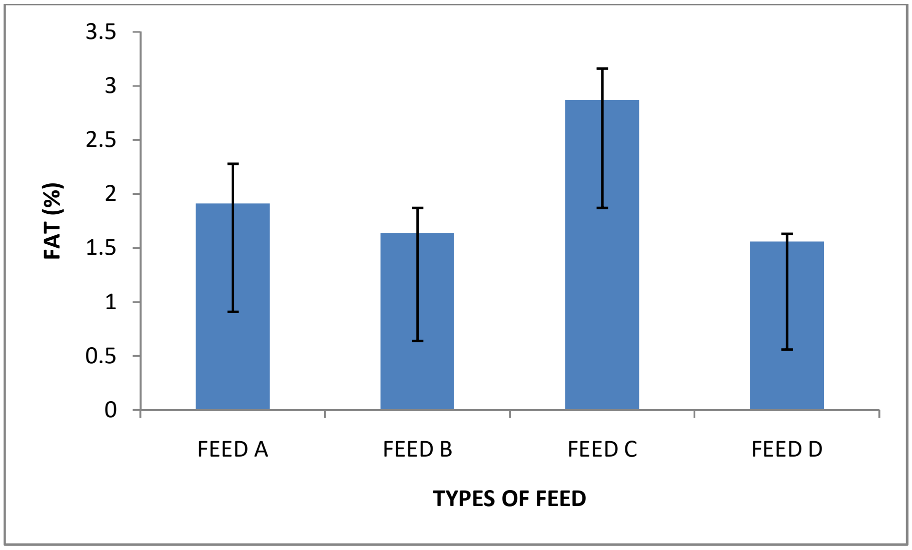


Figure 4.1.5.Fat content (%) of Rainbow Feed (FEED A), Animal Care Feed (FEED B), Top Feed (FEED C) and Jakee Feed (FEED D).

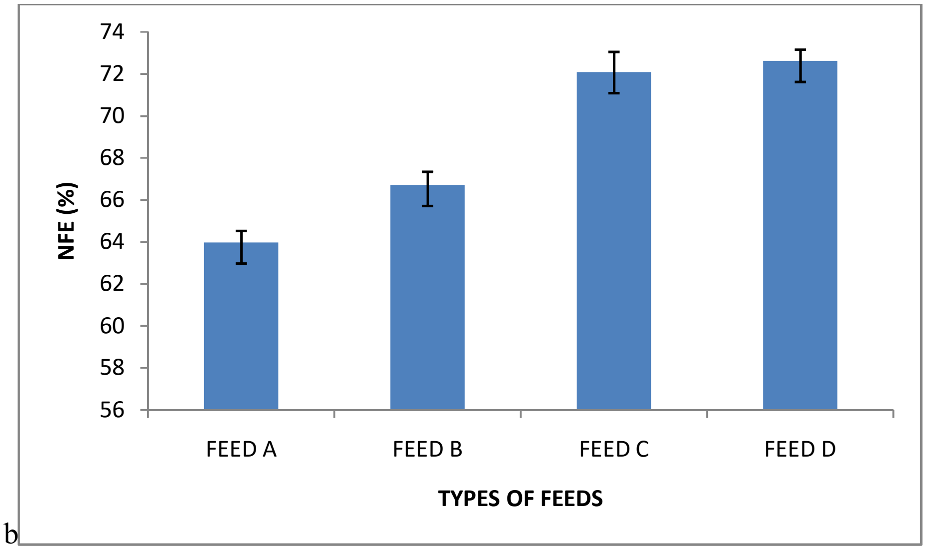
b


FIGURE 4.1.6. Carbohydrate or NFE content (%) of Rainbow Feed (FEED A), Animal Care Feed (FEED B), Top Feed (FEED C) and Jakee Feed (FEED D).

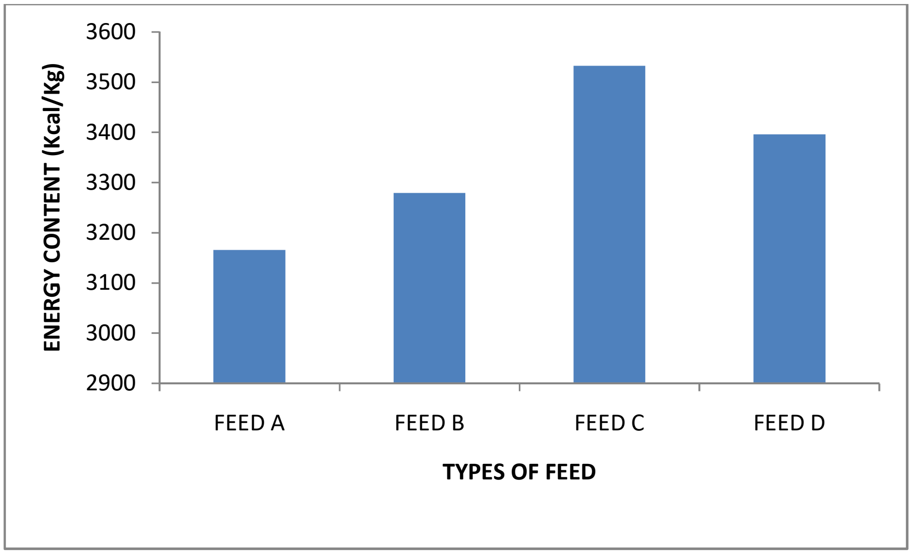


Fig 4.1.7 Calculated Energy content (Kcal/ Kg) of Rainbow Feed (FEED A), Animal Care Feed (FEED B), Top Feed (FEED C) and Jakee Feed (FEED D).

The crude protein (%) content (Table 3) of Rainbow feed, Animal care feed and Jakee feed (19.98%, 19.63% and 18.67%) respectively obtained in the study are lower than those claimed by the manufacturer (24.0%, 21.0% and 21.68%) for Rainbow feed, Animal care feed and Jakee feed respectively. However the crude protein contents (%) of Top feed (19.98%) obtained in this study is equivalent to the manufacturer's claimed value (20%).

The crude fat content (%) (Table 3) of all the feeds (1.91%, 1.64%, 2.87% and 1.56%) obtained in this study are lower than those values (3.0%, 2.75%, 5%, 3.45%) for Rainbow feed, Animal care feed, Top feed and Jakee feed respectively claimed by the manufacturers.

The NFE (%) value (Table 3) (63.98%, 66.71%, 72.08% and 72.62%) obtained in this study are higher than those values (52.29%, 51.78%, 54.95% and 41.31%) for Rainbow feed, Animal care feed, Top feed and Jakee feed respectively claimed by the manufacturers.

The metabolizable energy values (Kcal/Kg) (Table 3) (3166, 3279, 3533 and 3396) obtained in this study are higher than those values (2990, 2840, 3100 and 2551) for Rainbow feed, Animal care feed, Top feed and Jakee feed respectively claimed by the manufacturers.

Table 3: Comparison of manufacturer and present study values of feeds (%) composition and energy levels

Parameter	**Rainbow**		**Animal Care**		**Top**		**Jakee**	
	MV	**PSV**	**MV**	**PSV**	**MV**	**PSV**	**MV**	**PSV**
Crude Protein (%)	24.0	19.98	21.0	19.68	20.0	19.98	21.68	18.67
Fat (%)	3.0	1.91	2.75	1.64	5	2.87	3.45	1.56
NFE (%)	52.29	63.96	51.78	66.71	54.95	72.08	41.31	72.62
Metabolizable Enery (Kcal/Kg)	2990	3166	2840	3279	3100	3533	2551	3396

*Mv = Manufacturer's value *PSV = Present study values

4.2 Weight Gain of the Birds after Two Weeks

Figure 4.2.1. Shows the weight gain of the birds fed with the different feeds. The weight gain of the birds fed with the feeds was highest in FEED C, (218 ± 6.3g), followed by FEED A (211 ± 5.2g), FEED B (201 ± 5.3g), and the least was FEED D (193 ± 5.9g).There was no significant difference observed in all the samples (P> 0.05).

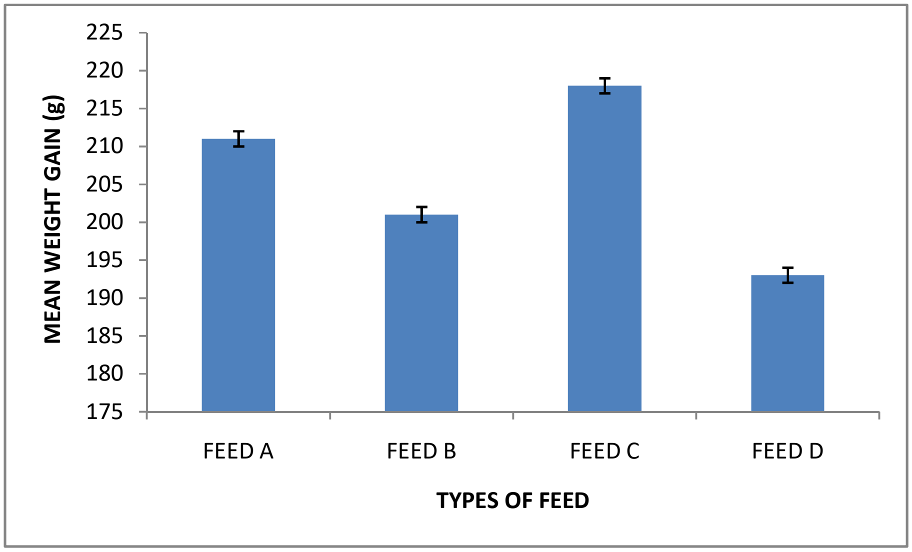


Figure 4.2.1.Weight gain of the birds fed with Rainbow Feed (FEED A), the birds fed with Animal Care Feed (FEED B), the birds fed with Top Feed (FEED C) and the birds fed with Jakee Feed (FEED D).

4.3 Biochemical Effects of Feeds on Broiler Chicks using some Blood Parameters

Values of the blood parameters of birds fed with the different commercial feeds are presented in figure 4.3.1 to 4.3.4

4.3.1 Aspartate Amino Transferase

The serum activity of AST was highest in broiler chicks fed with Feed D (19.69 ± 1.28 U/l), followed by broiler chicks fed with Feed C (10.09 ± 1.05 U/l), broiler chicks fed with Feed A (9.26 ± 0.56 U/l), and the least was broiler chicks fed with Feed B (8.16 ± 0.63 U/l).The serum activity of AST concentration of birds fed with Feed D was significantly increased than those fed with: Feed A; B; and C ($P < 0.05$) as well as the reference value (12 U/l)

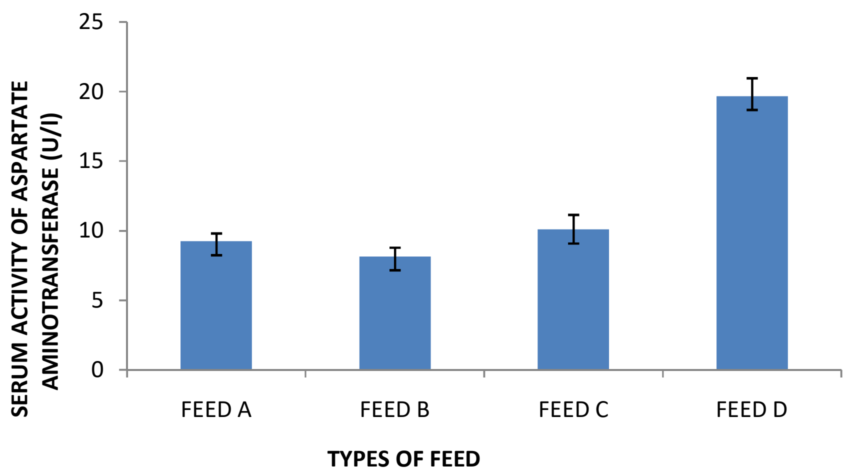


Figure 4.3.1: Serum activity of aspartate aminotransferase (AST) of the birds fed with Rainbow Feed (FEED A) , the birds fed with Animal Care Feed (FEED B), the birds fed with Top Feed (FEED C) and the birds fed with Jakee Feed (FEED D) after two weeks of feeding.

4.3.2 Alanine Amino Transferase

The serum activity of ALT was highest in broiler chicks fed with Feed A (10.37 ± 1.51 U/l), followed by broiler chicks fed with Feed C (8.94 ± 1.35U/l), broiler chicks fed with Feed D (7.67 ± 2.26 U/l), and the least was broiler chicks fed with Feed B (3.28 ± 1.06U/l). The serum activity of ALT concentration of birds fed with Feed A was significantly increased than those broiler chicks fed with: Feed B and D ($P < 0.05$).

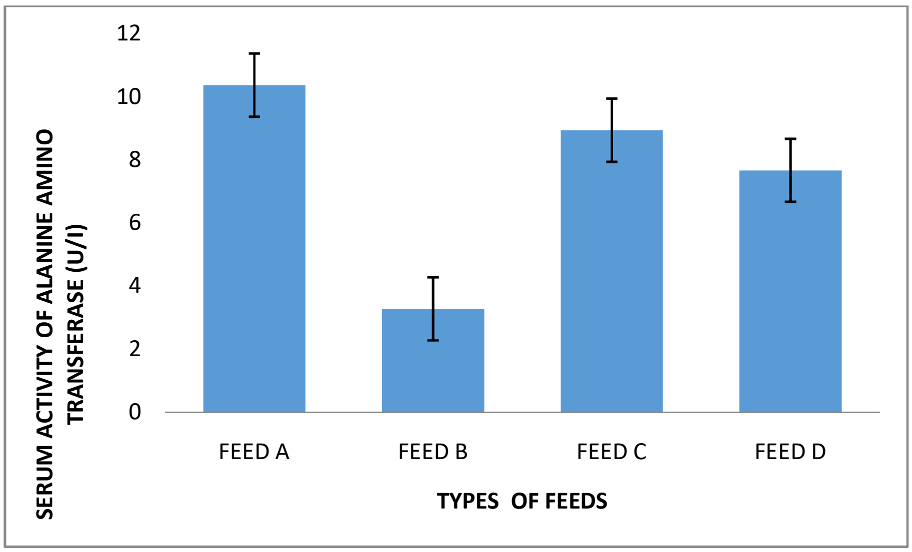


Figure 4.3.2: Serum activity of alanine aminotransferase (ALT) of the birds fed with Rainbow Feed (FEED A) , the birds fed with Animal Care Feed (FEED B), the birds fed with Top Feed (FEED C) and the birds fed with Jakee Feed (FEED D) after two weeks of feeding.

4.3.3 Calcium

The concentration of serum calcium was highest in broiler chicks fed with broiler chicks fed with Feed A (11.78 ± 1.61 mg/dl), followed by broiler chicks fed with FeedC (9.3 ± 0.31 mg/dl), broiler chicks fed with FeedB (9.07± 1.19 mg/dl) and the least was broiler chicks fed with Feed D (8.74 ± 0.31 mg/dl). There was no significant difference observed in the serum concentration of calcium of all the broiler chicks fed with the different feeds ($P > 0.05$).

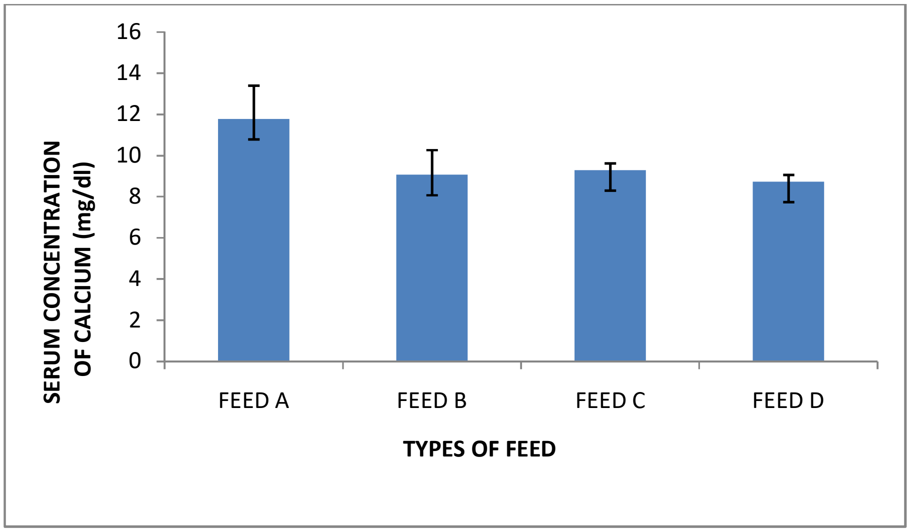


Figure 4.3.3: Serum calcium concentration of the different groups of the birds fed with Rainbow Feed (FEED A) , the birds fed with Animal Care Feed (FEED B), the birds fed with Top Feed (FEED C) and the birds fed with Jakee Feed (FEED D) after two weeks of feeding.

4.3.4 Urea

The serum concentration of Urea was highest in broiler chicks fed with Feed C (33.74 ± 1.72 mg/dl), followed by broiler chicks fed with FeedB (21.59 ± 1.96 mg/dl), broiler chicks fed with Feed A (16.41 ± 2.32 mg/dl) and the least was broiler chicks fed with Feed D (16.22 ± 0.31 mg/dl). The mean serum urea concentration of birds fed with Feed C was significantly increased than those fed with: Feed A and B (P< 0.05).

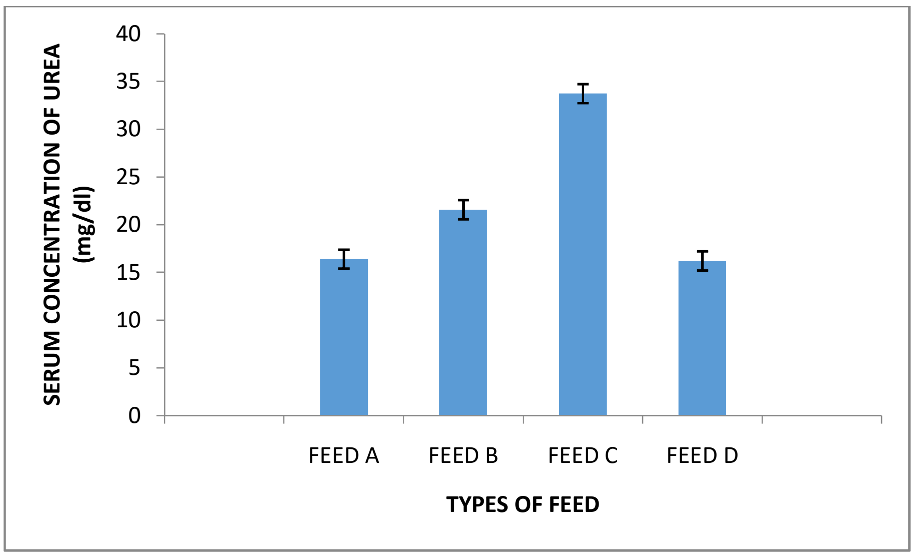


Figure 4.3.4: Serum urea concentration of the different groups of the birds fed with Rainbow Feed (FEED A) , the birds fed with Animal Care Feed (FEED B), the birds fed with Top Feed (FEED C) and the birds fed with Jakee Feed (FEED D) after two weeks of feeding.

CHAPTER FIVE

DISCUSSION, CONCLUSION, RECOMMENDATION AND CONTRIBUTION TO KNOWLEDGE

5.1 Discussion

Successful broiler development is dependent on optimal feed intake throughout the growing period. Optimal feed intake is dependent on a number of factors such as environmental, temperature, diet nutrient density and physical feed quality, which are considered to have a very significant impact on broiler growth (Addass *et al.,* 2010). The hot, humid climate has a negative impact on the performance and well being of broilers. Particularly during summer, the temperature and humidity remains much above the thermally comfortable zone of broilers significantly influencing the metabolizable energy requirement for maintenance (Behuru *et al.,* 2016)

We know that nutrition affects both productivity and welfare of animals and that delayed performance could mean high cost for the producer- a problem borne ultimately by the consumer (Uchegbu *et al*., 2009). The cereal grains that are the major contributors of the carbohydrates to poultry diets occur as starch, which is easily digested by poultry birds (NRC 1994). The nutritional requirements of the poultry animals are essentials for good performance. However, the qualities and proportions differ depending on the nature, purpose and age of the birds. The considerable percentage of ash, fats, crude fiber and protein content justifies the feed types (Arotopin *et al.,* 2007).

Uchegbue *et al*., 2009, reported a low performance of boilers at starter phase which could be a reflection of the stringent requirement for essential nutrient (protein and energy at this stage of life). In this study, the crude protein content (%) (Table 3) in Top Feed (19.98%) was equivalent to the manufacturer's claimed value (20%), while the crude protein content (%) of Rainbow feed, Animal Care feed and Jakee feed (19.98, 19.63 and 18.67%) respectively are lower than the manufacturer's claimed value for Rainbow feed, Animal Care feed and Jakee feed (24.00, 21.00 and 21.68%) respectively.

The addition of different fibre sources in the poultry diet has the ability to improve lean carcass, lower production cost, promote bowel movement which aids digestion and supply nutrients such as vitamins, minerals and some unidentified factors which improve growth and reduce the cost of wheat bran (Ojewale *et.al.,* 2001 and Maidala and Bello, 2016).The crude fiber contents (Fig 4.1.2) are in line with nutritional standards laid down for such groups of chickens (NRC, 1994). The fiber content in poultry ratio are critical as levels above recommendation affects feeds conversion efficiently in birds thus lowers economics of efficient production (Scott *et al.,* 1976; Ensminger, 1980). The fiber contents in this study,inregard to feed ingredients, were found to be within normal range as reported by Bashir *et al.* (2002).

The fat contents (%) (Table 3) in all the feeds in this study was lower than the claimed value of the manufacturers. The Nitrogen free extract and calculated metabolizable energy (Table 3) of the different feed obtained in this study was higher than the manufacturer's claimed values. The recommended energy value (NRC, 1994) for the poultry depends upon the age, stage of production and environmental temperature. The differences between the manufacturers claimed values and the present study values might be as a result of the standards and procedures used.

Significant growth performance was evident in all the experimental birds which might be the response to good management which include feeding of good feeds and general well being of the birds (Addass *et al.,* 2010). There was, however, no significant ($P>0.05$) difference in weight gain (Figure 4.2.1) among the boiler chicks fed with the different feeds.

Biochemical markers play an important role in accurate diagnosis and also for assessing risk and adapting therapy that improves clinical outcome. In the assessment of liver dysfunction, the determination of enzyme levels such as aspartate amino transferases (AST) and alanine aminotransferases (ALT) is largely used(Friedman *et al*., 1996). Elevation AST and AST reflects hepatic injury, some inflammatory disease or hepatic cellular damage (Ayalogu*et al*., 2001, Svoboda *et al*., 2001). Both the amino-transferases (alanine and aspartate) function as links between carbohydrate and protein metabolism by the interconversion of strategic compounds like α - ketoglutarate and alanine to pyruvic acid and glutamic acid respectively, a process known as transamination (Knox and Greenyard, 1965; Marking, 1992). Any abnormal increase in serum activity of AST and ALT may imply liver damage (Yalcin *et al*., 2012, Deepesh *et al*., 2016)).In this study the serum activity of AST concentration of birds fed with Jakee feed was significantly ($p<0.05$) increased than those fed with Rainbow, Animal Care and Top feed as well as the reference value (12 U/l). The significant ($P<0.05$) increase in serum activity of AST observed in the boiler chick fed with

Jakee feed (19.69 U/l) may not suggest liver damage since the serum activity of ALT (7.67 U/l) of birds fed with the same feed was not higher than the reference value (12 U/l).

The significant increase ($p<0.05$) of serum activity of the ALT concentration of birds fed with rainbow feed (10.37 U/l) may not also suggest liver damage since it is lower than the reference value (12 U/l). However the increase in the serum activityof AST observed in Jakee feed may not be due to the feed given but to other factors like changes in serum appearance during blood collection and coagulation, since these feeds are also rich in the basic nutrients previously measured as shown in the proximate analysis (Figures 4.1.1 – 4.1.6). Hence, it could be inferred that the poultry feeds Rainbow, animal care, and Jakee feeds do not appear to induce liver damage, at least, for the period of time under study (0- 2 weeks).

Serum urea levels in animals are indicative of muscular wastage (Fashina, 1991). Higher urea values may be brought about by the inadequacy or unavailability of the dietary protein, poor digestibility or inefficient utilization of the protein (Adesehinwa and Ogunmodede, 2004). Urea is the main nitrogenous end product arising from the catabolism of amino acids that are not used for biosynthetic roles in most vetebrates (Adesehinwa, 2004). Therefore its production reflects alterations in the dietary intake of protein and pattern of utilization. The higher urea and urea nitrogen values obtained with the test diets may be brought about by the inadequacy or unavailability of the dietary protein, poor digestibility or inefficient utilization of the protein (Adesehinwa and Ogunmodede, 2004). According to Egyum, (1970) and Iyayi *et al.,*(1998), serum urea depends on both the quality and quantity of the protein supplied in the diet. High levels of serum urea in the birds could be attributed to the presence of some anti - nutritional factors which might have lowered the quality of the protein indicating imbalances of amino acids in the diet which caused elevated blood urea concentration (Kaneko, 1989). However, kidney malfunction may also raise the level of blood urea. In this study, the serum urea concentration of birds fed with top feeds (33.74 ±1.72 mg/dl) was significantly ($P<0.05$) increased than those fed with Rainbow feds (16.41±2.32mg/dl) and Jakee feeds (16.22±0.31mg/dl).Although, there is a significant increase ($p<0.05$) (Fig 4.3.4) of serum urea (33.74±1.7231mg/dl) in chicks fed with Top feed, this level is not enough to suggest the presence of anti-nutritional factors and kidney malfunction in the broiler chicks since it is not above the reference range (10 – 50 mg/dl).

Calcium is one of the most important ions in the body. It is utilized in bone and structural organization, enzyme function, blood coagulation, in osmotic pressure and maintenance of fluid balances, and is essential in muscle activity. Calcium ions are responsible for healthy bones, skin, feather development as well as strong egg shells and good hatching rate (Aganga *et al*., 2000; Cevger and Yalcin, 2003).Furthermore, the mineral content in the serum of birds is considerably dependent on its mineral concentration in feeds as well as factors influencing the degree of their absorption in the digestive tract (Monika *et al*., 2012).The serum calcium concentrations of the birds in this study were not statistically different ($p > 0.05$) (Fig 4.3.3). The values (11.78, 9.07, 9.3and 8.74 mg/dl) for Rainbow, Animal care, Top and Jakee Feeds in this study are within the normal reference range (8 – 10 mg/dl)(Ritche *et al.,*1994:,Abdi – Hachesoo *et al*.,2011). This suggests that all the feeds contain adequate amount of calcium and the birds were able to metabolize the calcium in the feeds. This finding is very important because rapid growth rate in broiler chicken rearing is often associated with skeletal abnormalities (Scott, 2002).

Calcium deficiency has been closely associated with poor bone formation in birds and other vetebrates, aside other deficiency symptoms. According to Garner *et al.* (2002), birds are unable to effectively eat and drink because of the pain associated with the pathology of leg weakness, usually due to poor bone formation. The experimental birds in this study from day one to the end of this study were able to develop feathers and strong legs which aided them in flying and agile working within the experimental house. This again validates our findings that the feeds are rich in calcium ion which help the poultry birds in the bone and feather formation.

5.2 Conclusion

The data included in this study represented the slight variation among the quality of the poultry feeds from selected manufacturers. Each manufacturer has its own formulation which doesn’t remain constant throughout the whole year but changes according to the constituent of the poultry feeds. The feed used in this study can be concluded to contain the necessary nutrient (protein, ash, crude fibre, moisture, lipid and NFE) essential for the growth of the boiler chicks. Moreover none of the feeds imposed liver damage. Poultry farmers can use this feed for their broiler chicks.

5.3 Recommendation

This study has shown that the four feeds have the required nutrient (protein, fats, NFE, minerals and energy) for broiler production and does not impose any liver damage in the broilers chicks. Therefore, future research should be focused on the biochemistry of other feeds for layers and other animals. This kind of research should be carried out from time to time to check the poultry feed industry.

5.4 Contribution to Knowledge

This research has shown that locally manufactured animal feed are rich in nutrients and are healthy for animal production.

This study also revealed that the locally manufactured feeds have no toxicological effect on the livers.

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APPENDIX

TABLES OF RAW VALUES OF ANALYSIS / RESULT

1. Summarized proximate analysis of Rainbow Feed (FEED A), Animal Feed (Feed B), Top Feed C (FEED C) and Jaake Feed (FEED D).

FEEDS	% NFE	% LIPID	% ASH	% FIBRE	% PROTEIN	% MOISTURE	METABOLIZABLE ENERGY(Kcal/Kg)
FEED A	63.93	1.91	3.50	2.15	19.98	8.5	3166
FEED B	66.71	1.64	1.50	2.02	19.63	8.5	3279
FEED C	72.08	2.87	3.75	2.45	19.98	8.5	3533
FEED D	72.62	1.56	4.50	2.97	18.67	8.5	3396

2. Summarised activity of Aspartate aminotransferase (AST), Alanine aminotransferase(ALT), concentration of Urea and Calcium in the feeds and weight gain of the birds fed with the different feeds.

FEEDS	FEED A	FEED B	FEED C	FEED D
AST(U/I)	9.26 ± 5.2	8.16 ± 0.63	10.09 ± 1.05	19.69 ± 1.28
ALT(U/I)	10.37 ± 1.51	3.28 ± 1.06	8.94 ± 1.35	7.67 ± 2.26
CALCIUM(mg/dl)	11.78 ± 1.61	9.07 ± 1.19	9.3 ± 0.31	8.74 ± 0.31
UREA(mg/dl)	16.41 ± 2.32	21.51 ± 1.96	33.74 ± 1.72	16.22 ± 0.31
WEIGHT GAIN (g)	211 ± 5.2	201 ± 5.3	2.18 ± 6.3	193 ± 5.9

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APPARATUS /EQUIPMENT USED

Soxlet extraction apparatus

250ml round and flat bottom flask

Knife, iron motar and pestle

Electric grinder

Electric oven

Muffle furnance

Water bath

Hot plate

Heating mantle

50ml burettes

Different sizes of pipettes

Cornical flask of various sizes

Petri dish

Ash beaker

Volumetric flasks of different sizes(50ml, 100ml, 250ml, 500ml and 1000ml)

Electrical balance

Spectrophotometer

Dessicator

Funnels

Whatsman filter paper.