PERFORMANCE OF BROILER CHICKENS FED FULLFAT LIMA BEAN, GROUNDNUT AND SOYABEAN DIETS.

BY

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DECLARATION

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

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CERTIFICATION

This thesis entitled "PERFORMANCE OF BROILER CHICKENS FED FULLFAT LIMA BEAN, GROUNDNUT AND SOYABEAN DIETS by Isaac Achi meets the regulation governing the award of the degree of Master of Science of Ahmadu Bello University, and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This work is dedicated to my Parents

Mr. and Mrs. Achi Bonet

My Senior Brothers

Colonel K. G. Achi,

Mr. D. D. Achi

and

above all to God Almighty who attached me to this people,

whose unflinching support led to the success of this work.

ABSTRACT

Seven experimental diels, formulated using lima bean (Phaseolus lunatus L.) groundnut (Arachis hypogeae, L.) and soyabean (Glycine max L.) proteins were mixed in varying proportions to supply 23% CP for starter and 20% CP for finisher diels. The diets were chemically analysed and fed broiler chickens for 8 weeks to determine which one could support growth adequately. Commercial guinea feeds starter and finisher diet served as control.

Chemical analysis result revealed that most of the diets had protein content below the calculated 23% CP and 20% CP in starter and finisher diets. The diets with soyabean meal had the highest crude protein compared to other experimental diets without soyabean meal. All the experimental diets were not deficient in all the analysed essential amino acids. The energy given food (total digestible carbohydrate plus fat) in the experimental diets were higher than the control diet. Experimental diets with lima bean meal, groundnut meal and groundnut and lima bean meal had the highest energy given food.

The crude ash and fibre content were lower than control diet with groundnut meal diets recording the highest fibre content among the experimental diets. Digestibility of all the experimental diets was generally high.

The birds fed experimental diets consumed significantly less ($P<0.05$) food than the ones fed control diets. Birds fed with experimental diets with higher energy-giving food (diet 1, 3 and 5) had the lower food consumption rate and the food consumption rale increases with increase in the age of the birds except week 5.

In terms of weight gain, FCR and PER, the birds fed diet with soyabean meal, soyabean and lima bean meal, and soyabean, groundnut and lima bean meal (diet 2, 4, 6 and 7) had the best result. Their weight gain does not indicate significant difference ($P>0.05$) compared with the one fed control diet while that of lima bean meal, groundnut meal and groundnut and lima bean meal (diet 1, 3 and 5) shows a significant difference ($P< 0.05$).

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ABBREVIATIONS, DEFINITIONS, SYMBOLS AND GLOSSARIES.

C.P	-	Crude Protein
d.f	-	degree of freedom
D.M	-	Dry Matter
et al	-	and others
F.A.O	-	Food and Agricultural Organisation of United Nation.
F.C.R	-	Food Convertion Ratio
g	-	Gram
GM	-	Groundnut Meal
GLM	-	Groundnut and Lima bean Meal
I.U	-	International Unit
K/cal(s)	-	Kilocalorie(s)
Kg (s)	-	Kilogramme(s)
Mg(s)	-	Milligramme(s)
ML(s)	-	Milliliter(s)
N.F.E	-	Nitrogen Free Extract(s)
N.P.U.	-	Net Protein Utilization
N.R.C	-	National Research Council
P	-	Probability
PP	-	Pages
P.E.R	-	Protein Efficiency Ratio
P.H	-	Indicate Degree of Acidity or Alkalinity
PPm	-	Part per Million
S.D	-	Standard Deviation
SGM	-	Soyabean and Groundnut Meal
SGLM	-	Soyabean, Groundnut and Lima bean Meal
SLM	-	Soyeabean, and Lima bean Meal
SM	-	Soyabean Meal
VM	-	Vitamin Minerals
%	-	Percent
<	-	Less than
>	-	Greater than
ad libitum	-	at pleasure

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CHAPTER ONE

1.0 INTRODUCTION

Performance in the context of this work refers to changes in weight of birds (rate of growth) in response to the seven experimental diets fed them compared with that of the control diet. However, physiological studies have produced a large body of information regarding the major processes of growth. Some knowledge of these facts are obviously essential for understanding of the nutritive requirement involved and how they can be met.

According to David (1970) adequate nutrition of broiler chicks requires a knowledge of the quantitative nutrient requirements at various stages of the growth and for various physiological functions. The knowledge of the feeding behaviour of the animal, and the quantitative distribution of the essential nutrients in the feeding materials which can be used is also important. These kind of information are necessary to achieve maximum biological and economic efficiency in the use of nutritional resources. Consideration of this information will become even more important as problems of world food supply and the upgrading of human nutrition become increasingly urgent in the years ahead.

The rapid expansion of the livestock industries depends to a large extend on the availability of good quality foods and at reasonable, cheap prices. This is particularly true of monogastric species such as poultry and pigs whose performance depend on the use of concentrated balance ration (Duru, 1993).

According to Ravindran (1995) food represents the major cost of poultry production and often accounts for 60 - 65% of birds production cost under small farm conditions. Consequently, ever rising ingredient prices remains the greatest single item determining the profit margins in poultry farming in tropical developing countries. In these countries the situation is exaggerated by the heavy dependent on imported conventional feeding-stuffs and as a result, prices of poultry diets are subject to external fluctuations. The most appropriate strategy for these countries is likely to be the development of dietary formulations which allow locally available new ingredients to be used. Such an approach would reduce food cost as well as the dependency to import new materials.

Legume seeds are important as valuable protein sources for farm animals, particularly the monogastric species. Soyabean and groundnut have played a significant role in sustaining the poultry industry in most of the advanced countries of the world, such as United State of America, Great Britain and Canada. Commercially processed soyabean meal and groundnut have been used as a primary protein source Offiong (1979).

In Nigeria, although soyabean, lima bean and groundnut are produced, little attention is paid to commercially processing of soyabean, groundnut and lima bean meal. As a result, large quantities of fullfat soyabean, groundnut and lima beans may be available for use in poultry feeds. It is therefore, worthwhile to assess the nutritional value of the seed of this leguminous plants.

1.1 Statement of the Problem:

This research was carried out to find out how broiler chicks respond to diet in which fullfat lima bean, soyabean and groundnut are the major sources of protein. In particular,

a. how do broiler respond to diet with fullfat lima bean as major source of protein?

b. fullfat soyabean as major source of protein?

c. fullfat groundnut as major source of protein?

d. fullfat lima bean and soyabean as the major sources of protein?

e. fullfat lima bean and groundnut as major sources of protein?

f. fullfat groundnut and soyabean as major sources of protein? and lastly,

g. a diet with fullfat lima bean, soyabean and groundnuts as the major sources of protein?

This research was carried out to find out how food consumed is related to weight gained in all the seven experimental and control diets. Are the diets digestible? How efficient is the protein and the entire food consumed by the broilers? What are the level of amino acid, crude protein, crude fat, fibre, moisture, ash and nitrogen free extract of the diet used in the experiment?

1.2 Research Justification:

Animals are a significant source of food particularly of high quality protein, mineral, vitamin and micronutrients for majority of African people. The minimum crude protein intake of 65 grams by an average Nigeria for a healthy living should include 28 grams from animal sources in order to obtain the desired net protein utilization (NPU) value for the ingested crude protein.

It is now a common experience throughout the country that with every passing year, the gap between food requirements and supplies with particular reference to animal production is widening at an uncontrollable rate (Oyenuga 1975).

According to Omonona and Udeh (1999) there have been a wide gap between the FAO recommended quantity of animal protein intake (35 grammes per person per day) and the actual intake (7 grammes per person per day) in Nigeria (FAO, 1985) and this could be attributed to several factors. One of which is chains of problems associated with the distribution of the animal protein sources which translates to high cost of these commodities. And without commensurate rise in income of consumers, these products are less consumed compared to the plant sources of protein which are relatively cheaper.

The use of lima bean, soyabean and groundnut in formulating ration for broilers will increase their production which will in turn make animal protein available in human diet. It will help to close the widening food and animal protein gap between needs and production. The availability of meat from broiler chickens will also reduce the effect of animo acid deficiency that is associated with plant protein sources and cereal-based diet we usually consumed. The problem associated with protein deficiency in our diet like Kwashiorkor in children may become a thing of the past with increase in broilers production.

According to Onabid (1992) dealers in poultry feed in Africa, who supply laboratory animal feed can no longer stock them, while those who are able to import some, sell them at exorbitant price. The situation is such that

local feed manufacturers only produce on request and usually in very small quantities, since production cost is very high and demand for laboratory feed is scanty.

Since poultry feeds are very costly and production is low due to high cost, the formulation of this feed using locally available soyabean, groundnut and lima bean will save cost. It will also enhance the availability of feeds which will in turn promote the development of the poultry industry.

Mani (1983) stressed that, although science teaching involves the imparting of organised body of knowledge, the process of acquiring this knowledge must be sound and relevant. For biology to be relevant to our students, the use of indigenous materials and available biological life specimens should be encouraged. Onabid (1992) also stressed that science education in African Countries are faced with problems of providing relevant teaching materials as well as biological specimens for their ever increasing students and also for purposes of demonstration research and exhibition. They can no longer afford to continue to import all the biological specimens they need.

If the demand for the life animals for the purposes of demonstration, research and exhibition in our institutions must be satisfied in the near future, a cheap and practical alternative feeding method must be found. One possible solution is the evaluation of easily available local foods as suitable alternative to present commercial feeds. This will create dependence on local products and guarantee feed availability, and also help to conserve our foreign exchange earning.

However, no studies have been reported on the utilization of fullfat lima bean and a combination of fullfat lima bean, soyabean and groundnut on broiler production. It is therefore, necessary to assess the nutritional value of these leguminous plants seeds.

1.3 Research Objective:

The general aim of this study is to monitor the growth response of young broiler chicks fed artificially with various level of fullfat lima bean, fullfat groundnut and fullfat soyabean as the major protein sources. On the basis of their growth response, identify the best formulations that support maximum growth of the young broilers.

The specific objectives are as follows:

1. To update information on the nutrients level of common feed ingredient that can be used for rearing broilers in Nigeria.
2. To determine the best level of fullfat soyabean, fullfat lima bean and fullfat groundnut that would promote the growth of broilers.
3. Identify the relationship between food consumed by broilers and their weight increase.
4. Determine the digestibility of the different formulated diets.

CHAPTER TWO

LITERATURE REVIEW

2.1. Lima Beans (Phaseolus lunatus L.)

2.1.1 Chemical composition:

The lima bean Phaseolus lunatus belong to the family Leguminosae David and Adam (1988). Some authority separate it into two species namely P. limensis (Syn. P. lunatus F. macrocarpus), the lima bean, which was considered perenial. The species are completely interfertile, it is better to follow Mackie (1943) and regard it as single species P.lunatus (Purseglove 1974).

According to Purseglove (1974) the dried pulse contains about 12.6% water, protein 20.7% ash 3.8%, carbohydrate 57.3%, fibre 4.3%, fat 1.3%. The green beans contain about 66.5% water, protein 7.5%, fat 0.8%, carbohydrate 22.0%, fibre 1.5% ash 1.7%. Lima bean is a good source of protein with a high lysine content, good sources of energy and phosphorus but with a low calcium content (McDonald et.al., 1987). They stated that lima bean have little or no carotene or vitamin C but may contain significant amounts of thiamin, macin and riboflavin. McDonald et al (1987) also stated that beans high Lysine content is similar to that of fish meal protein but have low level of cystine and methionine which are important in the diets of poultry owing to the demands of feathering.

The mineral composition of Phaseolus lunatus is similar to that of cereals and oil seed residues, with high phosphorus and low calcium, little or no sodium or chlorine and is a poor source of manganese (Purseglove. 1974).

According to McDonald et. al. (1987) beans are used in the diets of all classes of farm animals. Traditionally they have been little used in poultry diets but present evidence indicates that field beans can be used to replace soyabean meal provided adequate methionine supplementation is practiced.

Lima bean Phaseolus lunatus, in common with other grain legumes, contain various compounds which when consumed by animals and man may result in a reduction in the nutritional value compared with that predicted from the amino acid profile (Ologhobo et. al. 1993) Phaseolus lunatus contains cyanogenetic glucoside phaseolunatin (Purseglove 1974, Ologhobo et al, 1984, McDonald et al, 1987) which is extremely toxic when hydrolysed. (McDonald et al, 1987). Phaseolus lunatus contains lectins (Aletor 1984), and protease inhibitor (Ologhobo and Fetuga 1983) all of which are potential antinutritional factors.

Several studies indicate that both autoclaving (Ologhobo and Fetuga 1983) and extrusion (Apata 1989) of bean meal significantly improved its nutritive value. Similar results have been reported if seed coat is excluded from animal diets (Marguardl and Campbell, 1989). Purseglove (1974) and David and Adams, (1988) reported that boiling in water can remove the hydrocyanic acid from the seeds of limabean.

Ologhobo et.al, (1993), demonstrated the effect of raw and soaked/boiled limabean. With the exception of broiler chicks fed on the diet containing soaked/boiled lima bean, growth was severely hindered in chicks fed on diets containing raw lima bean and lima bean fractions Ologhobo et. al., (1993) also observed that relative weight of the kidney, small intestine

containing raw lima bean and fraction containing high concentration of anti-nutritional factors whereas there were no differences in the weights of these organs in soaked lima bean diet fed birds.

The inclusion of raw lima bean, base-soluble protein acid, soluble protein defatted limabean and ether extracted meal in the diets for growing chicken was shown to produce serious histopathological change within the livers, kidneys, panerease, spleen and lungs (Ologhobo et. al., 1993). In line with the literature reviewed, lima bean have to be properly processed to remove the antinutritional factors and supplemented with ingredients that will correct the deficiencies.

2.1.2 Uses

In Africa and Burma the lima bean is grown for its dried shelled beans. In United States the large white butter ban varieties are favoured although fresh green beans are often canned or frozen David and Adam (1988).

2.2 Soyabean (Glycine max L.)

2.2.1 Composition of soyabean:

The soyabean is a member of the family legumisae and subfamily papolionoidae. Cultivated soyabean have been known by several botanical names but in 1948, Ricker and Morse presented evidence that the correct botanical name should be Glycine max (L). Their conclusion have been used almost exclusively in scienetific literatures. It is cultivated in many areas of the world, from the tropics to the temperate regions. At present the World production of soyabean amounts to 100839000 tonnes Asiedu (1989).

The average proximate composition of soyabean 38% crude protein for fullfat, 21% oil, 34% carbohydrate and 5% ash (Kawamura 1967 and Aduku 1993). Soyabean meal is generally regarded as one of the best sources of protein available to other plant protein sources (Lovell 1980; McDonald et. al. 1987; and Onwueme Sinha 1991). The protein contains all the indispensable amino acids, but the concentration of Cystine and methionine are sub-optimal (McDonald et. al., 1987). It is unique among the plant sources of protein in that it is rich in lysine one of the essential amino acid often limiting in most feed ingredients (Nose 1978). On the other hand methionine is the first limiting amino acid McDonald, et al (1987) and may be particularly important in high energy diet (Nose 1978).

Since the protein of corn is deficient in lysine and tryptophan, two amino acids, which are abundant in soyabean meal protein, and soyabean meal is low in methionine and cystine which are abundant in corn meal, a proper combination of corn meal, soyabean meal result in performance superior to the one occurring when either ingredient is fed singly (Baker et. al., 1974).

The carbohydrate portion of soyabean forms 35-40% of the raw bean and is made up of the crude fibre and nitrogen free extractions. The latter consists of polysaccharide, stachyose 3.8% raffinose 1.1 percent and sucrose 5.0 percent FAO (1971) and Asiedu (1989). The insoluble carbohydrates consist of cellulose 4 percent and hemicellulose 1.5 percent (FAO 1971). The starch content of soyabean is very small about 0.5% (Wilson et al., 1978) and thus most of the polysaccharide are acidic polysaccharide, arabinogalactan and cellulosic materials which are essentially non digestible. The more digestible

carbonydrate component of soyabean are found in the Oligosaccharide fraction (Potter and Potchanakoru 1984).

Soyabean oil belongs to the group of oils most valuable for animal nutrition with high digestibility and high content of polyunsaturated fatty acids (85%) and 15% saturated fatty acids (Asiedu, 1989) Ogundipe and Oguntunde (1990). The high content of linoleic acid (essential fatty acid) makes soyabean oil superior in nutritive value to other vegetable oils, since this acid cannot be synthesized by the body and must be provided by the diet (Asiedu 1989).

The saturated fatty acids are mainly palmitic (16.0) 9% and stearic (18.0) 4%. The polyunsaturated fatty acids consist of Oleic (18.1) 24% linoleic (18.2)54% and linolenic (18.3) 8% (Nwar 1985). The high linolenic acid content causes off-flavours through a reaction between oxygen and lenolenic acid to form compounds such as 2-1 pentylfuran (Smouse and Chang 1967).

The oil contained in the bean has a laxative effect and may result in the production of a soft body fat. The extracted meal does not contain sufficient oil to cause this problem, but should be burn in mind in view of the increasing tendency to use fullfat soyabean products in dietary formulation (McDonald et. al. 1987). However, too much fat can cause an inbalance of protein and energy in a ration (Lovell 1980).

The dehulled meal contains riboflavin 3.1mg/kg, nicotinic acid 22.0mg/kg, pantothenic acid 14.5mg/kg choline 2.7mg/kg, pyridoxine 8.0mg/kg, biotin 0.32mg/kg, folic acid 3.6mg/kg and alpha-tocopherol 3.3 iu/kg (Krider 1973). Tocopherol, in particular alpha-tocopherol act as natural

antioxidants and are responsible for keeping qualities of most oils. Inspite of the relatively high content of tocopherol in soyabean oil (about 120 mg per 100g oil), the shelf life of soyabean oil is short compared with other oils (Asiedu 1989).

However, if soyabean meal is used as the major protein source for monogastric animals, certain problem arise. The meal is poor in vitamin B12, and must be provided with animal by-product supplement (Hill et. al., 1944 and McDonald et. al, 1987). If such supplement is not practiced breeding hen produce eggs of poor hatchibility giving chick of poor quality. Such chicks may also have an increased susceptibility to haemorrhages owing to a shortage of vitamin K (McDonald et. al., 1987). Supplementing soyabean with blood meal will reduce the deficiency of vitamin B12.

Soyabean contains 0.28% calcium 0.22% magnesium, 0.66% phosphorus, 1.7% potassium, iron manganese and zinc are 97ppm 28ppm and 22ppm (FAO 1971). Even though soyabean not a major source of mineral, the mineral content contributes to the overall mineral availability of the feed (F.A.O. 1971). Soyabean also contains phytic acid which can chelate divalent cations such as calcium iron, and zinc and thereby reduce their availability.

The raw or uncooked soyabean has low food value because it contains a number of anti-nutritional factors. Some of the biologically active substance in soyabean that have been identified include trypsin inhibitors, haemagglutinins, urease enzymes, lipoxidase saponin and compound with oestrogenic activity Asiedu and Huilman (1989). Two of these, the Kunitz antitrypsin factor and Bowman-Birk Chymotrypsin inhibitor, are of practical

significance. The protease inhibitor, are partly responsible for the growth retarding property of raw soyabean or unheated soyabean. This has been attributed to the inhibition of protein digestion, but there is evidence that pancreatic hyperactivity, result in destruction of methionine is also involved (McDonald et al. 1987). Rats and chickens fed on diet supplemented with the Kunitz (STI) and Bowman-Birk (BBI) trypsin inhibitors from soyabean showed significant growth depression and enlargement of the pancreases (Birk 1989). Liener (1981) has suggested that only animal whose pancrease weighed more than 0.3 percent of total body weight will exhibit pancreatic hypertrophy when fed raw soyabacan. Trypsin inhibitor has been reported to cause a decrease in the protein quality of soyabean as a result of low methionine content. The reason that trypsin contains a large amount (15-22%) of sulphur amino acids methionine and cystine Hwang et al, (1978).

In summary raw soyabean not only inhibits growth and reduces protein digestibility, but it also depresses metabolization, energy and fat absorption, causes pancreatic hypertrophy, stimulates hyper and hyposecretion of pancreatic enzymes and reduce amino acid, vitamin and mineral availability (Raki's 1974).

Since other workers (McDonald et al 1987, Birk 1989, Asiedu 1989 and Huilman 1989) have shown that raw soyabean have antinutritional factors which retard growth of animals, their inactivation will promote economic and biological efficiency of the soyabean.

Trypsin inhibitors are inactivated by moist heat treatment. The degree of deactivation of the toxin depends upon the applied temperature, duration of

heating, particle size and the moisture condition (UNDP/FAO 1983 and Asiedu 1989). Atmospheric steaming (100°C) of raw defatted soyabean flakes for 15 minutes inactivated about 95% of the trypsin inhibitor (Weingartner 1987). Steaming of whole soyabeans for 20 minutes partially inactivates the inhibitor and if the whole soyabean is adjusted to 20% moisture atmospheric steaming for 20 minutes will inactivate almost all the trypsin inhibitor (Wolf and Cowan 1971).

Although heat treatment of raw soyabean inactivates the trypsin inhibitor and denatures the protein thereby making them more digestible, (Kakade et al., 1973), excessive heating may be undesirable because of the unavailable sugar amine complexes (Maynard et al.,1979) and the destruction of heat sensitive amino acid e.g. lysine and cystine (Smith and Circle 1972). Albrecht et. al. (1966) and Nelson et al, (1976) demonstrated that if whole soyabean are soaked overnight (to about 50 - 60% moisture) only five minutes blancing in boiling water is needed to inactivate trypsin inhibitor. The soyabean used in the experimental diets was not soaked overnight, as such, it was boiled in water for 45 minutes to inactivate growth inhibitors.

The presence of haemagglutinins in soyabean has been demonstrated. This substance non-specific interference with nutrients absorption in the intestine by combining with the cells of the intestines (Liener 1977). Haemagglutinins as their names suggest agglutinate red blood cells and some are extremely toxic (Lis et al, 1966; Turner 1975 and Liemer 1976). Heamagglutinins work by causing the release of lipase and amylase which are intestinal membrane bound. These digestive enzymes are thus eliminated in

the faeces, thereby causing a reduction in the digestive capabilities. These factors are destroyed by heat (Liener and Hill 1953).

Apart from the factors already mentioned raw soyabean contains goitrin. This factor acts principally by inhibiting the organic binding of iodine in thyroid and interferes with the synthesis of thyroxine. As a result, the anterior pituitory is stimulated to produce a thyroid stimulating hormone which acts on the gland causing hypertrophy and hyperplasia (Liener 1953). Olumu (1974) quoted Josefsson (1972) who reported that growth depression may result as a consequence of this action. Although goiter has been produced by feeding soyabean to rats, Barnett et al. (1979) there have been no report of goiter in chickens fed with soyabean diet. In addition to anti-nutritional factor mention above, soyabean also contain urease and lipoxidase. Lipoxidase oxidized unsaturated fatty acid releasing peroxides which interact with other compounds to cause harmful effects in animals. Urease hydrolysed urea to ammonia (NH3) and carbondioxide (CO2). Its activities in mammals are harmful and are confined to the gastro-intestinal tract (Koruberge, Davies 1955 and Weingarner 1987).

Phytic acid which is chemically hexametaphosphate of myoinositol, is another anti-nutritional factor found in soyabean. It is not a problem but it binds to various essential element such as protein, phosphorus, calcium, zinc and magnesium, thereby reducing the nutritive value of the feed stuffs (Robinson and Lovel 1984).

The whole soyabean contain 1-2 percent Phytic acid (Weingartner 1987). The phosphorus bound to Phytic acid are unavailable to monogastric

animals because they don't have the phytase in their intestine which is necessary to release the phosphorus from Phytic acid (Robinson and Lovel 1984). Since Phytic acid does not interfere with the bio-availability of minerals added to the rations (Forbe et al, 1979) they can be made available through supplementation.

Soyin is another antinutritional factor appears to be primarily responsible for appetite depression at least in rat (Liener 1953). Following experiment with rat, he observed that soyin is an appetite reducer associated with the feeding of raw soyabean meal diet. Soyin is a heat labile factor and can be destroy by proper heat treatment to prevent any deleterious effect on the animal when soyabean meal is fed.

As it is shown by the literature reviewed, soyabean contains a number of antinutritional factors that will make feeding it in a raw form harmful to broiler chickens. Since these factor are heat labile, once it is properly heated it could be use as a good source of protein for broiler chickens.

2.2.2 Uses of soyabean:

The uses of soyabean are numerous. According to Onwueme and Sinha (1991) the bulk of soyabean oil is used for edible purposes, particularly as a cooking and salad oil and for manufacture of margarine, but the oil is also used industrially in manufacture of paints linoleum, oilcloth, printing inks, soaps, insecticides and disinfectants. The meal and soyabean protein are use in the manufacture of synthetic fibre, adhesives, textiles sizes, waterproofing and fire fighting foam.

Asiedu (1989) stated that soyabean can be processed into soya milk, soya sauce, tofu (soyabean curd), yoghurt, soya flour and other products. Defatted soyabean can be used for the manufacture of protein isolates and concentrates. The soyabean protein concentrates and isolated soyabean protein are used in the development of meat substitute and other artificial, high protein food products. It is use in making candies ice cream and cheese (Onwueme and Sinha 1991).

2.3 Groundnut (Arachis hypogaea L)

2.3.1 Composition of groundnut:

The groundnut or peanut, Arachis hypogaea L. belong to the family Leguminosae. It is grown as an annual crop on about 19 million hecters in tropical and subtropical regions and the warmer areas of temperate regions of world Asiedu (1989). Two distinct groups of varieties (Spanish - Valencia and Virginia) are generally recognised David and Adam (1988). The seed of Spanish - Valencia were used.

Groundnut are highly nutritious food (Onwueme and Sinha 1991). The groundnut kernel is composed of approximately equal weight of fatty and non fatty constituents, the relative amount of each depending upon variety and maturity (Asiedu 1989). The average composition of shelled groundnut is approximately 11.7% carbohydrate, 28% protein, 47.7% oil (fat), 2.5% fiber, 2.3% ash and water 5.4% (Onwueme and Sinha 1991). The decorticated groundnut according to them contains about 22.2% carbohydrate, 46.8% protein, 7.5% fat, 6.4% fibre, 5.8% ash and water 10.3%.

According to Pattee et al, (1974) the mature kernels contain 20-25% carbohydrate, of which about 8-10 percent is cellulose and hemicellulose 4 percent is starch and 10-12 percent is sugar. Sucrose is the principal sugar varying from 2.89-6.35 percent depending on the cultivar (Asiedu 1989). When the Kernel are roasted, the sucrose is hydrolyses to fructose and glucose, which then reacts with free amino acid to form the numerous substance which give the characteristic flavour to the roasted product (Mason et. al., 1969). 100g of raw groundnut kernels provide about 510k/calories (2.39mj) of dietary energy (Ahmed and Young 1982).

The protein of groundnut meal has sub-optimal amount of cystine and methionine, although the first limiting amino acid is lysine (McDonald et. al., 1987) and it also has low threomine and sometimes isoleucine and valine (Pancholy 1978, Young.et. al, 1973). Aspartic and glutamic acid and arginine constitute about 54 percent of the total amino acids, and their proportion is greater than in the Standard Reference Protein (SRP). (Young et at, 1973). The protein of groundnut have certain unique functional properties, such as low viscosity at relatively high concentration (5-10 percent), good compatability with bread dough systems, white colour and bland flavour (Asiedu 1989). Where the meal is used in high-cereal diets, adequate supplementation with animal protein is necessary (McDonald et al, 1987).

Most of the fatty constituents are contained in the cotyledons, some are found in the germs of heart small amount are located in the testa or skin (Asiedu 1989). The oil contains about 53% oleic acid and 25% linoleic acid (Onwueme and Sinha 1991). Groundnut oil is a quality, non drying fats and

frying oils, a fraction that settle during the manufacturing process is used for making soap. The oil is also used for groundnut butter (Owueme and Sinha 1991). Groundnuts are important sources of thiamine niacin, topocol (vitamin E) and folic acid (Onwueme and Sinha 1991) and it is also deficient in vitamin B12 (McDonald et al,1987). Groundnuts are rich in calcium, phosphorus and iron (Owueme and Sinha 1991).

It has been reported that both growth factor and an antitrypsin factor occur in groundnut meal (McDonald et, al, 1987). According to them the antitrypsin factor has antiplasmin activity and so shortens bleeding times and it is destroyed by heating (McDonald et al, 1987). It is generally recognized that the toxic products from moulds, or mycotoxins as they are called constitute a potential and ever present environmental hazard to animal and man alike (Asiedu, 1989). In 1961 report appeared which implicated certain baches of groundnut meal in the poisoning of turkey poults and ducklings. The toxic factor was shown to be metabolite of the fungus Aspergillus flavus and was named aflatoxin (McDonald et, al, 1987). Many researchers have examined the biological effects of aflatoxin over the past two decades and have established that aflatoxin are lethal to various animals, and that aflatoxin B1 is most acutely toxic of the first four aflatoxin to be identified, followed by G1, B2 and G2 in order of decreasing potency (Asiedu, 1989). Aflatoxin are relatively stable to heat and methods of eliminating them from meal are elaborated. The best method of control suitable storage to prevent mould growth (McDonald, et. al, 1987).

Rations containing groundnut meal as the sole supplementary protein and used during the finishing period (6-9 weeks) delay weight at market age of broilers (9 weeks) by only two to three days compared to finisher ration containing fish-meal or synthetic methionine and lysine (Olumu and Offiong 1979). When such rations with groundnut meal as the sole, source of protein are fed from day old, market weight is delayed by 13 to 21 days (Offiong 1979).

Since groundnut deficiency in some nutrients led to poor growth rate, supplementing it with other sources of protein and proper treatment to eliminate antinutritional factors will improve the growth performance of broiler chickens..

2.3.2 Uses

According to Asiedu (1989) groundnut crops are grown for their kernels, the oil and meal derived from them, and the vegetative residue (haulms). As human food the Kernels are eaten raw, lightly roasted or boiled sometimes salted or made into a paste, which is known as peanut butter. The oil may also be used for margarines and vegetable ghee, for shortening in pastries and bread, for pharmaceutical and cosmetic products, as a lubricant and emulsion for insecticides, and as a fuel for diesel engines Duke (1981).

The dry pericarp of the mature fruit or pods, known as shells or husks, may be used for fuel, as a soil conditioner as a filler in feeds as a source of furfural, processed as a substitute for cork or for hardboard, or composted with the aid of lignin decomposing bactaria Adams and Hartzog, (1980). Groundnut haulms are nutritionally comparable with grass hay and are used in many countries Gibbons (1980).

2.4. Nutrient Requirement of Broiler Chicken:

According to Olumu (1979) the requirement for any nutrient is the amount of that which must be supplied in the ration to meet the needs of the normal healthy bird given an otherwise completely balanced ration in an environment compatible to health. He also stated that such a level of nutrient must be capable of meeting the requirement for maintenance including indegenous losses in addition to meeting the requirement for optimum growth and the desired productive performances of the bird. Nutrient requirement of broilers is shown in Table (2.1 and 2.2).

Aduku (1992) and Olumu (1979) indicated that broilers require 23-24% crude protein in the starter and 19-21% CP in the finisher mash. Aduku (1992) stated that the broilers are fed with starter mash from day old to the end of the fourth week and finisher from week 5 to 8. Holsheimer and Janssen (1991) all claim that maximum performance cannot be achieved by feeding broilers with low protein diets even when it is supplemented with amino acid.

Arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine threonine, tryptophan valine and glycine are indispensable amino acid for chicks McDonald (1989). Required level of each amino acid is shown in Table 2.1. According to Olumu (1979) all the amino acids required by chickens only methionine plus cystine and lysine are usually considered in practical rations. The other amino acids are usually supplied in adequate amount when conventional feed ingredients are used to formulate poultry ration.

Deficiency of some single essential amino acid decrease food intakes, body weight gain and energy retention (Sekiz et.al., 1975 Tasaki and Yanaka 1980, Ueda et al 1981). Single lysine and sulphur containing amino acid (SAA) have already been reported to increase the heat increment of feeding in growth chicks (Tasaki et al, 1972). Olumu (1979) stated that many workers demonstrated that within certain energy ranged feed consumption decrease with increase in energy level. For broiler chickens, we have found it more useful to employ the lower energy level (2800kcal/kg) during the starting period (zero to 6 weeks) and higher energy level (3000kcal/k) during finishing period (6 to 9 weeks).

Fat and oil are in broiler chicken diets as sources of dietary energy. The metabolizable energy and nutritive values of fat and oil are determined by their chemical structure (Wiseman and Lessieve 1987, Wiseman and Salvador 1989). A range of 3.0-5.0 starter mash and finisher mash have been fixed to obviate problem of feed due to high fat content and lowered feed utilization by the birds (Olumu 1979). The recommended crude fibre is shown in Table 2.1. page 24

NRC 1994 recommends feedings 1.0, 0.9 and .8% calcium and .45, .35 and .30% non phytase phosphorus from 0 to 3, 3 to 6 and 6 to 8 weeks of age respectively, Olumu (1979) recommended 1.2-1.3% calcium for starter and a finisher mash. He also recommended .85 phosphorus for starter and finisher mash. White et. al, (1971) found that the addition of fat to chicks diet containing 1.5% calcium reduced the retention of calcium and other minerals. The same author White et.al., (1972) showed that the addition of

5 or 10% fallow to a broiler diet containing .9% calcium lowered the retention of that element, although not sufficiently to cause a deficiency.

Olumu (1979) stated that most minerals (micro) and vitamin in our rations come in form of premixes. Aduku (1992) recommended that .25% should be added in the ration. When these premixes are added to rations at recommended amounts, the final levels of some of the vitamins, especially A and D_3, in the ration are far above level recommended by the panel (Table 2.2 page 25) Olumu (1979). Except in a few isolated cases, most of these premixes when employed in our ration do not normally produce any symptoms typical of vitamin or mineral deficiency or excess (Olumu 1979). For a better performance of broiler chickens the recommended nutrient level in the literature review should be maintain in the ration.

TABLE 2.1. ENERGY, CRUDE PROTEIN, CALCIUM, PHOSPHORUS AND AMINO ACID REQUIREMENT OF CHICKENS.

	STARTER DIET	FINISHER
DIET Metabolization energy kcal/kg	2800-3000	2800-3000
Crude protein	23-24	19-21
Fat (maximum %)	3.0-5.0	3.0-5.0
Crude Fibre (maximum%)	5.0	5.0
Calcium	1.2-1.3	1.2-1.3
phosphorus %	0.85	0.85
Lysine %	1.1-1.3	0.9-1.1
Methionine + Cystine %	0.7-0.8	0.6-0.7
Arginine %	1.30	1.10
Tryptophan %	0.21	0.18
Histidine %	0.54	0.46
Isoleucine %	1.20	1.02
Leucine	2.04	1.75
Phenylalanine %	1.62	1.38
Valine %	1.22	1.04
Glycine + serine %	1.29	1

Adopted from Olumu 1979

TABLE 2.2 VITAMIN REQUIREMENT OF CHICKENS (IN AMOUNT PER KG OF FEED) FOR PULLET/BROILERS

	PANEL	NRC (1971)
Vitamin A (Icu)	4.000	1.500
Vitamin D3(Icu)	600	200
Vitamin E (mg)	5.0	10
Vitamin K (mg)	2.0	0.53
Vitamin B1 (mg) + Thiamine	2.8	1.8
Vitamin B2 (mg) (Riboflavin)	5.0	3.6
Niacin (mg)	20.0	2.7
Pantothenic acid (mg)	11.0	10
Vitamin B6 (mg) (Pyridoxine)	5.0	3.0
Vitamin B12 (mg)	0.01	0.009
Folic acid (mg)	0.60	0.55
Biotin (mg)	0.10	0.09
Choline (mg)	1000	1300

Adopted from Olunu 1979

CHAPTER THREE

3.0 MATERIALS AND METHOD

3.1 Materials

3.1.1 Animals

Male and female broiler chicks of the commercial Anak 2000 strain were used in all trials. They were purchased from Kaduna hatchery along Kachia road. A total of fifty one day old broilers were obtained from the hatchery and all received the New castle disease vaccination within the hatchery. They were kept in the laboratory for nine days for acclimatization and were given free access to town water and commercial starter mash (Guinea Feed broiler starter mash) containing 21% crude protein. A total of 3 birds died during the acclimatization period.

3.1.2 Housing

During the experimental period 48 nine day old birds were housed in group in a deep liter floor laboratory within the biological science department. The spaces between the benches in the laboratory were demarcated. Two spaces were demarcated into four sections each, using moveable cupboard drawers. Each section represented a particular treatment or diet and were allocated six birds each. The sections were fitted with wooden feeders and two lunch boxes which served as drinkers for the supply of water. Wood-shavings (Sawdust) obtained from carpentry workshop in Chemistry Department served as the beddings. The sections that housed the birds were cleaned every seventh day and the beddings were changed during each cleaning. The lunch box were washed on daily bases.

3.1.3 Instrument for measurement:

The 48 birds that survived the acclimatization period were measured with Mettler Top Loading Balance before they were grouped and fed with the experimental diet. Thornto Birminggham two pan balance was used to measure the ingredients used in formulating the ration. A salter balance was used for subsequent measurement of the birds which was carried out on weekly bases.

3.1.4 Food stuffs:

The diets were formulated using local foodstuffs. These include maize (Zea may) as source of carbohydrate, lima bean (Phaseolus lunatus) soyabean (Glycine max), groundnut (Arachis hypogea) and blood meal as sources of protein. Bone meal was also used to provide enough calcium for the broiler chicks. Zoodry broiler starter and finisher premix (composition shown in Table 3.1 page 29 and 3.2 page 30) a formulation of trace elements and vitamins served as sources of minerals and vitamins. Common salt was also used in the diet formulation. Commercial guinea feed broiler starter and finisher mash (composition shown in Table 3.3. and 3.4) were used as control diet. The soyabean, common salt, zoodry broiler starter and finisher vitamin and trace minerals premix were purchased from Samaru market in Sabon Gari Local Government Area of Kaduna State. The groundnut, lima bean and maize were purchased from Kagoro Market in Kaura Local Government Area of Kaduna State. The blood meal and bones were obtained from Zango abattoir.

3.2 Method

3.2.1 Processing of foodstuffs:

The foodstuff used were all processed to obtain their flour for the preparation of the experimental diets.

Maize:

Grains were ground into flour to make feed mixing easy and to improve digestion.

Bones:

Raw bones were collected in a heap. Old motor tyres were inserted in the heap of bones and kerosine was poured. Fire was set to the tyres which burnt the bones. The brittle were allowed to cool and they were pounded into meal.

Soyabean:

Soyabean was boiled in water for 45 minutes, the seeds were sun dried on top of water tank within Akenzua hall. The dry seeds of soyabean were taken to hammer mill for grinding into flour.

Groundnut

The groundnut used for the experiment was heated in an oven at 100°C for 30 minutes. The heated groundnut seeds were converted into meal by hammer mill grinder.

Lima beans:

The Phaseolus lunatus was boiled in water for 60 minutes. This was carried out in two phases. The first phase last for 30 minutes after which the bean were washed with cold water. In the second phase, the washed beans

TABLE 3.1 ZOODRY BROILER - STARTER VITAMIN AND TRACE MINERAL PREMIX COMPOSITION TABLE.

Vitamin A	5,000,000 i.u
Vitamin D^3	1,000,000 i.u
Vitamin E	16.00g
Vitamin K_3	1.00g
Vitamin B_1	0.80g
Vitamin B_2	2.4og
Vitamin B_6	1.40g
Vitamin B_{12}	10.00g
Nicotinic acid	14.00g
Calcium pantothenate	4.00g
Folic acid	9.00g
Vitamin C	60.00g
Biotin	9.02g
Choline chloride	120.00g
Zinc bacitracin	16.00g
Lasalocid	36.00g
Manganese	40.00g
Iron	20.00g
Zinc	18.00g
Copper	0.80g
Iodine	0.62g
Cobalt	0.09g

Source: The Producers

TABLE 3.2 ZOODRY BROILER - FINISHER VITAMIN AND TRACE MINERAL PREMIX COMPOSITION TABLE.

Vitamin A	1,000,000 i.u
Vitamin D_3	800,000 i.u
Vitamin E	12.00g
Vitamin K	0.80g
Vitamin B_1	0.60g
Vitamin B_2	2.00g
Nicotinic acid	12.00g
Calcium D-Panthenate	4.00g
Vitamin B_6	1.40g
Vitamin B_{12}	8.00g
Folic acid	9.40g
Biotin	0.02g
Choline chloride	120.00g
Lasalocid (Avatec)	36.00g
Manganese	40.00g
Iron	20.00g
Copper	0.80g
Iodine	0.69g
Cobalt	0.69g
Selenium	0.01g
Selenium	0.04g

Source: The Producers

were boiled again for 30 minutes after which they were finally washed and sun dried on top of water tank. The dried lima bean seeds were also ground into flour.

Diet formulations:

All the experimental diet were derived by combining the various sources of proteins (blood, soyabean, lima bean and groundnut) to provide 23% and 20% crude protein for the starter and finisher mash. The ratio of blood meal to other sources of protein (Lima bean, soyabean and groundnut) was 1.3.

Composition of each diet

Diet I contain blood meal, lima bean, maize, bone meal, VM premix and common salt. Diet 2 consist of blood meal, soyabean, maize, bone meal, VM premix and common salt. Diet 3 was made up of blood meal, groundnut, maize, bone meal, VM premix and common salt. Diet 4 was made up of blood meal, soyabean, lima bean bone meal, VM premix and common salt. The ingredients of diet 5 were blood meal, lima bean, groundnut, bone meal, VM premix and common salt. Diet 6 consist of blood meal, groundnut, soyabean, maize, bone meal, VM premix and common salt. The diet 7 was made up blood meal, soyabean, lima bean groundnut, bone meal, VM premix and common salt, while diet 8 (control diet) was commercial guinea feed (Table 3.3 page 33 and 3.4 page 34).

Calculation were done using the algebraic method (details shown in appendix I) to get exact amount of blood meal, groundnut meal, lima bean meal and maize flour that provided 23% and 20% crude protein (CP) (Shown on Table 3.5 page 35 and 3.6 page 36) for the starter and finisher mash.

Details of the calculation is shown on appendix 1. The bone meal was fixed at 3% while VM premix and common salt were fixed at .25% each.

3.2.3 Chemical Analysis:

Determination of moisture:

Samples were thoroughly mixed. The water content was determined by weighing out 2g into a silica dish which has been previously dried and weighed. The dish including the sample was placed in hot air oven for 24 hours at 60°C. When the sample finally dried to constant weight it was cooled in a desicator for ten minutes before weighing. The percent moisture was calculated thus:

$$\% \text{ moisture} = \frac{G1 - G2}{G1} \times 100$$

Where G1 = Weight of the sample before drying

G2 = Weight of the sample after drying

Nitrogen and crude protein determination:

The nitrogen of protein and other compound were converted to ammonium sulphate by acid digestion with boiling sulphuric acid. A known weight of the sample (0.6g) was placed in Kjeldahl flask and about 200 milligram of catalyst mixture was added. A 5.0cm^3 of concentrated sulphuric acid was added to the content of the flask. It was gently heated for four minutes until frothing ceases and increase the heat to digest for two hours. It was allowed to cool and after which 100ml of distilled water was added. A 10.0cm^3 of 2% boric acid containing mixed indicator and it was titrate with 0.02N hydrochloric acid to grey end point.

TABLE 3.3 COMMERCIAL GUINEA FEED BROILER STARTER MASH COMPOSITION TABLE.

Crude protein	21%
Crude fat	7.2%
Crude fibre	4.4%
Crude ash	5.8%
Calcium	1%%
Phosphorus	0.65%
Available phosphorus	0.42%
Lysine	1.2%
Methionine + cystine	0.80%
Vitamin A	14,000 i.u
Vitamin D_3	13,000 i.u
Vitamin E	15mg
Vitamin B_2	6mg
Vitamin C	25mg
Manganese	50mg
Zinc	70mg
Sodium	0.16%
INGREDIENTS:	
Grains	
Animal protein	
Vegetable protein	
Limestone	
Minerals	
Vitamins	
Medicants	

Source: The Producers

TABLE 3.4 COMMERCIAL GUINEA FEED BROILER FINISHER MASH COMPOSITION TABLE.

Crude protein	19%
Crude fat	5.0%
Crude fibre	5.0%
Crude ash	6.4%
Calcium	1.1%
Phosphorus	0.6%
Available Phosphorus	0.4%
Lysine	0.9%
Methionine	0.45%
Methionine + Cystine	0.85%
Vitamin A	12.50 i.u
Vitamin D_3	3,000 i.u
Vitamin E	30mg
Vitamin B_2	5mg
Vitamin C	150mg
Manganese	70mg
Zinc	50mg
Sodium	0.16
INGREDIENTS:	
Grains	
Animals protein	
Vegetable protein	
Limestone	
Minerals	
Vitamins	
Medicants	

Source: The Producers

TABLE 3.5 CALCULATED COMPOSITION OF STARTER DIETS

Ingredients	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	Diet 7
Maize	42.89	58.77	50.2	50.83	46.55	54.49	50.62
Blood meal	13.40	9.43	11.58	11.42	12.49	10.51	11.47
Lima bean	40.21	-	-	20.11	20.11	-	13.43
Soyabean	-	28.3	-	14.15	-	14.15	9.43
Groundnut	-	-	34.72	-	17.36	17.36	11.58
Borne meal	3.0	3.0	3.0	3.0	3.0	3.0	3.0
VM premix	.25	.25	.25	.25	.25	.25	.25
Common salt	.25	.25	.25	.25	.25	.25	.25

TABLE 3.6 CALCULATED COMPOSITION OF FINISHER DIETS

Ingredients	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	Diet 7
Maize	53.41	66.18	59.29	59.80	56.35	62.74	59.63
Blood meal	10.75	7.58	9.30	9.17	10.03	8.44	9.21
Lima bean	32.34	-	-	16.17	16.17	-	10.78
Soyabean	-	22.74	-	11.37	-	11.37	7.58
Groundnut	-	-	27.91	-	13.96	13.96	9.30
Borne meal	3.0	3.0	3.0	3.0	3.0	3.0	3.0
VM premix	.25	.25	.25	.25	.25	.25	.25
Common salt	.25	.25	.25	.25	.25	.25	.25

Calculation of nitrogen/protein value:

a = Titre value for sample

b = Titre value for blank

c = Volume to which digest is made up with distill water

e = Weight of dried sample (mg)

0.01 = Normality of HCL

The percentage nitrogen was converted to the percentage by multiplying by the necessary conversion factor (6.25).

Determination of crude fibre:

About 1.5 of each defatted diet sample was transferred into individual conical flask measuring one litre. 200ml of freshly prepared 1.25% sulphuric acid was added to each flask and the whole content was heated quickly to boil under reflux. It was allowed to boil for 30 minutes, while keeping the volume constant. After 30 minutes, the content still hot, was filtered through muslin cloth stretched over Buchner funnel. The residue which was insoluble was washed several times and rinsed many times with hot distilled water until it was acid free as determined by the use of litmus paper. This was then transferred into a conical flask with the aid of a spatula.

200mls of freshly prepared 1.25 sodium hydroxide was added and the whole content was boiled again under reflux for 30 minutes, after which the content was filtered using a muslin cloth as before. The residue was then washed again several times, first with hot distilled water, then with 1% hydrochloric acid and again with boiling water until it was acid free. It was again washed with 95% methylated spirit, then finally with diethyle ether.

The residue was scrapped into a crucible and dried overnight in air oven at 105°C. The next day, the crucible was then transfered into a dessicator and weighed. This weight represent the weight of the ash and crude fibre (Wa). Therefore the residue was washed in a muffled furnace at 600°C for 2 hours to get rid of the crude fibre. After 2 hours each crucible was allowed to cool before being transfered into the dessicator, then the reweighed (Wb). The loss in weight was calculated as the percentage crude fibre as given by the equation below.

$$\text{Crude fibre \%} = \frac{Wa - Wb}{\text{Original sample weight}} \times 100$$

Ash determination:

3g of each sample was added into a previously clean and weighed crucible. The sample with container was oven dried at 120°C. The temperature was gradually raised to 600°C and left for 18 hours. The dish was repeatedly cooled in a desicator over calcium chloride and weighed until a constant weight was registered percent ash was calculated thus:

$$\% \text{ Ash} = \frac{C_3 - C_1}{C_2 - C_1} \times 100$$

Where C_1 = Weight of crucible

C_2 = Weight of crucible plus sample

C_3 = Weight of crucible and ash

Determination of fat:

Two grams of each sample was pressed evenly into an extracting thimble and fitted into a soxhlet extracting apparatus. A dried, weighed extracting flask with three glass beads was attached to the receiving end of the

oxlet apparatus.

Petroleum spirit at boiling point of 40°C to 60°C was used to extract the sample for 5 hours. Then, the sample were dried in a desicator and later weighed on a metric balance. The difference in weight of each sample before and after extraction was taken as the quantity of fat present in the sample. This was calculated as percent fat thus:

$$\% \text{ fat} = \frac{\text{Difference in weight}}{\text{Original weight}} \times 100$$

Amino acid analysis:

The amino acid contents in the eight samples were determined using method describe by Spackman et.al (1958) and Association of Official Analytical Chemists (1980). The sample were defatted with chloroform and methanol mixture in a soxlet extraction apparatus for eight hours, and then hydrolysed in oxygen free 6N HCL. The sample were evaporated to dryness at 40°C under vacuam in a rotatory evaporator. The residues were finally dissolved with acetate buffer (p" 2.0) use to estimate the amino acid, analyser (TSM) with a pen recorder was used to estimate the amino acid profile of the samples. The amount of each amino acid present in the samples was calculated in g 16g -1 nitrogen and this was later converted to percentage dry matter (DM).

Digestibility determination:

The digestibility determination involve the use of chromic oxide (Cr_2, 0_2) as an indigestible marker. It was introduced into the diet on the last four days of the experimental period. It was assumed that all the chromic oxide consumed passed through the digestive tract and appeared in the faeces.

Analysis of the relative changes in chromic oxide percentage of the feed and faeces will represent the percentage of feed that was ingested.

The collection of faeces started when the chromic oxide appear on the excreta. The expelled faeces where collected from each group and stored in the freezer at - 6° C $\pm$ 4°C.

0.05g of sample was weighed on a Whatman No.1 filter paper and transfered with the filter paper to a dry 100cm^3 Kjeldahl flask 0.5cm^3 of concentrated nitric acid was added in such a manner that the particles that adhered on the inside of the flask were washed down. The flask was allowed to stand for 10 minutes after which it was heated on an electric heater for the sample to digest. When a white precipitate was obtained, the flask was turned off and the flask allowed to cool. 3cm^3 perchloric acid was added to the digestion mixture and flask reheated until the green colour changed to yellow, orange or red. The digestion was extended for 10 minutes to avoid change in colour from green to yellow due to insufficiency oxidation of the content. The flask was allowed to cool slightly afterward and 50cm^3 of distilled water was added. The flask was allowed to cool again before it was made up to 100cm^3 with distilled water. The flask was allowed to stand for 10 minutes for the organic material to precipitate. The solution was transferred from the volumetric flask to the curve and the optical density was read at 350mm against distilled water. The digestibility of the nutrient was expressed from the following formula:-

$$100 - \frac{(100 \times (\%\ Cr_2\ 0_3 \text{ in food})}{(\%Cr_2\ 0_3 \text{ in faeces})} \times \frac{(\%\ \text{nutrient in faeces})}{(\%\ \text{nutrient in foods})}$$

3.2.4 **Feeding**

These experiment was designed to evaluate the effect of combining different proportions of lima bean, soyabean, and groundnut, on the growth performance of broiler chickens. Each group in the experiment was alloted a diet as follows:

Group one was fed with diet 1, group two diet 2, group three diet 3, group four diet4 group five diet 5, group six diet 6, group seven diet 7 and group eight (control diet). The details of ingredients and quantity of each in all the seven experimental diets are shown in Table 3.5 and 3.6. The birds in all the groups were fed with their respective diet and water ad libitum. In the first three weeks of the experimental period, the birds were fed with the starter diet formulated to provide 23% crude protein. They were fed with the finisher diet from week four to week eight of the experimental period and it was prepared to provide 20% crude protein. The quantity supplied and left over food were recorded on daily bases.

3.2.5. **Growth determination:**

The birds were weighed at the onset of the experimental period and the weight of each group served as the initial weight. Each treatment, lot contain equal number of male and female to eliminate possible sex effect on the results.

Criteria used to measure growth were weight change and protein efficiency ratio. Feed conversion ratio (FCR) was calculated to test the efficiency of the diets. To determine these, weights of each bird in each group was taken on weekly bases and food consumed was recorded on daily bases .

From the measured parameters above the following biological indices were computed.

i. Weight gain or weight lost given by weight of the animal at the end of experiment minus (-) weight of animal before the experiment.

ii. Feed conversion ratio (FCR)

$$FCR = \frac{\text{Total feed consumed}}{\text{weight gain/lost}}$$

iii. Protein efficiency ratio (PER)

$$PER = \frac{\text{Weight gain/lost}}{\text{Protein consumed}}$$

Where protein consumed $= \frac{\text{Protein in food}}{100} \times$ food consumed

3.3 **Vaccination**

The day old chickens were vaccinated against the Newcastle disease within the hatchery. They were also given multivitamin antibiotic (Terramycin chick formula)during the first 5 days of the acclimatization period. The multivitamin was administered through drinking water and the content is shown in Appendix 8.

During the experimental period the birds were given coccidiostat in fifth week. This was followed by multivitamin antibiotic (terramycin chick formula) in the sixth week, all were administered through drinking water.

3.4 **Statistical Analysis:**

The data of mean food consumed, weight gain, protein efficiency ratio (PER) and food conversion ratio (FCR) of week 1 - 3, 4 - 8 and 1 - 8 were subjected to 'F' test since the variables were more than two. They were

subjected no analysis of variance in a computer to verify whether there was any significant differences among the diets and weeks. Duncan's multiple range test for variables was used to separate the means.

CHAPTER FOUR

4.0 RESULT

4.1 Chemical Analysis

The chemical analysis of the seven experimental diet and the control are shown in Figure 4.1 page 45 (starter mash) and Figure 4.2. page 46 (finisher mash). The figure shows the values obtained for the crude protein content, crude fat (ether extracts), crude fibre, ash, moisture and calculated nitrogen free extract for starter and finisher mash used throughout the experimental period.

4.1.1 Crude protein (%)

The highest protein in the starter mash was 22.57 and it was recorded in diet two (2). This value was slightly higher than diet 4, with 22.44. This was closely followed by diet 6 and 8 (control) which all have values above twenty two percent. The lowest crude protein value (21.08) was recorded in diet 3 and was slightly lower than diet 1 and 5 with value of 21.96 and 21.13 respectively.

In finisher diet, the highest crude protein value of 20.76 was recorded in diet 4. It was slightly above diet two with a crude protein value of 20.67. This was closely followed by diet 6 with crude protein above 20. The control diet (8) crude protein value of 18.06 is the lowest among the diet used throughout the experimental period. It was lower than diet 1,7,3, and 5 with crude protein value of 19.20, 19.74, 18.73 and 18.95.

Figure 4.1 Proximate Composition of Starter Diets

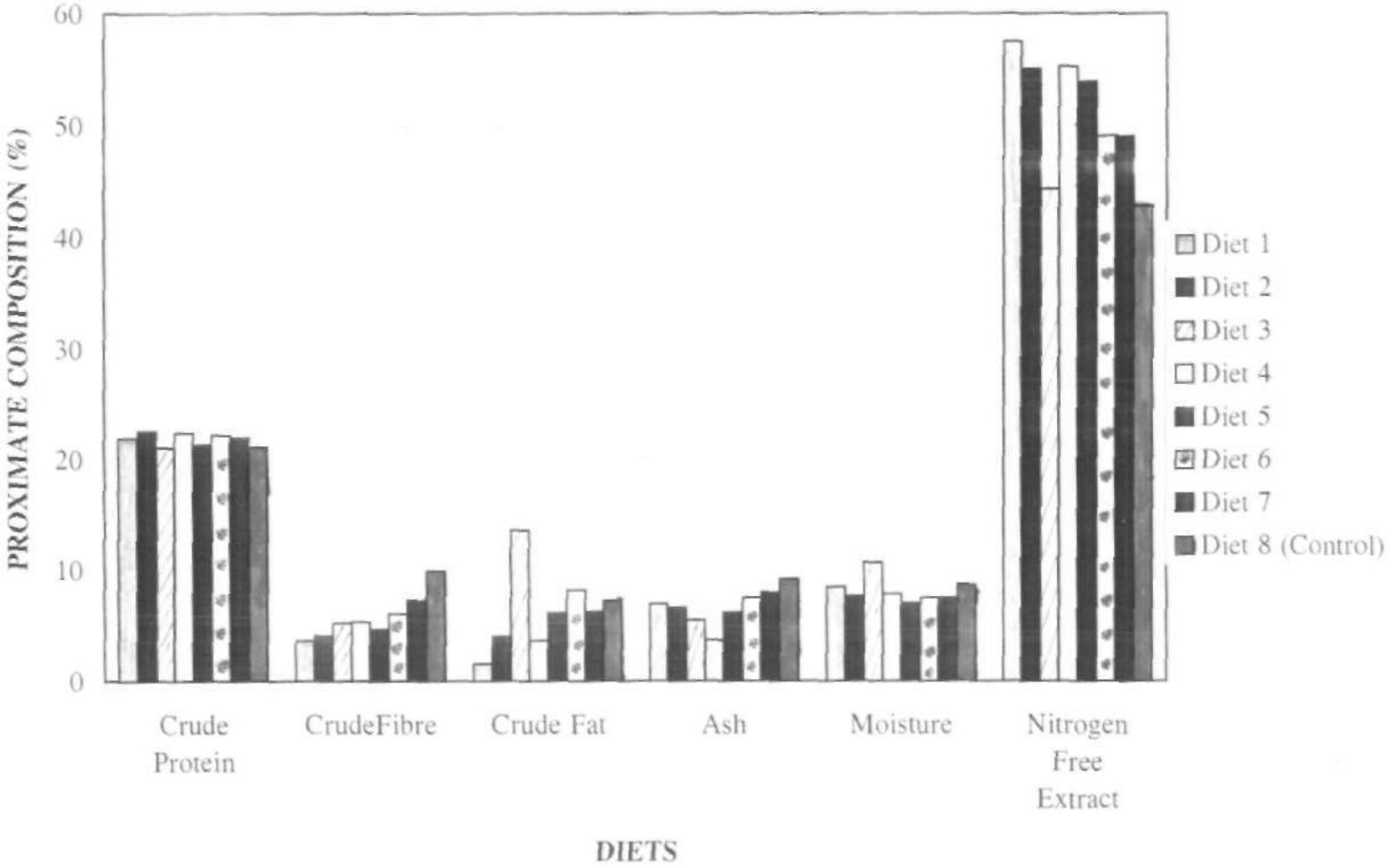
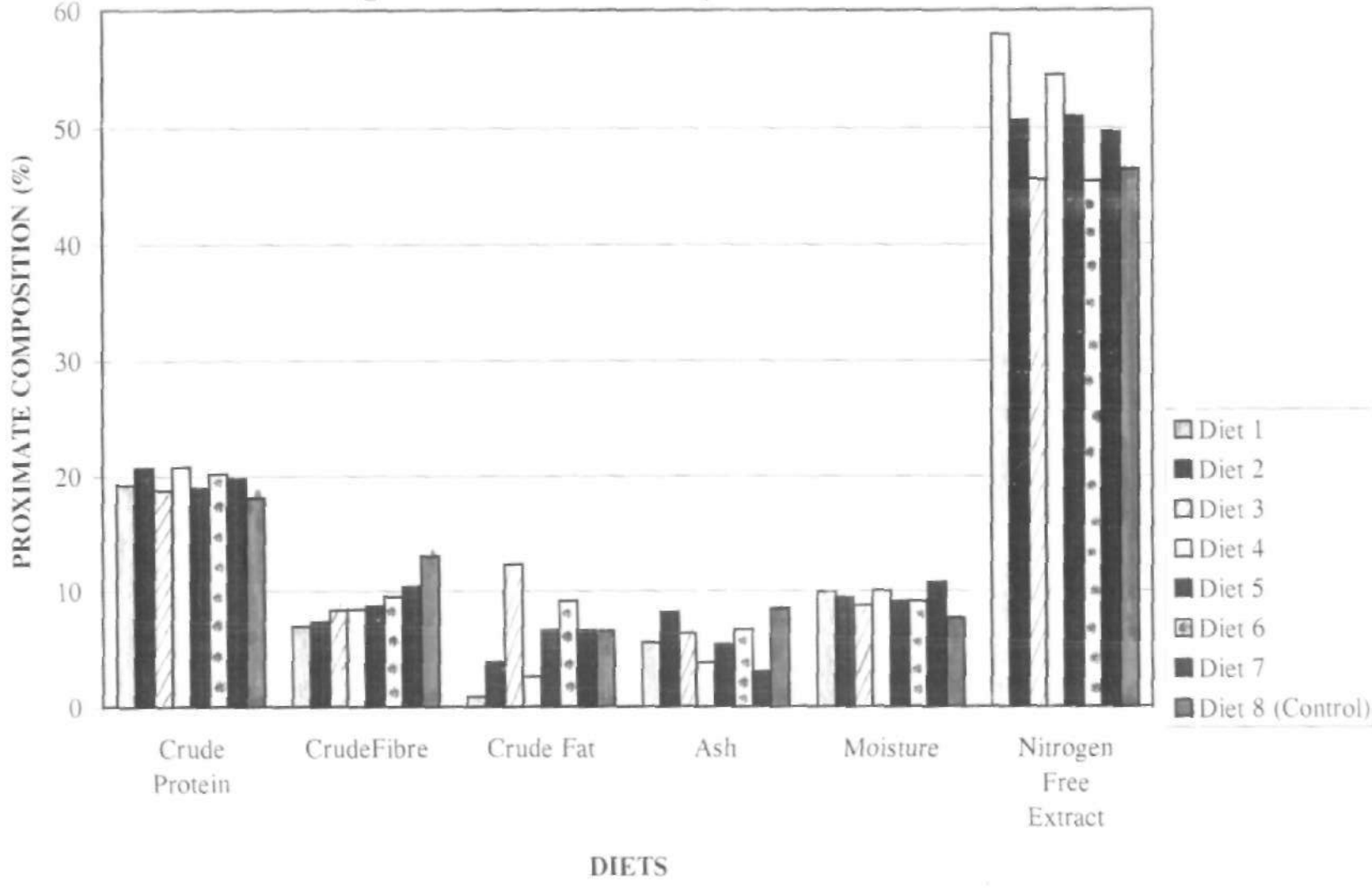


Figure 4.2 Proximate Composition of Finisher Diets



4.1.2 Crude fat (%):

The values in the starter diet show that diet 3 had the highest crude fat value of 13.64. This value was followed by that of diet 6(8.19) and diet 7(7.20). The lowest crude fat was found in diet 1(1.56) a value slightly lower than that of diet 4.

Diet 2,5 and 6 had 4.01, 6.11 and 6.25 respectively.

The finisher diets on the other hand recorded the highest crude fat value of 12.33 in diet 3. This was closely followed by diet 6 (9.10). There was no much different between 5,7 and 8 (control) with value of 6.63, 6.58 and 6.47. The lowest crude fat value of 0.88 was recorded in diet 1 and was lower than diet 2 and 4 which had 3.80 and 2.57.

4.1.3 Crude fibre (%):

The crude fibre value of 9.90 recorded in the control diet (8) of the starter diet was higher than all the seven experimental diets. This was followed by diet 7 and 6 with crude fibre value of 7.25 and 6.03 respectively. There was no much difference between diet 3 and 4 with crude fibre value of 5.22 and 5.32. The lowest crude fibre value of 3.60 was obtained in diet 1 and was slightly lower than diet 2 (4.09).

In the finisher diets the highest crude fibre value of 12.98 was recorded in control diet (8). Diet 7 was next with 10.38 followed by diets 6,5,4 and 3 with value of 9.51, 8.69, 8.39 and 8.33 respectively. The lowest value of 6.89 was obtained from diet 1 and was slightly lower than diet 2 (7.34).

4.1.4 Ash (%)

The starter diets highest ash content was recorded in diet 8 (control). This value was followed by diet 7 and 6 with value of 7.94 and 7.46. Diet, 1, 2, 5 and 3 were next while diet 4 was the lowest with value of 3.67.

The finisher diets highest value of 8.46 was recorded in the control diet (8). This was closely followed by diet 2 with a value of 8.15. The next were diets 6,3,1, with 7 having the lowest value of 2.99 and was slightly lower than diet 4 (3.78).

4.1.5 Moisture (%):

Starter diet highest moisture content was recorded in diet 3 with a value of 10.01, Diet 4 was next with 9.66, followed by diet 8 (control), 1,5,2,7, while diet 6 had the lowest value of 6.99.

Diet 7 had the highest value of 10.70 in the finisher diets. This was closely followed by diet 4 with 10.03. Next to this value was diet 1 with 9.92 followed by diet 5,2,3, while diet 8 (control) had the lowest value of 7.61.

4.1.6 Nitrogen free extract (N.F.E)%

The calculated nitrogen free extract (total digestible carbohydrate) of starter (Table 4.1) indicate that diet 1 had the highest value of 57.53 followed by diet 3, 2 and 5. Next to this was diet 6 and 7 with the value of 49.12 and 49.09 respectively. The lowest value of 42.9 was obtained in diet 8 (Control). The finisher diet on the other hand (Figure 4.2) had the highest value of 57.59 N.F.E. in diet 1 followed by diet 4, 5, 2 and 7. Diet 3 had the lowest value of 45.45 and was slightly lower than diet 6 and 8 (control) with the value of 45.57 and 46.42

4.1.7 **Percentage digestibility:**

Diet 4 had the highest digestibility value of 91.11 (Fig. 4.3 page 50). The next value to the highest was obtained in diet 2 (89.46) followed by diet 1,3,5,6 with 89.31, 89.21, 89.19, and 86.71 respectively. The lowest value of 81.63 was recorded in diet 8 (control) and was lower than diet 7 with 84.63.

4.1.8. **Amino Acid Analysis:**

The amino acid composition of all the seven experimental and control diets are shown in Fig. 4.4 page 51. Attention was focused on the indispensable amino acid that were analysed because these amino acid are needed for maintenance and growth of the broiler. They are arginine, histidine, leucine, lysine, isoleucine, methionine threonine, phenylalanine and valine. Tryptophan was not analysed because of logistic problems and it is one of the essential amino acid. Glutamic acid and glycine are considered because they are indispensable under fast growing condition of broilers.

Arginine (%):

The highest value of 4.25 was obtained in diet 2. This was slightly above diet 1 and 7 with value of 3.67 and 3.47 respectively. The next was diet 6,3,8 (control), and 4 while diet 5 had the lowest value of 2.67.

Figure 4.3 Digestibility of Diets

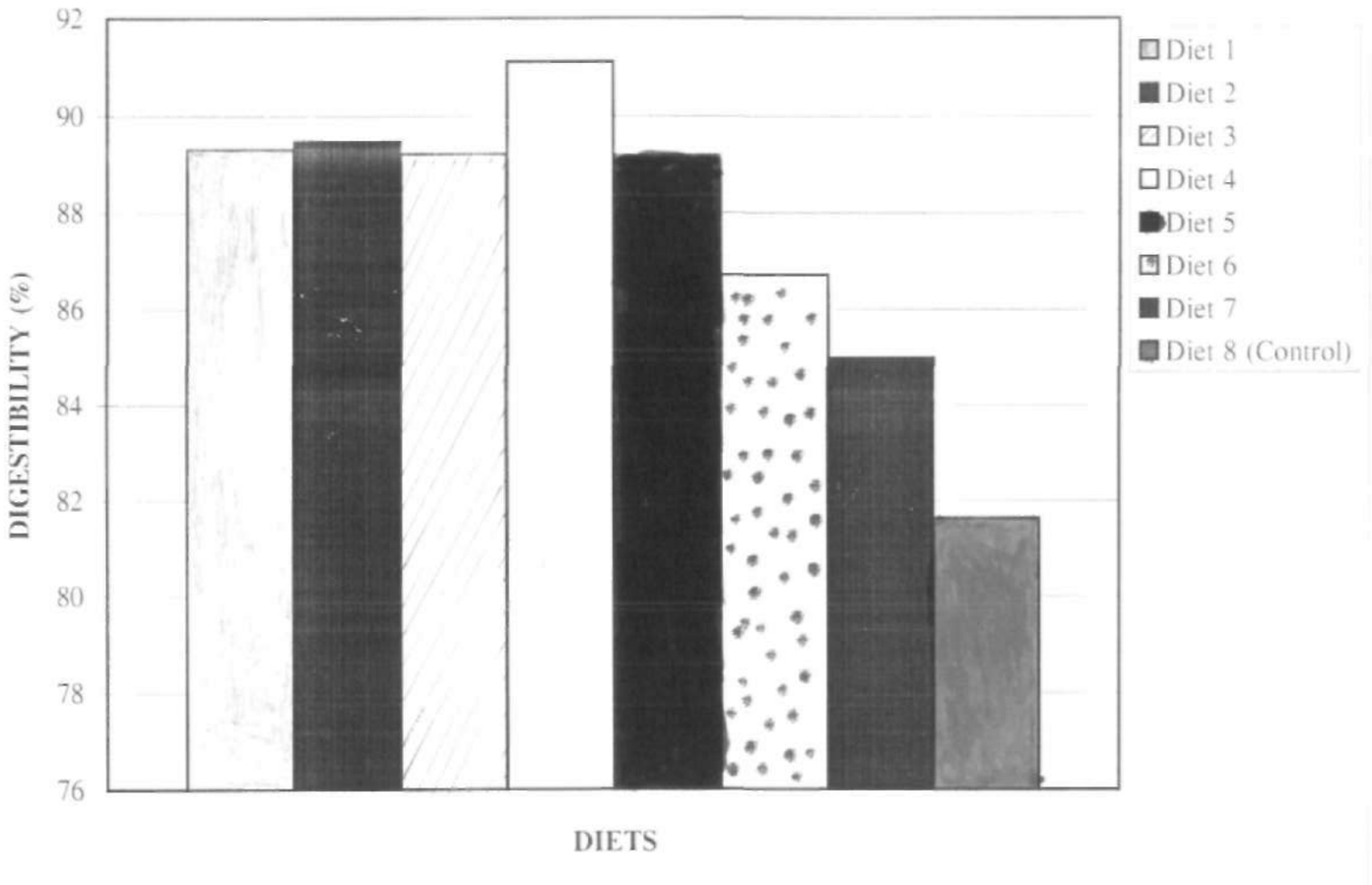
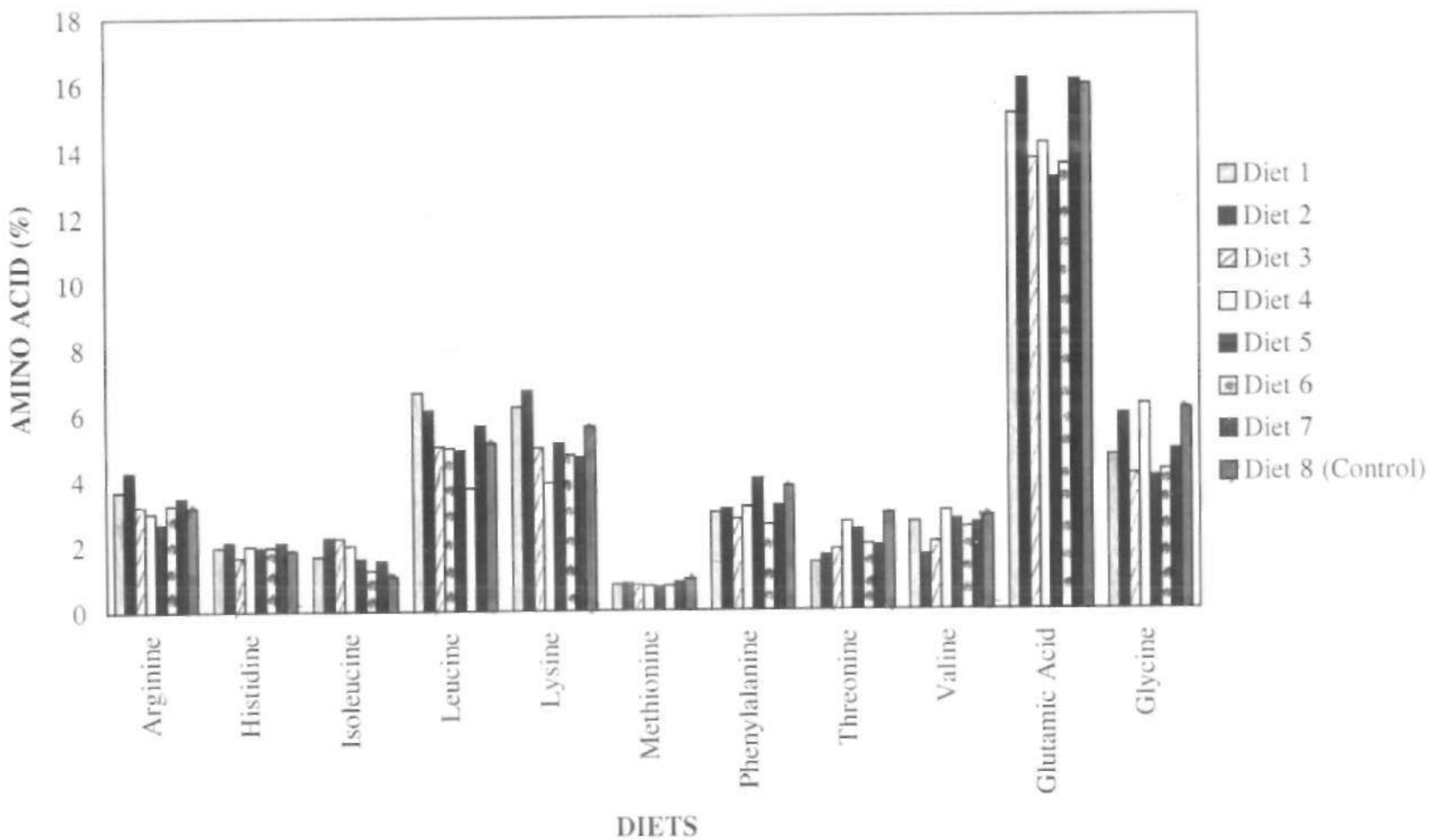


Figure 4.4 Analysed Amino Acids of Finisher Diets



Histidine (%):

Diet 2 had the highest value of 2.11 and it was closely followed by diet 7 with a value of 2.09. This was followed by diet 4,1,6 and 5 with a value of 12.00, 1.96, 1.95 and 1.94. The lowest value of 1.65 was recorded in diet 3.

Isoleucine (%):

The highest value of isoleucine was recorded in diet 2 (2.23), followed by diet 3 and 4 with value of 2.21 and 2.00. Diet 1, 5 and 7 were moderate. The lowest value of 1.06 was recorded in the control diet (8) and was slightly lower than diet 6(1.25).

Leucine (%):

Leucine was found in considerable quantity in all diets. The highest leucine value was obtained in diet 1. This was slightly above diet 2 with a value of 6.12 followed by diet 7, 8 (control), 4 and 5 with value of 5.65, 5.11, 4.97 and 4.88 respectively. Diet 6 had the lowest value of 3.74.

Lysine (%):

The highest value of 6.72 was obtained from diet 2. This was slightly above diet 1 with a value of 6.22 followed by diet 8(control) 5.62, and diet 5 with 5.11 and diet 3 (4.97). The lowest value of 3.89 was recorded in diet 4 and it was slightly lower than diet 6 with a value of 4.75.

Methionine (%):

The sulphur amino acid methionine was good enough in diet 8 (control), 7,2,1,3,4 and 6 with values of 0.95, 0.86, 0.82, 0.79, 0.77 and 0.75. Methionine value of diet 5 (0.70) was the lowest among all the experimental diet including the control.

Phenylalanine(%):

Diet 5 had the highest value of 4.00. This was closely followed by diet 8 (control) with values of 3.78 and the next were diet 7,4,2,1,3 while diet 6 recorded the lowest value of 2.60.

Threonine(%)

Diet 8 (control) recorded the highest value of 2.94 and it was closely followed diet 4 and 5 with 2.67 and 2.45 respectively. Next to this was diet 6,7,3 and 2. The lowest value was recorded in diet 1 with a value of 1.44.

Valine(%):

Valine was found in considerable quantity in all the diets. The highest value of 3.01 was obtained in diet 4. This was slightly above diet 8 (control) 5, 1 and 7 with a value of 2.85, 2.75, 2.67 and 2.64 respectively. The next to these values were diet 6 and 3 while diet 2 had the lowest value of 1.66.

Glutamic acid (%):

The highest value of 16.05 was obtained from diet 2. This was slightly above diet 7, 1 and 8 (control) with 16.05, 15.92, and 15.05. The next to this values were diet 4, 3, 6 while diet 5 had the lowest value with 13.10.

Glycine (%)

Diet 4 recorded the highest value of 6.24. Next to this value was diet 8 (control) with 6.11 followed by diet 2,7,1,6. The lowest value (4.11) was recorded in diet 3.

4.2 Growth and Food Consumed:

The growth rate of each bird in each diet is shown in Figure 4.5 page 57 while weight gain, food conversion ratio, protein efficiency ratio and food consumed are shown in Table 4.1 page 64 The weight of each bird and

the standard deviations shown in Appendix 3. The ANOVA of each variable is shown on Appendix 2. Summary of F value of each variable is shown is Table 4.5 page 65..

4.2.1 **Food consumed:**

Diet 8 (control) recorded the highest food consumed (1861.4g) per bird in week 1 to 3. Next to this was diet 7 with 1260g per bird followed by diet 4,2,6 and 1. The lowest food consumed was recorded in diet 3 with 1038.7g and was lower than diet 5 with 1081.9g (Table 4.1 page 64). The ANOVA of food consumed from week 1 to 3 indicated that there was high significant difference ($P<0.01$) between the diet and between the week (Table 4.2 page 65).The mean grouping showed there were two groups of insignificant difference (CD and EF). Diet 8 (AB) was significantly higher than others, while diet 7 mean was significantly higher than that of diet 3.

Diet	8	7	4	2	6	1	5	3
Mean	620.47g	420.00g	403.93g	380.27g	365.93g	360.80g	360.63g	346.2g
	A	B	C					D
			E					F

The group of week mean indicated that week 3(AB) is significantly higher than week 2 (CD) and 1 (EF) while week 2 is significantly higher than week 1.

Week	3	2	1
Mean	502.40g	422.89g	296.56g
	A	B C	D E F

Week 4 to 8 total food consumed by each bird showed that diet 8 (control) recorded the highest value of 6742.8g. Next to this was diet 4 with 4024.3g per bird followed by diet 7.2, 6 and 5. Diet 3 recorded the lowest value (3391.6g). The analysis of variance of food consumed from week 4 to 8 indicated that there was high significant difference ($P < 0.01$) between the diets and between the weeks. Duncan's ranking of diet mean showed that there are two groups of non significant difference (CD and EF). The mean of diet 8 (AB) is significantly higher than other mean, while diet 4 is significantly higher than diet 3.

Diet	8	4	7	2	6	5	1	3
Mean	1348.56g	804.90 g	762.38g	745.84g	728.80g	706.16g	693.92g	678.32g
	A	B	C					D
					E			F

Diet 8 had the highest food consumed (8604.2g) per bird in week 1 to 8. Next to this was diet 4 with value of 5236.1g followed by diet 7, 2,6 and 5. The lowest value was recorded in diet 3 (4430.3g). The analysis of variance of weekly food consumed per bird indicated that there was high significant difference ($P < 0.01$) between the diets and between the weeks (Table 4.2 page 65). In ranking the mean of food consumed within diet, there was one group of non significant difference between means of group CD. The mean of diet 8 was significantly higher than all other means.

Diet	8	4	7	2	6	5	1	3
Mean	107.53g	654.51g	634.02g	608.75g	592.65g	576.59g	569.00g	553.79g
	A	B	C					D

In Duncan's ranking of week means, there were two groups of non significance difference (GH and IJ). Week 8 (AB) was significantly higher than other weeks while week 7 (CD) significantly higher than others except week 8. Week 6 (EF) is significantly higher than week 4,5,3,2 and 1. Week 4 and 5 significantly higher than week 3, 2 and 1. Week 3 and 2 are significantly higher than week 1 (KL) statistically.

Week	8	7	6	4	5	3	2	1
Mean	1029.55g	919.64g	793.86g	668.80g	631.21g	502.32g	422.89g	296.56
	A	BC	DE	F G		H I	J K	L

4.2.2 Weight gain

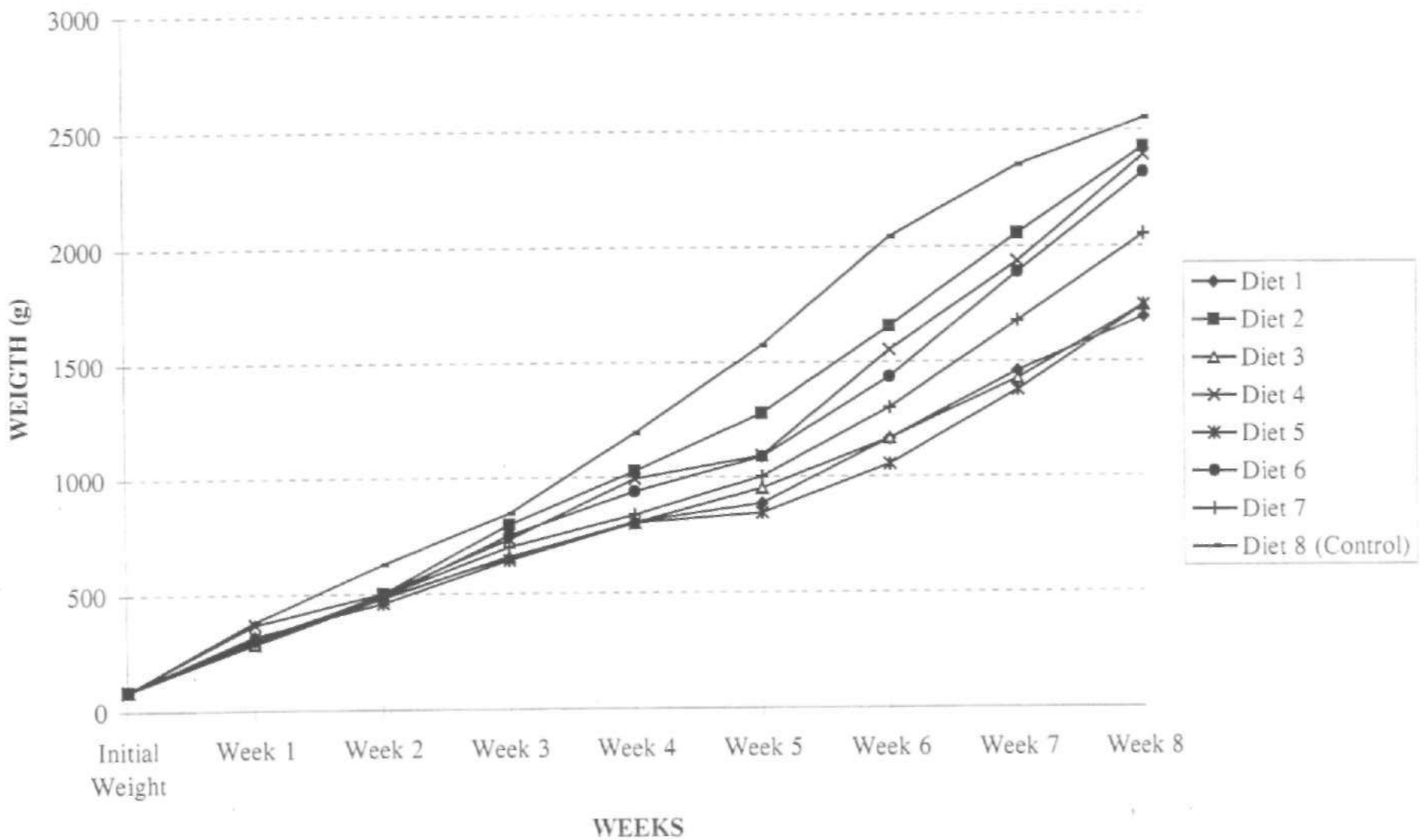
All the birds fed with the seven experimental diet and control show positive growth rate throughout the experimental period (Figure 4.5 page 57). The highest growth rate was recorded in diet with lima bean meal, soyabeans meal and soyabean and groundnut meal (diet 1, 2 and 6) week 7, diet 3, 4 and 5 week 8 while diet 8 (control week 6. The lowest growth rate was recorded in diet 1,3,4, 5 and 6 week diet 2 and 7 week 4, and diet 8 (control) week 8 (values shown in appendix 4).

The total weight gain per bird week 1 to 3 shows that diet 8 (control) had the highest value of 762.1 followed by diet 2 with 713. Next to these values were diet 6,4, and 7. The lowest value was recorded in diet 5 with a value of 557.8 and was slightly lower than diet 1 with 571.5g.

The analysis of variance of weekly weight gain per bird from week 1 to 3 indicated that there was no significant difference ($P > 0.05$) between diets and between the weeks at degree of freedom and 2 degree of freedom (Table 4.2 page 65).

Total weight gain for each bird from week 4 to 8 shows that the highest value of 1705 was obtained from the control diet (8) followed by diet

Figure 4.5 Mean Growth Rate of Broilers Fed with Seven Experimental and Control Diets



4 and 2 with 1658.4 and 1629.2g respectively. The lowest value was obtained in diet 1 (1037.5g) and was lower than diet 3,5,7 and 6.

The analysis of variance of weekly weight gain per bird from week 4 to 8 indicated that there was significant difference ($P<0.05$) in weight gain between the diets and high significant difference ($P<0.01$) between the weeks

(Table 4.2 page 65). Ducan's multiple range test for variables shows that there was three groups of non significant difference (AB, CD and EF) among the means of diet. The mean of diet 8 and 4 were significantly higher than that of diet 5, 3 and 1 while diet 2, 6 and 7 were significantly higher than diet 3 and 1

Diet	8	4	2	6	7	5	3	1
Mean	343.00g	331.64g	325.84g	313.34g	270.00g	220.00g	213.34g	207.52g

A_____B

C_____D

E_____F

The weeks mean weight gain grouping indicate two group of non significant difference (AB and CD) but the means in group AB are significantly higher than those of group CD.

Week	7	8	6	4	5
Mean	346.51g	343.60g	335.82g	198.56g	165.73g

A_____B C_____D

In the overall weight gain (week 1 to 8) diet 8 (control) had the highest value (2467.1). This was followed by diet 2,4,6 and 7 with 2342.2g, 2308.8g, 2233.9g and 1967.1g respectively. The lowest weight gain was recorded in diet 1 with a value of 1609.7g and was slightly lower than diet 5 and 3 (Table 4.1, page 64). Low weight gain of birds fed diet 1 may be due to low food consumption rate and quality of protein in the diet.

ANOVA of weekly wight gain per bird from week 1 to 8 shows significant

difference ($P<0.05$) between the diet and high significant difference ($P<0.01$) between the weeks (Table 4.2 page 65). Duncan's mean grouping indicated that there was no significant difference between the means weight gain of diet 8,2,4,6 and 7 but were significantly higher than diet 3,5, and 1 except diet7. The group AB and CD means were groups of non significant difference.

Diet	8	2	4	6	7	3	5	1
Mean	308.39g	292.80g	288.60g	279.24g	245.89g	207.3g	207.22g	201.14g
	A				B			
					C			D

In week mean grouping of weight gain, there was two group of non significant difference (AB and CD) but the means of group AB were significantly higher than that of group CD.

Week	7	8	6	1	3	4	2	5
Mean	346.54g	343.80g	335.84g	233.80g	215.74g	198.57g	191.84g	164.48g
	A			B	C			D

2.3 **Food conversion ratio (FCR):**

In week 1 to 3 diet 2 and 6 had the best FCR with a value of 1.6g each. Next to this was diet 3 (1.8g) followed by diet 1 and 5 with 1.9 each. The lowest food conversion ratio was recorded in diet 8 (control) with 2.4 and was lower than diet 4 and 7 with value of 1.8g and 2.0g (Table 4.1 Page 64). The ANOVA of FCR of week 1 to 3 indicated an insignificant difference ($P>0.05$) between the diets but high significant difference ($P<0.01$) was recorded between the weeks. In grouping the means of diet of FCR there were two groups with insignificant difference (AB and CD). The mean of diet 8 (control) is significantly higher than other mean except that of diet 5,7,4 and

1.

Diet	8	5	7	4	1	3	6	2
Mean	2.467g	2.100g	2.100g	2.033g	1.933g	1.733g	1.700g	1.600g
	A				B			
		C						D

The Duncan's grouping of week mean of FCR on the other hand indicate that the mean of week 3 and 2 have no significant difference but they were significantly higher than that of week 1.

week	3	2	1
Mean	2,388g	2,225g	1,263g
	A	B	C D

Diet 2 and 6 recorded the best FCR in week 4 to 8 with a value of 2.3g each. This was followed by diet 4 with 2.4g. Next to this was diet 7, 5 and 1 but diet 8 (control) recorded the lowest food conversion ratio of 4.0g. In the analysis of variance there was no significant difference between FCR of diet in week 4 to 8. The FCR of week indicated a significant difference at 4 degree of freedom. The grouping of the means of week FCR showed that the mean of week 5 is significantly higher than other means except that of week 4 and 8. There were two groups (AB and CD) with insignificant difference.

Week	5	4	8	7	6
Mean	4.887g	3.500g	3.313g	2.750g	2.475g
	A		B		
		C			D

The FCR of week 1 to 8 had 2.1g as the best value and was recorded in diet 2 and 6. Next to this was diet 4 with 2.3g followed by diet 7, 3 and 1. The lowest food conversion ratio was recorded in diet 8 (control) with

value of 3.5g. The analysis of variance of FCR indicated an insignificant difference between the diets and a high significant difference between the weeks.

Duncan's mean grouping FCR of weeks showed that the mean of week 5 (AB) is significantly higher than other mean. While group CD and EF difference was insignificant but week 4, 8 and 7 are significantly higher than week 1.

Week	5	4	8	7	6	3	2	1
Mean	4.887g	3.500g	3.313g	2.750g	2.475g	2.388g	2.225g	1.263g
	A	B C					D	
					E			F

4.2.4 **Protein efficiency ratio(PER):**

The best protein efficiency ratio in week 1 to 3 was recorded in diet 2 with a value of 2.8g. Next to this was diet 3 and 6 with 2.7g each followed by diet 5, 1 and 4 with 2.4g each. The lowest value was recorded in diet 8 (control) with value of 1.9 and was slightly lower than diet 7 with 2.2g (Table 4.1. page 64).

The ANOVA of PER of week 1 to 3 indicated that there was no significant difference between the diets, but there was high significant difference between the weeks (Table 4.2 page 65). The Duncan grouping showed that the mean of week 1 is significantly higher than week 2 and 3 while week 2 is significantly higher than week 3.

Week	1	2	3
Mean	3.637g	2.100g	1.612g
	A B	C D	E F

The highest value of 2.1 in week 4-8 PER was recorded in diet 2 and 6. Next to this value was 1.9g recorded in diet 7 and 4 followed by the value of diet 3 (1.7g). The lowest value was obtained from diet 1 and 5 with 1.6g each. There was significant difference in the PER of diet but week PER indicated high significant difference. Duncan's multiple range test for variable showed that the mean of PER in diet 2 is significantly higher than other mean except the mean of diet 6,7 and 4. The means of diet 6 is significantly higher than that of diet 5 and 8. While group AB,CD and EF had insignificant difference.

Diet	2	6	7	4	3	1	5	8
Mean	2.280g	2.080g	1.820g	1.800g	1.660g	1.520g	1.460g	1.420g
	A			B				
		C					D	
			E					F

The Duncan's means grouping of week PER indicated three groups of non significance difference (AB,CD, and EF). week 6 and 7 mean are higher than mean of week 4 and 5, while week 8 was significantly higher than means of week 5.

Week	6	7	8	4	5
Mean	2.100g	1.987g	1.875g	1.512g	1.300g
	A	B	C	D	
				E	F

In week 1 to 8 the best protein efficiency ratio of 2.3g was recorded in diet 2 and 6. This was closely followed by diet 4 with 2.0g. Next to this was diet 3 and 7 with 1.9g each and the value was so slightly above that of

diet 1 and 5. The lowest PER was recorded in control diet (8) with a value of 1.5g. The ANOVA of PER of week 1 - 8 indicated a significant difference between diet and a high significant difference between the weeks. Duncan's grouping of the diet mean showed three group of non significant difference (AB, CD, and EF). Diet 2 mean was significantly higher than other diet mean except that of diet 6, 4 and 3. The mean of diet 6,4,3 and 7 were significantly higher than diet 8.

Diet	2	6	4	3	7	5	1	8
Mean	2.500g	2.163g	2.100g	2.100g	1.937g	1.900g	1.875g	1.550g
	A			B				
		C					D	
							E	F

The week mean grouping show three groups of non significant difference (CD, EF, and GH). The mean of week 1 (AB) was significantly higher than other mean. Week 2 and 6 are significantly higher than week 4 and 5 and week 7 had significant difference with mean of week 5.

Week	1	2	6	7	8	3	4	5
Mean	3.637g	2.100g	2.100g	1.987g	1.875g	1.612g	1.512g	1.300g
	A	B	C				D	
				E			F	
							G	H

4.2.5. Percentage death rate:

There was no death recorded in diet 1,2,3,4,5,6, and 8 (control). One bird felt sick and died after 2 days which represent 16.67% death rate in diet 7 (Table 4.1 page 64). One bird each got paralysed in diet 2 and 8 (control). The death recorded may be due to infection. The problem of birds paralyses may be due to consumption of excess protein or lack of sufficient quantity of vitamin D and calcium in the diets.

TABLE 4.1 DETAIL OF INITIAL WEIGHT, FINAL WEIGHT, FOOD CONVERSION RATIO, PROTEIN EFFICIENCY RATIO PERCENTAGE DEATH RATE AND FOOD CONSUMED PER BIRD IN GRAMS.

	DIET	INITIAL WEIGHT	FINAL WEIGHT	WEIGHT GAIN	FOOD CONVERSION RATIO	PROTEIN EFFICIENCY	PECENTAGE DEATH RATE	FOOD CONSUMED
DIET 1	Week 1-3	82.7	654.2	571.3	1.9	2.4	00	1082.4
	Week 4-8	654.2	1691.7	1037.5	3.3	1.6	00	3469.5
	Week 1-8	82.7	1691.7	1609	2.8	1.8	00	4551.7
DIET 2	Week 1-3	82.8	795.8	713	1.6	2.8	00	1140.8
	Week 4-8	795.8	2425	1629.2	2.3	2.1	00	3729.2
	Week 1-8	82.8	2425	2342.2	2.1	2.3	00	4870
DIET 3	Week 1-3	82.9	675	592.1	1.8	2.7	00	1038.7
	Week 4-8	675	1741.7	1066.7	3.2	1.7	00	3391.6
	Week 1-8	82.9	1741.7	1658.8	2.7	1.9	00	4430.3
DIET 4	Week 1-3	82.9	733.3	650	1.9	2.4	00	1217.8
	Week 4-8	733.3	2391.7	1638.4	2.4	1.9	00	4024.3
	Week 1-8	82.9	2391.7	2308.8	2.3	2.0	00	5226.1
DIET 5	Week 1-3	83.9	641.7	557.8	1.9	2.4	00	1081.9
	Week 4-8	641.7	1741.7	1100	3.2	1.6	00	3530.8
	Week 1-8	83.9	1741.7	1657.8	2.8	1.8	00	4812.7
DIET 6	Week 1-3	82.8	750	667.2	1.6	2.7	00	1097.8
	Week 4-8	750	2316.7	1566.7	2.3	2.1	00	3644.
	Week 1-8	82.8	2316.7	2233.9	2.1	2.3	00	4741.8
DIET 7	Week 1-3	82.9	700	617.1	2.0	2.2	00	1260
	Week 4-8	700	2050	1350	2.8	1.9	00	3812.2
	Week 1-8	82.9	2050	1967.1	2.6	1.9	16.67	5072.2
DIET 8	Week 1-3	82.9	845	762.1	2.4	1.9	00	1861.4
	Week 4-8	845	2550	1705	4.0	1.4	00	6742.8
	Week 1-8	82.9	2550	2467.1	3.5	1.5	00	8604.2

TABLE 4.2 SUMMARY OF 'F' VALUE (COMPLETE ANOVA TABLE IN APPENDIX 2) OF WEIGHT GAIN, FOOD CONVERSION RATIO, PROTEIN EFFICIENCY RATIO AND FOOD CONSUMED

WEEKS		WEIGHT GAIN	FOOD CONVERSION RATIO	PROTEIN EFICIENCY RATIO	FOOD CONSUMED
1-3	DIET WEEK	1.24 NS 2.60 NS	2.77* 34.77**	2.26 NS 48.73**	21.15** 27.81**
4-8	DIET WEEK	2.91* 10.99**	1.55 NS 3.10*	2.59* 5.06**	38.69** 35.32**
1-8	DIET WEEK	3.93* 11.71**	2.01 NS 6.42**	3.09 21.12**	26.99** 56.83**

NS = Non Significant ($P > 0.05$)
* = Significant ($P < 0.05$)
** = Highly Significant ($P < 0.01$)

CHAPTER FIVE

DISCUSSION:

5.1. Chemical Analysis

The chemical analysis of diets has revealed that there was variation in the proximate composition of crude protein content of the seven experimental diets. All crude protein in the diets were below the calculated value of 23% of the starter diets. The crude protein content of the experimental diets (starter) are higher than the one recommended by N.R.C. (1971) and slightly lower than that of Aduku (1993) and Olumu (1979) recommended level. The finisher diets on the other hand show variation in crude protein with most of the values falling below the calculated 20% crude protein. Despite the variation in the crude protein of the finisher diets the crude protein were within the recommended range of Olumu (1979), with most of the values slightly lower than that of Aduku (1993). The differences observed in respect of the crude protein of the diets may be due to variation of crude protein content of seeds used as the source of protein. The variation of crude protein of grains is caused by differences in soil fertility, time of harvest, genetic constitution and several other factors (Santosh 1991).

The proximate composition of crude fibre of experimental and control finisher diet showed a higher value than the 5.0 percent maximum value recommended by Olumu (1979). The crude fibre in the starter diets are within the Olumu (1979) recommended range. Since the fibres are not digestible carbohydrate, the variation in the composition of crude fibre may cause variation in the digestibility of the diets.

The fat which is an important raw material in broiler chicken diets as sources of dietary energy shows variation in composition within the diets used in the experiment. The percentage fat content of diet with lima bean meal (both finisher and starter diet) are below the recommended level of N.R.C (1971) and Olumu (1979). The percentage crude fat content of the diets (starter and finisher) that contain groundnut meal are above the recommended level. There is variation in the crude fat content of seeds used as sources of protein in the diets. As shown by Asiedu (1989) Onwueme and Sinha (1991) and Purseglove (1974), groundnut seeds has the highest fat content followed by Soyabean and lima bean. The level of crude fat content of the diets further confirms the ranking of these seeds in respect of their crude fat content as diets form with high fat ingredient indicated high crude fat. As a source of energy, variation in the composition of fat within the diets will lead to variation in the caloric density of the diets.

The level of crude ash in the experimental diets shows that the diets with groundnut meal and diet with soyabean and lima bean meal (starter) and diet with groundnut meal and diet with groundnut and soyabean meal (finisher) are similar to N.R.C. (1984) recommended level. The crude ash of diet with soyabean meal and control (finisher) and diets with LM, SM, SGM (diet 1,2,6 and 7) and control starter are higher than N.R.C. 1984 recommended level. The level of crude ash in diet with soyabean and lima bean meal (diet 4) starter, diet with soyabean and lima bean meal and diet with soyabean, groundnut and lima bean meal (diet 4 and 7) finisher are lower than recommended value. Since crude ash represents the mineral content of

the diet, its variation indicate variation of mineral composition within the experimental diets. The observed difference may be due to the type of ingredient used in formulating the diets.

The chemical analysis of the experimental and control diets revealed that there was variation in moisture content (both starter and finisher diets). This shows that the water content of the ingredients used in formulating the rations are not the same.

The calculated nitrogen free extracts (total digestible carbohydrate) in both starter and finisher of experimental and control diets also revealed that there was variation in their composition. There is variation in the carbohydrate content of the seed used as source of protein. As shown by Asiedu (1989). Purseglove (1974), Onwueme and Sinha (1991) lima bean has the highest carbohydrate content followed by soyabean and groundnut. The level of N.F.E. (total digestible carbohydrates) content of the experimental diets further buttress the ranking of these seeds, as diet form with meal containing high carbohydrate indicate high N.F.E. Since there is variation in total digestible carbohydrate (N.F.E.) the caloric density of the diets will not be the same among the experimental and control diets.

Generally, the digestibility test of the experimental and control diet indicate high percentage digestibility. This shows that most of the ingredients were made available for absorption into the body system. The percentage of crude fibre generally affect digestibility of food (Adolph and Moiyiwu 1984) and as such the low level of digestibility of control diet compared to the experimental diet may be due to its high fibre content. The variation observed

in respect to digestibility within the experimental diets may be due to variation in their crude fibre content.

One important consideration of a foodstuff that is to serve as a protein source for livestock and in particular poultry is its balance of amino acids (Offiong 1979, Aduku 1992). However, the amino acids in all the diets (experimental and control) are in agreement with N.R.C. (1984), McDonald et al (1987) and Aduku (1993) and non of the value is deficient compared to Olumu (1979) recommended level. Even though the amino acid level in all the experimental and control diets were not the same, all the values were up to the level required by broiler. Since plant protein sources are associated with deficiency of particular amino acid, the attainment of required level may be due to the combination of different foodstuffs with different amino acid levels. The deficiency of amino acid associated with a particular foodstuff may be corrected by another as they were combined together to form a diet. The amino acid has met the requirement of broiler chicken, as such any growth depression cannot be explained by amino acid deficiency.

5.2. Growth/Food intake:

The food consumed by the bird in all phases of the trial indicates a high significant difference ($P<0.01$) between the diet and between the weeks. The mean food consumed indicate significant difference ($P<0.05$) between the control and experimental diets. The bird fed with diet having high energy giving food (total digestible carbohydrate plus fat) consumed less food compared to the one with less energy giving food. This finding is in agreement with Olumu (1979) and Scott et al (1982) who reported that

chickens consume food to meet their energy requirement and within a certain energy range, food consumption decreases with increase in energy level. The difference observed between weeks may be due to age because food consumption increases with increase in age of the animal up to a particular level.

The result of weight gain indicated that there was a general increase in body weight in all trials without decrease in weight. However, the result of weight gained during the brooding period (week 1-3) shows that there was no significant differences ($P > 0.05$) in the performance of the bird between the diets and between weeks. The performance of birds during the period they were fed with finisher diet indicates significant difference ($P < 0.05$) between the diets and high significant differences ($P < 0.01$) between the weeks. The final weight gained shows significant differences ($P < 0.05$) between performance of the bird fed with different diets. The bird fed with control diet which had the highest mean weight gain shows non significant differences ($P > 0.05$) with the mean weight of bird fed with diet containing soyabean, soyabean and lima bean, soyabean and groundnut and diet with soyabean, lima bean and groundnut (diet 2, 4, 6, and 7). The best performance in terms of weight gained among experimental diet was recorded in diet with only soyabean as the vegetable protein. It may be due to the quality of protein in soyabean which according to McDonald et al (1987) and Onwueme and Sinha (1991) have the best protein compare to other plant protein sources. The weight gained increases with the increase of the quantity of soyabean in the diet. The bird fed with diet without soyabean (diet with

lima bean, groundnut and diet with groundnut and lima beans) mean weight gain were significantly ($P<0.05$) lower than control diet.

These findings are in agreement with Barbour et al, (1992) who reported that protein sources cause significant differences in chick performance, soyabean meal promoted the fastest, gain gluten meal the lowest gain and groundnut meal and sesame meal intermediate gains.

The lower performance of birds fed with diet without soyabean cannot be explained by amino acid deficiency as their amino acid level do not fall below the Olumu (1979) and N.R.C. (1984) recommended level. The birds probably consumed less feed to meet their total nutrient requirement and thus resulted in depressed body weight gains compared to those fed with diets containing soyabean meal with good performance. The differences observed in respect to weeks weight gain may be due to age and environmental factor. Week five was characterized by heavy wind accompanied by rainfall which interrupted light supply which led to low food consumption.

The best food conversion ratio (week 1 - 3) was recorded in diet with soyabean and groundnut and one with soyabean. The bird fed diet with lima bean, groundnut, soyabean and groundnut, lima bean and groundnut and a diet with groundnut, soyabean and lima bean are similar to Aduku (1993) expected value. The food conversion ratio of the bird fed control diet is lower than all the experimental diet.

The food conversion ratio of week 4 - 8 showed that the birds fed diet with soyabean, soyabean and groundnut, soyabean and lima had values similar to Aduku's (1993) expected food conversion ratio. Other experimental and

the control diets are lower in rating compared to the one mentioned above. The overall result (Week 1 - 8) indicated that the bird fed with soyabean and the one fed with soyabean and groundnut had an improved food conversion ratio compared to Aduku's (1993) expected value. Other experimental diets food conversion ratio are similar to the expected value but the control diet had a lower food conversion ration. The observed difference in respect to food conversion ratio may be due to variation in the composition of experimental and control diets.

There was significant difference ($P<0.05$) in protein efficiency ratio (PER) of the bird fed different diet and high significance difference ($P<0.01$) between the weeks in week 1-3. The bird fed with soyabean, groundnut, soyabean and groundnut had the best protein efficiency ratio (PER); while other experimental diet had intermediate value with control recording the lowest value. When the birds were fed with the finisher diet, (week 4 - 8) the bird fed with soyabean had the best protein efficiency ratio while birds in other experimental diet had intermediate PER. When compared with experimental diet the bird fed control diet had the lowest protein efficiency ratio.

The over all result of protein efficiency ratio (week 1-8) is similar to that of week 4 to 8. The performance of bird between the diets indicate significant difference ($P<0.05$) while that of week 1-8 protein effeciency ratio indicates high significant difference ($P<0.01$). The birds fed diets with soyabean had the best protein efficiency ratio (PER) compared with other experimental diets without soyabean. The performance of birds fed control

diet is lower than that of all experimental diets. The differences observed between the diets may be due to variation in protein source of the diets.

The leg problem developed by the birds in diet with soyabean meal (diet 2) and control may be due to consumption of excess protein or insufficient vitamin D. That of diet two developed earlier than that of the control diet. This may have caused the difference in terms of body weight as there was not much significant increase in weight among birds with leg problem.

The death rate of birds fed experimental diets was generally low. This is a clear indication that the birds can tolerate the experimental diets. The death rate was lower than those reported by Ologhobo et al (1993). The difference observed in respect to mortality rate may be due to the food processing methods, types of experimental diets and nature of routine management techniques employed.

5.3 Conclusion/Recommendation:

Poultry nutritional research in Nigeria has come a long way from what it used to be only 3 to 5 years ago. However, this study indicates that birds fed diets containing high carbohydrate and fat consume less food compared with those fed with diet containing lower fat and carbohydrate. The birds fed diets with soyabean meal had high mean weight gain which show no significant difference with the birds fed control diets. The diets with soyabean meal also had the best food conversion ratio and protein efficiency ratio.

The significance of this research investigation lies in the fact that soyabean, groundnut lima bean were successfully combined in various proportion in diets which adequately supported growth of broiler chickens.

The indispensable amino acids in all the experimental diets are not dificient and the digestibility of the diets was high. There was low mortality rate of the birds fed with these diets. This indicates that the experimental diets had the potential to be used in feeding broilers.

However, in order of magnitude, diet 2, 4 and 6 are recommended for use in broiler production in Nigeria. The birds fed with these diets do not indicate significant difference with the one fed with commercial Guinea Feed. They also had a better protein effieiency and food conversion ratio compared to that of control diet.

This work can serve as a spring-board for other researches in an effort to finding the most suitable locally available feed for broiler chickens. In view of the fact that high carbohydrate and fat usually lead to low food consumption rate, extraction of the oil from groundnut and partial replacement with some carbohydrate source might prove useful in subsequent work or feed formulation using lima bean, groundnut and soyabean.

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APPENDIX

APPENDIX 1
CALCULATION OF 23 PERCENT CRUDE PROTEIN STARTER AND 20 PERCENT FINISHER DIET WITH MAIZE AS THE SOURCE OF ENERGY.

Diet 1 Ratio of 1:3 blood and lima bean with premix, common salt and bone meal fixed at .25, .25 and 3% (starter)

Blood meal 1 x 80 = 80

Lima bean 3 x 22 = $\frac{66}{146}$ $\frac{146}{4}$ = 36.5 (Protein)

X = Maize

Y = Protein

1. $x + y = 100 - 3.5 = 96.5$

2. $.08x + .365 = 23$

3. $.08x + .08y = 7.72$

4. $0x + .285y = 15.28$

$= Y = \frac{15.28}{.285} = 53.61$

$X = 96.5 - 53.61 \quad 42.89$

Blood meal $= \frac{53.61}{4} = 13.40$

Lima bean $= 53.61 - 13.40 = 40.21$

Diet 2 Ratio of 1.3 blood meal and soyabean with premix, common salt and bone meal fixed at .25, .25 and 3% (starter)

Blood meal 1 x 80 = 80

Soyabean 3 x 38 = $\frac{114}{194}$ $\frac{194}{4}$ = 48.5

x = Maize

y = Protein

1. $x + y = 100 - 3.5 = 96.5$

2. $.08x + .485y = 23$

3. $.08x + .08y = 7.72$

4. $.0x + .405y = 15.28$

$$y = \frac{15.28}{.405} = 37.72$$

$$x = 96.5 - 37.72 = 58.77$$

$$\text{Blood} = \frac{37.72}{4} = 9.43$$

$$\text{Soyabean} = 37.72 - 9.43 = 28.29$$

Diet 3 Ratio of 1:3 blood meal and groundnut with premix, common salt land bone meal fixed

at .25, .25 and 3%

Blood meal $1 \times 80 = 80$

Groundnut $3 \times 28 = \frac{84}{164}$ $\frac{164}{4} = 41$

x = maize

y = protein

1. $x + y = 100 - 3.5 = 96.5$
2. $.08x + .41y = 23$
3. $.08x + .08y = 7.72$
4. $.0x + .33y = 15.28$

$$y = \frac{15.28}{33} = 46.30$$

$$x = 96.5 = 46.30 = 50.2$$

$$\text{Blood} = \frac{46.30}{4} = 11.58$$

Groundnut = 46.30-11.58 = 34.72

Diet 4 Ratio of 1:3 blood meal to lima bean and soyabean (starter)

Blood $13.40 + 9.43 = 22.83 \div 2 = 11.42$

Soyabean $= 28.29 \div 2 = 14.15$

Lima bean = 40.21 ÷ 2 = 20.11

Maize 42.89 + 58.78 = 101.67 ÷ 2 = 50.83

Diet 5, starter Blood = 11.58+13.40 = 24.98 ÷ 2 = 12.49

Maize = 42.89 + 50.2 = 93.09 ÷ 2 = 46.55

Lima bean = 40.21 ÷ 2 = 20.11

Groundnut 34.72 ÷ 2 = 17.36

Diet 6, starter Maize = 58.78 + 50.2 = 108.98 ÷ 2 = 54.49

Blood = 9.43+11.58 = 20.01 ÷ 2 = 10.51

Soyabean = 28.29 ÷ 2 = 14.15

Groundnut = 34.72 ÷ 2 = 17.36

Diet 7 starter Maize = 58.78 + 50.2+42.89 = 151.87 ÷3 = 50.62

Blood = 9.43+11.58+13.40 = 34.41 ÷ 3 = 11.47

Lima bean = 40.21 ÷ 3 = 13.40

Groundnut = 34.72 ÷ 3 = 11.57

Soyabean = 28.29 ÷ 3 = 9.43

Diet 1 Ratio of 1:3 blood mean and lima bean with common salt, VM premix and bone meal fixed at .25, .25 and 3% (finisher)

Blood 1 x 80 = 80

Lima bean .3 x 22 = $\frac{66}{146}$ $\frac{146}{4}$ = 36.5 (protein)

x = maize

y = protein

1. xy = 100 - 3.5 = 96.5

2. .08x + .365y = 20

3. .08x + .08y = 7.72

4. .0x + .285y = 12.28

$$y = \frac{12.28}{285} = 13.09$$

x = 96.5 - 43.09 = 53.41

$$\text{Blood} = \frac{43.09}{4} = 10.77$$

Lima bean = 43.09 - 10.77 = 32.32

Diet 2 Ratio of 1:3 blood meal and soya bean with common salt, VM premix and

bone meal fixed at .25, .25 aand 3% (finisher)

Blood = 1 x 80 = 80

$$\text{soyabean } 3 \times 38 = \frac{114}{194} \quad \frac{184}{4} = 48.5$$

x = Maize

y = Protein

1. x + y = 100 - 3.5 = 96.5
2. .08x + .485y = 20
3. .08x + .08y = 7.72
4. 0x + .405y = 12.28

$$y = \frac{12.28}{.405} = 30.32$$

x = 96.5 - 30.32 = 66.18

$$\text{Blood} = \frac{30.32}{4} = 7.58$$

Soyabean = 30.32 - 7.58 = 22.74

Diet 3 Ratio of 1:3 blood meal and groundnut with premix, common salt and bone meal fixed at .25, .25 and 3% (Finisher).

Blood meal 1 x 80 = 80

Groundnut 3 x 28 = $\frac{84}{164}$ $\frac{164}{4}$ = 41

x = maize

y = Protein

1. x + y = 100 - 3.5 = 96.5

2. .08x + .41y = 20

3. .08x + .08y = 7.72

4. 0x + .33y = 12.20

$y = \frac{12.28}{.33} = 37.21$

x = 96.5 - 37.21 = 59.29

Blood = $\frac{37.21}{4}$ = 9.30

Groundnut = 37.21 - 9.30 = 27.91

Diet 4 Finisher

Blood = 10.77 + 7.58 ÷ 2 = 9.18

Soyabean = 22.74 ÷ 2 = 11.37

Lima bean = 32.32 ÷ 2 = 16.16

Maize = 53.41 + 66.18 ÷ 2 = 59.80

Diet 5 finisher

Blood = 10.77 + 9.30 ÷ 2 = 10.03

Lima bean = 32.32 ÷ 2 = 16.16

Groundnut = 27.91 ÷ 2 = 13.96

Maize = 59.29 + 53.41 ÷ 2 = 56.35

Diet 6 finisher

Blood = 7.58 + 9.30 ÷ 2 = 8.44

Groundnut 27.91 ÷ 2 = 13.96

Soyabean 22.74 ÷ 2 = 11.37

Maize = 59.29 + 66.18 ÷ 2 = 62.74

Diet 7. Finisher

Blood = 10.77 + 7.58 + 9.30 ÷ 3 = 9.22

Groundnut = 27.91 ÷ 3 = 9.30

Soyabean = 22.74 ÷ 3 = 7.58
Maize = 53.41 + 66.18 + 59.29 ÷ 3 = 59.63

Lima bean 32. 32 ÷ 3 = 10.77

APPENDIX 2

COMPLETE ANOVA TABLE OF WEIGHT GAIN, FOOD CONSUMED, FOOD CONVERSION RATIO AND PROTEIN EFFICIENCY RATIO.

WEIGHT GAINED
WEEK 1 - 3

SOURCE	DF	SS	MS	F.
Week	2	7044.23250	3522.11625	2.60
DIET	7	11785.77167	1683.68167	1.25
ERROR	14	19000.60087	1357.18577	

WEEK 4 - 8

SOURCE	DF	SS	MS	F.
WEEK	4	250266.3135	62566.5784	10.99
DIET	7	116080.5950	16582.9421	2.91
ERROR	28	159398.4625	5692.8022	

WEEK 1 - 8

SOURCE	DF	SS	MS	F.
WEEK	7	301178.0150	45882.5736	11.71
DIET	7	108191.9950	15455.9995	3.94
ERROR	49	192067.4500	3919.7439	

FOOD CONSUMED
WEEK 1 - 3

SOURCE	DF	SS	MS	F.
WEEK	2	172398.1858	86199.0929	75.81
DIET	7	168371.4533	24053.0648	21.15
ERROR	14	15918.9542	1137.0682	

WEEK 4 - 8

SOURCE	DF	SS	MS	F.
WEEK	4	898962.111	224740.528	35.32
DIET	7	1723159.856	246165.694	38.69
ERROR	28	178164.389	6363.014	

WEEK 1 - 8

SOURCE	DF	SS	MS	F.
WEEK	7	3487567.880	498223.983	56.83
DIET	7	1656155.412	236593.630	26.99
ERROR	49	429562.996	8766.612	

FOOD CONVERSION RATIO (FCR)

WEEK 1 - 3

SOURCE	DF	SS	MS	F.
WEEK	2	5.91583333	2.95791667	34.77
DIET	7	1.6516667	0.23595238	2.77
ERROR	14	1.19083333	0.08505952	

WEEK 4 - 8

SOURCE	DF	SS	MS	F.
WEEK	4	3.62650000	0.90662500	5.06
DIET	7	3.25500000	0.46500000	2.59
ERROR	28	5.01750000	0.17919643	

WEEK 1 - 8

SOURCE	DF	SS	MS	F.
WEEK	7	64.50500000	9.21500000	6.42
DIET	7	20.24500000	2.89214286	2.01
ERROR	49	70.35000000	1.43571429	

PROTEIN EFFICIENCY RATIO (PER)

WEEK 1 - 3

SOURCE	DF	SS	MS	F
WEEK	2	17.87250000	8.93625000	48.73
DIET	7	2.90000000	0.414228571	226
ERROR	14	2.56750000	0.18339286	

WEEK 4 - 8

SOURCE	DF	SS	MS	F
WEEK	4	3.62650000	0.90662500	5.06
DIET	7	3.25500000	0.46500000	2.59
ERROR	28	3.01750000	0.1791643	

WEEK 1 - 8

SOURCE	DF	SS	MS	F
WEEK	7	28.74437500	4.10633929	21.12
DIET	7	4.21187500	0.60169643	3.09
ERROR	49	9.52812500	0.19445153	

APPENDIX 3

MEAN WEIGHT/STANDARD DEVIATION OF BIRD IN GRAMS

WEEKS	I	II	III	IV	V	VI	VII	VIII
DIET	MEANS WEIGHT ± SD	MEAN WEIGHT ±SD	MEAN WEIGHT ± SD	MEAN WEIGHT ±SD	MEAN WEIGHT ± SD	MEAN WEIGHT± SD	MEAN WEIGHT ±SD	MEAN WEUGHT±SD
1.	291.7 73.6	483.3 87.6	654.2 67.9	804.2 64.1	883.3 60.6	1166.7 816.5	1458.3 159.4	1691.7 247.8
2.	287.5 44.0	500 118.3	795.8 134.6	1025 175.4	1275 172.5	1654.2 222.7	2054.2 282.1	2425 379.1
3	283.3 58.5	479.2 78.1	675 44.7	800 77.5	950 126.5	1166.7 180.7	1425 271.6	1741.7 288.8
4.	366.7 49.2	500 100	733.3 153.8	991.7 165.6	1091.7 132	1550 184.3	1933.3 201.7	2391.7 243.8
5	316.7 73.6	458.3 102.1	641.2 124.2	800 179.6	841.7 198.5	1054.2 317.2	1375 377.8	1741.7 427.1
6	308.3 73.6	483.3 116.9	750 150.8	937.5 141.7	1087.5 167.3	1434.2 308.4	1887.5 404.8	2316.7 414.3
7	300 35.4	490 65.2	700 117.3	835 127	1000 108.0	1300 154.1	1675 125.8	2050 216
8	380 57.0	625 79.1	845 54.2	1190 96.2	1570 135.1	2040 163.6	2350 255	2550 162.0

APPENDIX 4

WEIGHT GAIN IN GRAMS (AV) PER WEEK

DIET	WEEK I	WEEK II	WEEK III	WEEK IV	WEEK V	WEEK VI	WEEK VII	WEEK VIII
1.	209	191.6	170.9	150.1	79.1	283.4	291.6	233.4
2.	204.7	212.5	295.8	229.2	250	379.2	399.8	371
3	200.4	195.9	195.8	125	150	216.7	258.3	316.7
4.	283.8	183.3	183.3	258.4	100	458.3	383.3	458.4
5	232.8	141.6	183.4	158.3	41.7	212.5	320.8	366.7
6	225.5	175	266.7	187.5	150	366.5	433.5	429.2
7	217.1	190	210	135	165	300	375	375
8	297.1	245	220	345	380	470	310	200

APPENDIX 5

(AV) FOOD CONSUMED PER WEEK IN GRAMS

DIET	WEEK I	WEEK II	WEEK III	WEEK IV	WEEK V	WEEK VI	WEEK VII	WEEK VIII
1.	294.8	382.8	404.8	490.5	516.3	695.8	853.5	913.5
2.	256	394.5	490.3	660.8	613.7	741.3	851.2	862.2
3	252.7	354	432	565	465.2	650.8	813.8	896.8
4.	301.8	422.2	487.8	745.7	508	749.8	902.5	1118.3
5	267.8	376.8	437.3	615.3	457.8	704.5	892	861.2
6	272.8	382.2	442.8	673.5	598.5	655.8	796.2	920
7	272.2	429	558.8	505.6	557	772.5	833.3	1143.8
8	454.4	641.6	765.4	1094	1333.2	1380.4	1414.6	1520.6

APPENDIX 6

FOOD CONVERSION RATIO IN GRAMS

DIET	WEEK I	WEEK II	WEEK III	WEEK IV	WEEK V	WEEK VI	WEEK VII	WEEK VIII
1.	1.4	2.0	2.4	3.3	6.5	2.5	2.9	3.9
2.	1.2	1.9	1.7	2.9	2.5	1.9	2.1	2.3
3	1.2	1.8	2.2	4.5	3.1	3.0	3.2	2.8
4.	1.1	2.3	2.7	2.9	5.1	1.6	2.4	2.4
5	1.2	2.7	2.4	3.9	11.0	3.5	2.8	2.3
6	1.2	2.2	1.7	3.6	4.0	1.8	1.8	2.1
7	1.3	2.3	2.7	3.7	3.4	2.6	2.2	3.1
8	1.5	2.6	3.3	3.2	3.5	2.9	4.6	7.6

APPENDIX 7

PROTEIN EFFICIENCY RATIO

DIET	WEEK I	WEEK II	WEEK III	WEEK IV	WEEK V	WEEK VI	WEEK VII	WEEK VIII
1.	3.2	2.3	1.9	1.6	0.8	2.1	1.8	1.3
2.	3.5	2.4	2.7	1.7	2.0	2.5	2.3	2.9
3	3.8	2.6	2.1	1.2	1.7	1.8	1.7	1.9
4.	4.2	1.9	1.7	1.7	0.9	2.4	2.0	2.0
5	4.1	1.8	2.0	1.4	0.5	1.3	1.9	2.2
6	3.7	2.1	1.1	1.4	1.2	2.8	2.7	2.3
7	3.6	2.0	0.8	1.4	1.7	2.0	2.3	1.7
8	3.0	1.7	0.6	1.7	1.6	1.9	1.2	0.7

APPENDIX 8

MULTIVITAMIN ANTIBIOTIC (TERRAMYCIN CHICK FORMULA) COMPOSITION TABLE

Oxytetracycline hydrochloride	55gm
Vitamin A	2,200,000 i.u.
Vitamin D_3	396,000 i.u
Vitamin E	600 i.u
Vitamin K	0.792 gm
Vitamin B_{12}	2.200gm
Pantothenic acid	4.62gm
Niacinamide	13.2 gm
Riboflavin	2.86 gm

APPENDIX 9

PROXIMATE COMPOSTION OF STARTER DIETS

	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	Diet 7	Diet 8 (Control)
Crude protein	21.96	22.57	21.08	22.44	21.31	22.21	21.98	22.13
Crude Fibre	3.60	4.09	5.22	5.32	4.64	6.03	7.25	9.90
Crude Fat	1.56	4.01	13.64	3.64	6.11	8.19	6.25	7.20
Ash	6.90	6.63	5.47	3.67	6.17	7.46	7.94	9.19
Moisture	8.45	7.63	10.66	7.83	6.99	7.49	7.49	8.68
Sub-Total	42.47	44.93	55.42	44.73	46.05	50.88	50.91	57.1
N.F.E	57.53	55.07	44.38	55.27	53.95	49.12	49.09	42.9

APPEDIX 10

PROXIMATE COMPOSTION OF FINISHER DIETS

	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	Diet 7	Diet 8 (Control)
Crude protein	19.20	20.67	18.73	20.76	18.95	20.17	19.74	18.06
Crude Fibre	6.89	7.34	8.33	8.39	8.69	9.51	10.38	12.98
Crude Fat	0.88	3.80	12.33	2.57	6.63	9.10	6.58	6.47
Ash	5.52	8.15	6.29	3.78	5.31	6.68	2.99	8.46
Moisture	9.92	9.44	8.75	10.03	9.09	9.09	10.70	7.61
Sub-Total	42.41	49.4	54.43	45.53	49.07	54.55	50.39	53.58
N.F.E	57.59	50.6	45.57	54.47	50.93	45.45	49.61	46.42
Digestibility	89.31	89.46	89.21	91.11	89.19	86.71	84.97	81.63

APPENDIX 11

TABLE 4.3 ANALYSED AMINO ACIDS OF FINISHER DIETS

AMINO ACID.	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	Diet 7	Diet 8 (Control)
Arginine	3.67	4.25	3.21	3.01	2.67	3.25	3.47	3.18
Histidine	1.96	2.11	1.65	2.00	1.94	1.95	2.09	1.85
Isoleucine	1.68	2.23	2.21	2.00	1.59	1.25	1.52	1.06
Leucine	6.66	6.12	5.02	4.97	4.88	3.74	5.65	5.11
Lysine	6.22	6.72	4.97	3.89	5.11	4.75	4.69	5.62
Methionine	0.79	0.82	0.77	0.75	0.70	0.75	0.86	0.95
Phenylalanine	2.98	3.07	2.77	3.14	4.00	2.60	3.18	3.78
Threonine	1.44	1.66	1.85	2.67	2.45	2.00	1.95	2.94
Valine	2.67	1.66	2.06	3.01	2.75	2.51	2.64	2.85
Glutanic acid	15.05	16.10	13.69	14.17	13.10	13.52	16.05	15.92
Glycine	4.68	5.94	4.11	6.24	4.04	4.23	4.85	6.11