EVALUATION OF AFRICAN LOCUST BEANS (*Parkia biglobosa)* PULP FOR BROILER CHICKENS AS AN ENERGY SOURCE

BY

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DECLARATION

I hereby declare that the whole of this thesis is the result of my investigation and record of my research work, except where reference is made to published literature and where any assistance is acknowledged, it has not been part of any presentation for any other qualification previously.

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CERTIFICATION

This thesis titled Evaluation of African locust beans *(Parkia biglobosa)* pulp for broiler chickens as an energy source by Maryam Hassana Bot meets the regulations governing the award of the degree of Master of Science of Ahmadu Bello University, Zaria, and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This work foremostly is dedicated to God Almighty and Jesus Christ who gave me the ability to go through this study. To my darling husband who encouraged and supported me and to my loving children; Jemimah, Jeremiah, Joseph-Destiny and Kucheli-Sele who endured my absence while undergoing this course, and to my loving father of blessed memory, late Joshua N. Mshelbwala who supported me till he passed away.

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ABSTRACT

Man`s increasing demand for maize *(Zea mays),* a major source of energy for livestock has made the search for alternative sources of energy for livestock imperative. The African locust bean (*Parkia biglobosa)* is one such potential energy source. In this study its proximate analysis gave the following results; 11.52% crude protein(CP), 12.49% crude fibre (CF), 3.09% Ether Extract (EE), 4.08% ash, 68.32% Nitrogen free extract (NFE), 0.48g/100g calcium (Ca) and 0.10g/100g phosphorus (P).The anti-nutritional factors determined were: oxalate (150mg/100g), phytic acid (210mg/100g) and tannin (3.23mg/100g) which was relatively low. Total starch (5.84mg/100g), ascorbic acid (24.22mg/100g) and reducing sugar (4.56mg/100g) were determined to evaluate the nutritive value of African locust beans pulp as source of energy for broiler chickens. Two experiments were conducted at the large animal experimental station, National Veterinary Research Institute, Vom, with two sets of broiler chickens. In the first experiment, two hundred and twenty-five (225) day-old Arbour acre Broiler chicks were used. The chicks were randomly allotted to five dietary treatments with three replicates of fifteen birds each in a completely randomised design (CRD) which lasted for sixty-three (63) days. Parkia pulp was included at 0, 10, 20, 30 and 40% levels, respectively in the diets. The feed intake, final weight and weight gain, were significantly ($P>0.05$) depressed, feed conversion ratio and feed cost/kg gain were significantly ($P<0.05$) higher across the dietary treatments. Similarly, glucose, total protein, haemoglobin (Hb), packed cell volume (PCV), mean corpuscular haemoglobin concentration (MCHC), Platelet and red blood cell (erythrocyte) distribution width standard deviation (RDW-sd) were negatively affected across dietary treatments. However, cholesterol, red blood cell (RBC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and red blood cell (erythrocyte) distribution width coefficient of variation (RDW-cv) were not affected by the inclusion levels of Parkia pulp across the dietary treatments. Live weight, carcass weight, dressing percentage, prime cuts and organ parts expressed as a percentage of live weight decrease across the dietary treatments. In the Second Experiment, two hundred and twenty-five (225) day-old Marshall Broiler chicks were used for the

starter phase which lasted for twenty-eight (28days). The birds were randomly allotted to five dietary treatments with each treatment having three replicates of fifteen birds each. The dietary treatments contained 0, 25, 50, 75 and 100% Parkia pulp which replaced maize in the diets, respectively. Feed intake, final weight and weight gain were significantly (P>0.05) decreased, feed conversion ratio, cost/kg gain and mortality were significantly (P<0.05) higher across the dietary treatments as the level of African locust beans pulp increased. In the finisher phase, which lasted for twenty-eight (28) days, two hundred and eleven broiler chickens obtained from the starter phase were used for the finisher study. The birds were allotted to five dietary treatments with three replicates of fourteen birds each. In the finisher phase feed intake, final weight, weight gain were significantly (P>0.05) lower, feed conversion ratio, cost/kg gain and mortality were negatively affected by Parkia pulp which made the parameters to increase across the dietary treatments. In the biochemical and haematological analyses; glucose and cholesterol, including Platelet, RDW-cv and RDW-sd were not affected. However, total protein, RBC, PCV, Hb MCV, MCH and MCHC were significantly (P<0.05) affected, however, all the blood parameters were within the normal ranges. Live weight, carcass weight and dressing percentage significantly (P<0.05) decreased as Parkia increased in the diet. The prime cuts and organs: wings, drumsticks, proventriculus, small and large intestines were observed to have been negatively affected in birds fed all the dietary treatments. However, some of the prime cuts; back, thighs, liver, heart, gizzard and spleen showed that Parkia pulp did not have any negative effect on them. It is concluded that Parkia pulp can be included at 10% level for starter and finisher diets in the first experiment; and replace 25% of maize at the starter and finisher phases respectively without adverse effects on the growth performance of the birds, respectively.

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CHAPTER ONE

INTRODUCTION

There is rapid population increase in Africa without corresponding increase in food production (Christopher *et al.* 1997 and Vanderzijpp, 1997). The population of developing countries has continued to increase resulting in increased demand for protein of animal sources. Nigeria has the highest population in Africa which is about 140million, and there is also high maternal-child mortality due to under- nutrition(Sobayo*et al.*2008).

Poultry is a business that can flourish with good care and understanding from the farmer. The poultry industry occupies a unique position in the livestock sector. They are highly prolific and are good feed converters (Obioha, 1992). Holness, (2005) stated that broilers have high mortgage values and the meat of broilers yield less cholesterol than red meat. The world trend is towards the consumption of more white than red meat because white meat yields less cholesterol than red meat. The acute shortage of animal protein in the diet of average Nigerians requires a logical solution like increasing the production and consumption of poultry (FAO, 1997). Christopher *et al.* (1997) and Fasuyi (2005) reported that per capita consumption of animal protein has been on the decline over the past decades. This is because the livestock industry in Nigeria has never supplied the Nigerian market with adequate quantities of animal products. On the alternative, plant proteins are deficient in certain essential amino acids (lysine, methionine, cystine and tryptophan). However, more than 250,000 plant species have been described worldwide as source of food to man, but less than 30 species provide 90% of the world`s food requirement and mostly cereals, to which rice, wheat and corn are the major sources and collectively supply nearly 60% of the world`s food supply (Oliveira *et al*. 2000; Parvathin and Kumar, 2002). Available statistics indicatethat Nigeria is one of the countries where the protein intake of the people ranks among the lowest. It is estimated that on the average, Nigerians consume only about 7g of animal protein on a daily basis, as against the minimum requirement of 28g/head/day recommended by FAO (Uchegbu*et al.* 2007). Acute

shortage and high cost of feed ingredients have been identified as major hindrances to the expansion of poultry industry in Nigeria and other developing African countries (Fasuyi, 2005). Feed constitutes about 70-80% of the cost of producing broilers (Aduku, 1992). The growing demand for maize in the last few years for both human and livestock consumption has pushed its market price to an alarming rate that has directly affected the production cost of farm animals, particularly the non-ruminants. This has invariably escalated the market prices of livestock products out of the reach of the common man. There is therefore, an urgent need for an alternative to maize in livestock feeds to reduce the current pressure on maize as staple food for man (Uchegbu and Udedibie, 1998).

In an attempt to boost poultry production, nutritionists have tried to harness and utilise agro-industrial by-products that are not directly utilized by man. A large number of alternative feedstuffs that have potential as poultry feed ingredients abound in Nigeria (Ologhobo, 1992). Adeniyi and Balogun (2002) stated that research into the use of cheaper industrial by-products and wastes have been intensified in the last few years to determine the efficiency of their utilization in terms of growth and production. According to Fadipe (1996) the search for cheaper sources of feed ingredients for livestock feeding in Nigeria and many developing countries will continue, as long as protein requirement in human diet has not been met. There are several attempts to reduce the cost of poultry production by replacing some percentage of maize with other agro-industrial by-products such as maize offal, brewers dried grain, wheat offal, cassava peel meal, rice offal etc (Ademosun, 1976; Ogbonna*et al.*1993; Dafwang and Shwarmen, 1996). One alternative novel feed ingredient that is receiving attention is the African locust bean pulp. The pulp is obtained from the locust bean tree.

The African locust bean, *Parkiabiglobosa*is a perennial tree legume which belongs to the sub family *Mimosoideae* and family *Leguminosae*. It grows in the savannah region of West Africa up to the southern edge of the Sahel zone 13^{o} N (Campbell-Platt, 1980).The trees of the Parkiaspecies are usually and carefully preserved by the inhabitants of the area where they grow because they are

valuable sources of reliable food, especially the seeds which serves as source of useful ingredients for consumption (Campbell-Platt, 1980).

The fruit pulp of the African locust bean is sweet to the taste when it is ripped, which indicates the presence of natural sugars and thus a potential energy source. According to Uwaegbute (1996), the powdery fruit pulp contains more carbohydrate than the seeds, the carbohydrate being primarily reducing sugars, non-reducing sugars and other complex carbohydrate. The attractive yellow colour indicates the presence of phyto-nutrients possibly carotenoids, which are important precursors of retinol (vitamin A). It has a sour taste when unripe which indicates the presence of ascorbic acid (vitamin C). Hassan and Umar (2005) reported that theParkiapulp has poor essential amino acid content with a score of 1/8. Literature reveals that the fruit pulp is used in rural Africa during emergencies when grain stores are empty, which is an indication of its edibility and non-toxicity (Owoyele*et al.* 1987 and Akoma*et al.* 2001).

The carbohydrate content of the fruit pulp was found to be 67.30% (Gernah*et al.* 2007); this is much higher than the 49.49% carbohydrate in the seeds (Fetuga*et al.* 1974). Though proteins and fats also provide energy, carbohydrates are much cheaper and more easily digested and absorbed (Fox and Cameron, 1989). While the use of Parkia seeds as an alternative source of protein in livestock diets abound in literature the use of the pulp is still being investigated. It is against this background that this study was designed to evaluate the nutritive value of Parkiafruit pulp in broiler diets.

1.1 OBJECTIVES OF THE STUDY

The objectives of the study are as follows:

- To determine the proximate, mineral and antinutritional factors in Parkia pulp.
- To determine the reducing sugars, total starch and ascorbic acid content of Parkia pulp.
- To determine the effects of Parkia pulp on performance and carcass characteristics of broiler chickens.

- To examine the haematological parameters of broiler chickens fed diets containing Parkia pulp.

CHAPTER TWO

LITERATURE REVIEW

2.1 Origin and distribution of African locust bean

The African locust bean tree,*Parkiabiglobosa* is a perennial legume tree which belongs to the sub-family *Mimosoidaea*and family *Leguminosae.* It grows in the savannah region of West Africa up to the southern edge of the Sahel zone 13^{o}N (Campbell-Platt, 1980). These trees are normally cultivated but can be seen in populations of two or more in the savannah region of Nigeria (Schnell, 1957; Hopkins, 1983).

2.2 Use of Parkia pulp

The Parkia trees play a vital ecological role in recycling of nutrients from deep soils, by holding the soil particles to prevent soil erosion with the aid of roots. The trees also provide shades for farmers (Campbell-Platt, 1980). Parkia tree is used as timber for making pestles, mortars, bows, hoe handles and seats (Hagos, 1962; Irvine, 1961). The fruit may also be used as an ingredient for the preparation of various stews, soups and sausages for the consumption of cereals pressed into cakes and preserved for later use or used in the preparation of some indigenous drinks (Muller, 1988). Literature reveals that the fruit pulp is used in rural Africa during emergencies, when the grain stores are empty, which is an indication of its edibility and non toxicity (Akoma*et al.* 2001).

2.3 Nutritional value of Parkia pulp

The African locust bean pulp is sweet to taste when ripe, which indicates the presence of natural sugars and thus a potential energy source. The attractive yellow colour indicates the presence of phyto-nutrients, possibly carotenoids, which are important precursors of retinol (vitamin A). It has a sour taste when unripewhich indicates the presence of ascorbic acid (vitamin C) *(*Gernah *et al.*2007*)*.

According to Uwaegbute (1996) the powdery fruit pulp contains more carbohydrate than the seeds, the carbohydrate being primary reducing sugars, non reducing sugars and other complex carbohydrate. High carbohydrate content of feed is desirable; a deficiency causes depletion of body tissue (Barker, 1996). Gernah*et al*. (2007) reported that the fruit pulp contains 67.30% carbohydrate that is comparable to lentils and Bambara nuts with a carbohydrate value of 65.00% (Muller, 1988).

The reducing sugar content in carbohydrate sources is partly responsible for browning as a result of Maillardreaction between the reducing sugar and the protein content of the sample. Maillard reaction might not pose any problem in those samples with low level of both protein and reducing sugars (Adewusi*et al.* 1995). Bello *et al*. (2008) reported a sugar content of 4.27mg/g, a starch content of 151.88mg/g and a protein content of 5.25mg/g for Parkia fruit pulp.

Gernah*et al.* (2007) reported a crude fibre value of 11.75% for Parkia pulp which is on the high side. The crude fibre is higher in the Parkia fruit pulp than those of other legumes which ranged from 2.10% in groundnuts to 7.60% in kidney beans (Ihekoronye and Ngoddy, 1985).

Gernah*et al.* (2007) reported that Parkia fruit pulp has a crude fat content of 1.80%. Ihekoronye and Ngoddy, (1985) reported a fat content of 45.30% for groundnuts, soya beans (17.70%) and winged bean (17.00%).Stein (1982) reported a fat content of 0.50% for Mediterranean locust bean (*Geratoniasiliqua*) fruit pulp. The low fat content is an indication that the fruit pulp can be stored for long periods at the right temperature and moisture without spoilage by rancidity, which is characteristic of many legumes.

Gernah*et al.* (2007) reported a mineral content value of 4.18%. This is within the range for most legumes of 2.00% in peas to 5.00% in soybeans. This value is higher than the 1.00% obtained for the fruit pulp of the Mediterranean species by Stein (1982), which is an indication that African fruit pulp is a potential good source of mineral required by the body.Gernah*et al.* (2007) reported a vitamin C content of 191.20ug/100g for Parkia fruit pulp, while Muller (1988) reported a value of 200mg/100g for locust bean yellow pulp. This is higher than most regularly consumed foodstuff as

reported by Gaman and Sherrington (1990); and compared to the recommended daily intake of 30mg/65kg body weight adult human (Olson and Hodges, 1987). Vitamin C is present abundantly in fruit and vegetables where the common man in the developing countries receives most of their daily intake (Faladee*t al.* 2004). Bello *et al.* (2008) reported vitamin C content of 215mg/100g for Parkia fruit pulp.

2.4 Chemical properties of Parkia pulp

The sugar content was found to be 9.0%, apart from imparting sweetness, sugar acts as a preservative when present in food in high concentration by making water unavailable to micro-organisms. It is also a ready source of energy since it is more easily digested and absorbed than other complex carbohydrates (Gernah*et al*. 2007).Hydrogen ion concentration (pH) of 5.22 suggests that the fruit pulp is a slightly acidic food material; this means that enzymes and microbiological activities would be inhibited to some extent, thus having a positive influence on protein stability (Gernah*et al.* 2007).Parkia pulpcontains 49.175jul/100g carotenoids (Gernah*et al.*2007). Carotenes are usually converted to retinol (vitamin A) in the small intestine, and its colour also makes food more attractive to the eye. This value of carotenoids indicates that the Parkia fruitis a potential source of vitamin A, given that the recommended daily intake is 750ug/100g/65kg for adult human (Muller, 1988). Table 2.1 shows the chemical composition of Parkia pulp.

Table 2.1 Chemical composition of Parkia pulp

Nutrient	(%)*	(g/100g)**
Dry matter	88.70	96.00
Crude protein	6.70	5.68
Ether extract	3.00	18.0
Crude fibre	8.00	12.00
NFE	58.00	68.75
Total Ash	3.00	4.00
ME/Kcal/kg	3079.14	3476.42

Source : Kwari and Igwebuike (2002)*
Bello *et al.* (2008)**
NFE = Nitrogen Free Extract
ME = Metabolizable Energy

2.5 Anti-nutritional factors of Parkia pulp

Gernah*et al.* (2007) reported phytic acid content of60.00mg/100g for Parkia pulp. McCance and Widdowson (1935) found no apparent effect in human subjects fed 2.00g of phytate except that as much as 50% of dietary phytate phosphorus was rendered unavailable to the body, being excreted unchanged. Bello *et al.* (2008) reported a value of 0.20mg/g for Parkia fruit pulp. The problem with phytic acid in foods is that it can bind some essential mineral nutrients in the digestive tract and can result in mineraldeficiencies. Food that contain high amount of phytate when consumed over a long period of time can decrease bioavailability of minerals in monogastric animals (Thompson, 1993). Phytic acid also bonds with phosphorus and converts it to phytate, while other mineral elements like calcium, zinc, manganese, iron and magnesium are converted to the phytic complexes, which are indigestible substances, thereby decreasing the bioavailability of these elements for absorption. Phytic acids also have a negative effect on amino acid digestibility thereby posing a problem to non- ruminant animals due to insufficient amount of intrinsic phytase necessary to hydrolyse the phytic acid complex, but the presence is also beneficiary because it may have a positive nutritional role as an anti oxidant and anti cancer agent (Turner *et al.* 2002). The availability of phosphorus in plant sources is limited by the presence of a naturally-occurring compound phytate. It contains about two-thirds of the phosphorus in cereal grain and oil seed meal, both of which are major components of poultry feed. Phosphorus and other minerals, which bond withphytic acid, become poorly available as shown in humans, poultry and pig (Thompson*,* 1993).

Gernah*et al.* (2007) reported asaponin content of 17.80mg/100g for Parkia pulp which could be a contributory factor to the foaming characteristics of the fruit pulp. Osagie (1998) reported a value of (24.50mg/100g) for lima beans and 19.47mg/100g for millet. Although saponins have been shown to be highly toxic under experimental conditions, acute poisoning is relatively rare, both in man and animals (Tannenbaum, 1979).

Gernah*et al.* (2007) reported a Parkia fruit pulp content of 81.00mg/s100g found in tannin. Osagie (1998) reported a tannins content of 140.00mg/100g for some everyday consumed legumes like lima beans and pigeon pea (100.00mg/100g). Tannins in fruits impact an astringent taste that affects palatability, reduce food intake and consequently body growth. Tannins are known to inhibit the activities of digestive enzymes; and nutritional effects of tannins are mainly related to their interaction with protein. Tannin-protein complexes are insoluble and the protein digestibility is decreased (Carnovale*et al.* 1991). Bello *et al.* (2008) reported a tanninscontent of 1.08mg/g for Parkia fruit pulp. Studies on rats, chicks and livestock revealed that high tannins in diet adversely affects digestibility of proteins and carbohydrates, thereby reducing growth, feeding efficiency, metabolizable energy and bioavailability of amino acids (Aletor, 1993). From the medicinal point of view, polyphenol to which tannins belongs has been reported to act as antioxidant by preventing oxidative stress that causes diseases such as coronary heart disease, some types of cancer and inflammation (Tapiero*et al.* 2002). Ingestion of dietary tannins reduced daily weight gain and impaired feed efficiency due to reduced digestibility of protein and energy utilization (Singh, 1993).Gernah*et al.* (2007) reported a total phenols content of Parkia fruit pulp to be 204.60mg/100g. However, Osagie (1998) had a phenol content of 12160.00mg/100g for lima beans. Gernah*et al*. (2007) observed 17.30mg/100g of hydrocyanic acid in Parkia fruit pulp. Osagie, (1998) reported a lethal dose for man to be 50-60mg/kg body weight/day.

Bello *et al.* (2008) stated that a content of 15.55TIU/g for trypsin inhibitor in Parkia fruit pulp was found. Usually Parkia pulp is consumed uncooked. The presence of trypsin inhibitor in uncooked animal feed has long been known to cause diminished growth in rats, chickens and other experimental animals (Liener and Kakade, 1980). Trypsin inhibitor is heat labile and can be inactivated by heat treatment such as steaming and extrusion cooking (Liener, 1994).

Oxalate is a concern because of its negative effect on mineral availability. High oxalate diet can increase the risk of renal calcium absorption and has been implicated as a source of kidney stones (Chai and Liebman, 2004). Bello *et al*. (2008) reported an oxalate content of 0.093g/100 for Parkia

fruit. Munro and Bassir (1989) have revealed that the possibility of oxalate poisoning in Nigeria from consumption of local fruits and vegetables is as remote as it is in other parts of the world. Spinach that recorded 19.72g/100g oxalate can only be hazardous if there is calcium oxalate interaction in the body. Table 2.2 shows the anti nutritional factors level in Parkia pulp.

2.6 Mineral content of Parkia pulp

Bello *et al.* (2008) reported a high calcium content of 11650mg/kg for Parkia fruit pulp. The recommended dietary allowance for calcium is 800mg/day (FNB, 1974), which means that about 68g dry weight of Parkia pulp fruit would provide the recommended daily allowance for calcium.Bello *et al.* (2008) stated that Parkia fruit pulp has a magnesium content of 7000mg/kg. Magnesium plays a major role in relaxing muscles along the airways to the lungs thus allowing asthma patients to breathe easily. It plays fundamental roles in most reactions involving phosphate transfer believed to be essential in the structural stability of nucleic acid intestinal absorption, while deficiency of magnesium in man is responsible for severe diarrhoea, migraines, hyper-tension, cardiomyopathy, Arteriosclerosis and stroke (Appel, 1996).

Bello *et al.* (2008) reported a potassium content of 3945mg/kg; sodiumcontent of 1795mg/kg and manganese content of 661.56mg/kg for Parkia fruit pulp. Manganese supports the immune system, regulates blood sugar levels and is involved in the production of energy and cell reproduction. It works with vitamin K to support blood clotting. Working with the–complex vitamins, manganese helps to control the effects of stress. Birth defects can possibly result when an expecting mother does not get enough of this important element (Anhawange, *et al.* 2004).Bello *et al.* (2008) observed an iron content of 1814mg/kg for Parkia fruit pulp. Iron is said to be an important element in the diet of pregnant women, nursing mothers, infants convulsing patients and elderly to prevent anaemia and other related diseases (Oluyemi*et al.* 2006).

Table 2.2 Antinutritional factors levelin Parkia pulp

Substance		Composition
Tannin (mg/g)	-	1.08
Trypsin inhibitor unit (TIU/G)	-	15.55
Phytate(g/100g)	-	0.20
0xalate (g/100g)	-	0.93

Source: Bello *et al.*, (2008)

Bello *et al.* (2008) reported a zinc content of 437.52mg/kg for Parkia fruit pulp. Zinc is said to be an essential trace element for protein and nucleic acid synthesis and normal body development. It plays a central role in growth and development, vital during periods of rapid growth such as infancy, adolescence and during recovery from illness. Zinc deficiency has been largely attributable to the high phytic acid content of diets leading to poor growth, impaired immunity, and increased mortality (Melaku*et al.* 2005).Bello *et al.* (2008) stated a copper content of 447.48mg/kg for Parkia fruit pulp. Deficiencies of copper have been reported to cause cardiovascular disorders as well as anaemia and disorders of the bone and nervous systems (Mielcarz*et al.* 1997). According to Reddy and Love (1999) these essential elements are needed for growth, production of bones, teeth, hair, blood, nerves, skin, vitamins, enzymes and hormones. The healthy function of nervous transmission, blood circulation, fluid regulation, cellular integrity, energy production and muscle contraction are influenced by essential elements and too little of any essential element can lead to deficiency disease and too much of any can be toxic (Schauss, 1995). The concentration of mineral elements in fruit of Parkia pulp is presented in Table 2.3.

2.7 Nutrient requirement of birds

Nutrients are those chemical substances contained in foodstuffs that are needed for various metabolic and physiological processes in the body of the animal (Mac Donald *et al*. 1995). Such substances which include carbohydrate, protein, fats, vitamins, minerals and water are utilised by the animal for maintenance, growth, lactation, egg production or reproduction depending on the aim of the producer (Aduku, 2004). The feed requirements of birds are largely determined by the anatomy and capabilities of the digestive tract. These determine what type of feeds can be ingested and nutrients delivered to the circulatory system. Alteration and impairments within the digestive system may affect feed utilization and subsequently growth (Weibel and Devegowda, 1982). The most reliable assessment of feed quality is its effect on the performance of the birds. However, their effects can be predicted to some extent from the chemical analysis of the diet.

Table 2.3 Concentration of mineral elements in the fruit of Parkia pulp

Element		Composition(mg/kg)
Calcium	-	11650
Magnesium	-	7000
Potassium	-	3945
Sodium	-	1795
Manganese	-	661.56
Iron	-	1814.50
Zinc	-	437.52
Copper	-	447.48

Source: Bello *et al.* (2008)

2.7:1 *Energy requirement of birds*

It has been reported earlier by Aduku (1992) that the energy requirement of broilers at the starter and finisher phases are 2800 kcal/kg and 3000 kcal/kg respectively. The energy in diets is derived from maize, millet, sorghum, rice and to some extent wheat. One of the major problems with grains is that they are consumed by human beings as food and are therefore ingredients competed for by both man and animals (Adegbola, 1990, Daniel, 1992 and Ranjhan, 2001). Dietary energy and protein interact because protein and energy are needed for protein turn over and deposition; and body proteins form part of the stored energy of the body (Bonerman, 1980).The energy of the diet is largely in form of carbohydrates. Fats and amino acids also contribute to the energy content of feed but to a lesser extent. Usually, birds are allowed to consume as much feed as to meet their nutrient requirements. This control of intake is based primarily on the amount of energy in the diets (Smith, 2001). It has however, been reported that birds perform equally well on energy levels 10–15% below the recommended levels (Olomu, 1995). It has also been noted by Farrel (2005) that broilers have the ability to perform well on low energy diets, observing that the optimum level for production was lower for birds reared in summer (2700KcalME/kg) than for birds reared in winter (3000 KcalME/kg). In the same vein the total energy supplied in the diets is used for various purposesincluding heat loss during metabolism, reproduction, growth and production of eggs. At higher temperatures, heat losses and basal metabolic rates are lower than those at lower temperatures. Therefore, at higher temperatures, energy is used more for productive and reproductive purposes and as such energy requirements are less; Sugandi*et al*(1975) observed that broilers have the ability to perform well on low energy diets.

2.7.2 *Protein requirement of birds*

Proteins generally are used for building up and maintenance of body tissues and organs. They are also used for replacement of worn out or damaged tissues and used in several other ways in the body. These are constituents of enzymes and hormones which make proteins very essential for the growth and development of livestock (MacDonald *et al.* 1995). The protein requirement of broiler starters and broiler finishers are 23% and 20%respectively (Aduku, 1992). Proteins are essential

components of the diet needed for survival of animals and humans; their basic function in nutrition is to supply adequate amount of required amino acids (Pugalenthi*et al*. (2004). They are not stored in the body and as such any protein consumed above the birds' requirement is oxidized for energy (Olomu, 1995).

It is more than adequate to meet the FAO/WHO recommended daily allowance of 0.59g/kg body weight for an average healthy individual and 0.88g/kg body weight for children aged 1-10years (Shakuntala and Shadaksharaswamy, 1987). Protein deficiency causes growth retardation, muscle wasting, oedema, abnormal swelling of the belly and collection of fluids in the body (Zarkada*et al*. 1997).According to McLeod (1997) the catabolism of amino acids have a high energy cost for the bird. High protein diets may have lower net energy content, and this would explain the decreased fat deposition in the carcass of broilers. Potential sources of protein include soyabeans meal, groundnut cake, cowpea, bambara nut and palm kernel meal. The animal sources are chiefly fish meal, blood meal, milk powder and to some extent meat meal (Schwartz and Allen, 1981). The quality of dietary protein is the extent to which its essential amino acid pattern coincides with the needs of the animals. Theoretically, the poorer a protein is the more of it that is needed to satisfy the needs for particular nitrogen retention. Therefore, maximum nitrogen retention is achievable with a poorer dietary protein but more of the protein ingredient will be needed and the rate of increase in nitrogen retention per unit intake of the protein will be less than that of a better protein source (Butterly and Lindsay, 1980).

2.7.3 *Crude fibre requirement of birds*

The minimum crude fibre requirement of broiler birds have been put at 5- 6% (Olomu, 1995 and Aduku, 2004).Crude fibre does not give any contribution to nutrients of the feed, but it is a source of dietary fibre which is essential for bowel movement and helps in preventing obesity, diabetes, and cancer of the colon and other ailments of the gastro-intestinal tract of man. Fibre helps in the maintenance of human health and has been known to reduce cholesterol level in the body.

Emphasis has been placed on the importance of keeping fibre intakes low in the nutrition of infants and pre-school children (Eromosele and Eromosele, 1993). High fibre levels in weaning diet can lead to irritation of the gut mucosa, reduced digestibility, vitamin and mineral availability. Fruits with high fibre contents are desirable in adult diet. Fibre diets promote the wave-like contractions that move food through the intestine. High fibre diet food expands the walls of the colon, easing the passage of waste, thus making it an effective anti-constipation. It also lowers cholesterol level in the blood, reduce the risk of various cancers, bowel diseases and improve general health and well being. Crude fibre has a negative effect which includes high fibre content, which affects bioavailability of nutrients and toxic/anti-nutritional factors contained in these ingredients which are deleterious to the animals' healthy growth (Dafwang, 2006). Viscosity-promoting potential of crude fibre has also been shown to reduce the overall digestive absorptive efficiency by preventing nutrients from being available at the absorptive sites in the intestinal mucosa (Webel*et al.* 2003). Udedibie and Enangi (2009) reported that young broilers could not tolerate total replacement of maize with a mixture of sun-dried cassava tuber meal, brewers' dried grains and palm oil, probably due to its high fibre and possibly HCN content. Onifade (1993) and Onifade and Babatunde (1997) reported that high fibre content was found to interfere with nutrient availability for growth and maintenance. Both Hedge *et al.* (1978), and Trait and Write (1990) observed that high fibre in the diet could be the cause of decrease in the availability of nutrients which is as a result of reduction in the period of exposure of the feed to digestive enzymes which in turn impairs absorption of nutrients.

2.7.4 *Fatrequirement of birds*

The fat requirements of broiler birds are 5 – 6% (Olomu, 1995 and Aduku, 2004). Lipids are essential because they provide the body with maximum energy, approximately twice the amount of protein or carbohydrate and facilitate intestinal absorption and transportation of fat- soluble vitamin A D E and K (Dreon*et al.* 1990). Leeson (1997) reported that fats are widely used as energy sources in addition to improving the consistency and palatability of mash feeds. Carcass fat content

is one of the main concerns of poultry companies as increasing awareness of consumers on health problems has generated rejection of fat carcasses. The different types of oil that have been or can be used to increase the energy in poultry diets include palm oil, groundnut oil, melon seed oil and palm kernel oil (Schwartz and Allen, 1981).

2.7.5 *Mineral requirement of birds*

The mineral requirements of poultry chickens are presented in Table 2.4. Minerals are inorganic elements found in the body of animalsneededfor normal functioning of the body. They are required for the formation of the skeleton, as components of various compounds, as activators of enzymes and for maintenance of osmotic balance in the body (NRC, 1994). Mineral elements are nutrient supplements or additives, this is because they are already in foodstuffs especially protein and energy sources, but not enough to sustain their economic production and good health. Hence, they are supplemented from rich inorganic and organic sources. The level of supplementation depends on the age of the animal, quality of feed, system of management and type of production. Growing chicks and laying hens require more calcium than fully grown and non–laying birds (Aduku, 2004).The major effect of high temperatures is on electrolyte balance. Loss of dietary electrolyte balance has wide ranging effects on growth and production. The mineral requirements of poultry chickens are presented in Table 2.4.

2.7.6 *Vitamin requirement of birds*

Vitamins are defined as organic compounds which are required in small amount for the maintenance and growth of animals' life. The bulk of the vitamins supplied in animal feeds are derived from adding a vitamin mineral premix that is formulated to meet animal requirements when the quantities specified by the manufacturers are used (Dafwang, 2006). Synthetic vitamins are supplied singly or as low potency premixes in combination with active ingredients like minerals, antibiotics and others (Oluyemi and Roberts, 1985). Vitamins are divided into fat soluble and water soluble vitamins. The fat soluble vitamins are ADEK and the water soluble vitamins are vitamin B_1

thiamine, riboflavin (B_2), pyridoxine (B_6), pantothenic acid, biotin, folic acid, choline and cyanocobalamine (B_{12}). The vitamin requirements of broilers are presented in Table 2.5.

2.7.7 *Water Requirement of birds*

Water is the most essential nutrient for life; it should be supplied cool, ad libitum and clean daily. Lack of water quickly leads to rise in temperature and death; it also affects feed intake (Dafwang, 2006). Water requirement for livestock depends on several factors such as environmental temperature, dryness of feed and type of production like egg production which requires more water (Aduku, 2004).

Table 2.4 Mineral requirements of poultry chickens (g/kg)

Element	class of poultry	NRC (1984)	AFRC
Calcium	chickens (0-4)	8.0 – 9.5	11.5 – 12.0
	4 – 8 weeks	7.0 – 8.5	7.0 – 8.0
Phosphorus	0 – 4 weeks	-	6.6 – 6.8
	4 – 8 weeks	-	5.7 – 6.3
Sodium	0 – 4 weeks	1.4 – 1.8	1.3
	4 – 8 weeks	1.4 – 1.5	1.2
Potassium	0 – 4 weeks	4.0	2.6
	4 – 8 weeks	3.0	2.3
Chlorine	0 – 4 weeks	1.5	1.1
	4 – 8 weeks	1.5	1.0
Magnesium	0 – 4 weeks	0.6	0.4
	4 – 8 weeks	0.5	0.4

Source: Hill, (1988).
NRC– National Research Council
AFRC– Agricultural Food Research Council

Table 2.5: Vitamin requirements of broilers

Vitamin	Composition*	Composition**	Vitamin
A (IU)	4000.00	8000.00	
Vitamin D_3 (IU)	600.00	3500.00	
Vitamin E (IU)	5.00	50.00	
Vitamin K (IU)	2.00	3.00	
B_{12} (kg)	0.01	0.012	
Biotin (mg)	0.10	0.00	
Choline (mg)	1000.00	400.00	
Folic acid (mg)	0.60	1.00	
Niacin (mg)	20.00	40.00	
Pantothenic (mg)	11.00	14.00	
Pyridoxine (mg)	5.00	4.00	
Riboflavin (mg)	5.00	5.00	
Thiamine (mg)	2.80	4.00	

Source: Hill, (1988).
Olomu (1995)*
Leeson and Summers. (1995)**

Table 2.6 Nutrient requirements of broiler chickens as percentages or as milligrams or units per kilogram diet.

	Age in weeks			
Nutrients	0-6	6-9	9-12	12-15
ME, kcal/kg	3000	3000	3000	3000
Crude Protein %	24.00	20.00	18.00	16.00
Arginine, %	1.30	1.10	1.00	0.90
Glycine+serine, %	1.30	1.10	1.00	0.90
Histidine, %	0.54	0.45	0.40	0.35
Isoleucine, %	1.20	1.00	0.90	0.80
Leucine, %	2.00	1.70	1.50	1.30
Lysine, %	1.20	0.95	0.85	0.75
Methionine, %	0.55	0.40	0.40	0.35
Methionone+cystine, %	0.75	0.65	0.60	0.50
Phynylalanine, %	0.87	0.75	0.65	0.60
Phynylalanine+tyrosine, %	1.62	1.38	1.20	1.10
Threonine,%	0.70	0.55	0.50	0.47
Tryptophan, %	0.20	0.18	0.15	0.13
Valine, %	1.22	1.04	0.90	0.80

All values are expressed on as fed basis (88-90% dry matter).

Source: Olomu, (2011)

CHAPTER THREE

MATERIALS AND METHODS

3.1 Location of the study

The study was conducted at the Large Animals' Experimental Station, National Veterinary Research Institute (NVRI) Vom, Nigeria. Vom is in the Plateau Savannah zone of Nigeria, which has two distinct (dry and rainy) seasons.The dry season starts in October and ends in March with a temperature range of 13^{o}C-26^{o}Cor may even be less.While the rainy season is from April-September, and the temperature also ranges from 16^{o}C- 28^{o}C. The geographical location of Vom is 8^{o} 45`E, 9$^{o}$ 43`N and 4200 feet (1280m) above sea level. Mean relative humidity ranges from 14-17% (Knudsen and Sohel, 1970; NVRI, 2006). The environmental temperature ranges from 13.8^{o}C-28.5^{o}C (Knudsen and Sohel, 1970).The months of October-January usually experience a wider range of temperature due to differences in weather pattern. It is usually characterised by the dry hamattan winds which are cold and dry. From the middle or towards the end of January, as the hamattan winds begin to recede. The temperature risesup gradually to as high as 38^{o}C early in April just before the on-set of the rains(NVRI, 2006).

3.2 Source of Parkia pulp

The Parkia pulp used for the experiments was bought from a local market in Zaria and Giwa, Kaduna state.

3.3 Chemical Analysis

3.3.1 *Proximate Analysis for Parkia pulp*

The proximate analysis of Parkia pulp was carried out according to AOAC, (1990) at the BiochemistryLaboratory of the Department of Animal Science and that of the nutritional composition of Parkia pulp was at the Department of Food Science, Institute of Agricultural Research, Ahmadu Bello University, Zaria.

3.4 Determination of Anti-nutritional factors

The anti-nutritional factors determinations were carried out at the Biochemistry Department, National Veterinary Research Institute (NVRI), Vom and wereas follows:

3.4.1 *Determination ofPhytate*

The method used for phytate analysis was as described by AOAC (1990). 2g of Parkia pulp was weighed into a glass stopper bottle. 50ml of 0.5N HClwas addedand shaken on an orbital shaker at 2000rpm (revolution per minute) for about 3hrs to ensure homogeneity and maximum extraction of the phytic acid. The extract obtained was filteredusing filter paper. 12ml of the filtrate was takenand neutralised with 12ml of 10N NaOH. 2ml of 20% $FeCl_3$ solution was added to theneutralised filtrateand then place in a boiling water bath for 15minutes to precipitate ferric phytate. Then the solution was removed, cooled and centrifuge at 700rpm for 7 minutes, andthe supernatant discarded. The precipitate was washedwith 3ml of 0.17N HCl and transferred into a beaker. The precipitate wasthen heated in waterbath at 80^oC for 10 minutes;and 10ml of 0.5N NaOHadded to the precipitate and heated further for 15minutes to precipitate in ferric hydroxide and thenitwas converted to Sodium phytate. The precipitate was washedwith hot water and centrifuged at 700rpm for 7 minutes again. The supernatant was discardedand transferred into a beaker using 5ml hot distilled water. 1ml of concentrated H_2SO_4 and1.2ml of 60% perchloric acid were addedto the residue (filtrate) and the mixture was digestedon a hot plate to evaporate the acids. Theresidualperchloric acid was removedby strong heating on Bunsen burner. It was then cooled and 10-20ml of distilled water was addedand neutralised with 10N NaOH (PH 7).The volume was made up to 50ml with distilled water and the concentration of the phytate was calculated.

Calculation: $1cm^3$ of 0.02M$FeCl_3$ = 0.60mg Phytate

3.4.2 *Determination ofOxalate*

The oxalate content of Parkia pulp was determined using the method described by AOAC (1990). 2g of the Parkia pulp was weighed into a 250ml beaker; 190ml of distilled water and 10ml of6molar HCL were added to the beaker. It was allowed to stand for 5minutes while mixing it at intervals of 30 seconds. The volume was made up to 250ml with distilled water, 50ml was measured out and titrated using few drops of methyl red indicator while adding drop by drop concentrated ammonium until the colour became faint yellow. It was then heated on steam water bath to boil,removed and allowedto cool, before it was filtered and heated again to boil. 10ml of 5% $CaCl_2$was added while constantly stirring, another 5ml of $CaCl_2$was addedto give more precipitate of oxalate from the sample; it was then removed and allowed to stand overnight. The following day it was filtered and the precipitate was washedinto a beaker using 1:4 H_2SO_4acids and it wasrinsed with 5ml of hot distilled water. The solution was heatedand titrated against 0.05N $KMnO_4$. The titre value of the blank was subtractedfrom that of the sample and multiplied by 50 to get the result in mg/100g of the sample.

Calculation: 1m of 0.05 N$KMnO_4$= 3.0mg Oxalate.

3.0 x 50 = 150mg/100g Oxalate

3.4.3 *Determination ofTannins*

The method of estimation of tannins content of Parkia was according to the standard method described byJosely (1970), Lohan (1980), Santram*et al*.(1981) and Negi (1980). 5g of Parkia pulp wasdissolved in 200ml of hot distilled water. It was allowed to stand for 30 minutesafter which it was filteredand dried in the ovum, and the filtratewas concentrated.The dried sample was dissolvedusing 20ml of distilled water, mixed properly and filtered, where a colourless solution was obtained.The solution was made up to 25ml using distilled water in a 25ml volumetric flask.

Calculation: Soluble tannins % = $\frac{\text{cone graph x extract volume}}{\text{10 aliquotx sample weight}}$

3.5 Determination of reducing sugar in Parkia pulp

10ml of Fehling`s solution was dilutedand almost all the sugar solution required to complete the titration was added. Thecold mixture washeat to boiling on a wire gauge,after the liquid had boiled it was keptin a moderate ebullition for 3minutes before removing the flame. 4 drops of methylene blue indicator was addedand the titration was completedin 2minutes. The total time for boiling the reaction mixture was 5minutes. 10ml of Fehling`s solution equals 50mg of reducing sugar which was expressed in terms of glucose.

Calculation: 10ml of Fehling solution = 50mg reducing sugar

3.6 Determination of Ascorbic acid in Parkia pulp

5ml of the prepared solution was pipette and transferred to a 25ml flask, 20ml of water and 25ml of a 1% soluble starch were added to the solution. Standardised 0.01 N Iodine solution containing 16g potassiumIodide per litre wasrapidly titrated. Each millilitre of iodine is equivalent to 0.88mg of ascorbic acid; the milligram of Vitamin C per millilitre can be calculated from this relationship.

Calculation: 1ml of Iodine = o.88mg Ascorbic acid

3.7 Determination of Total starch in Parkia pulp

0.1g of driedParkia fruitwas weighedinto a 100ml volumetric flask and 10ml of distilled water was added and stirred to disperse the granules. 13ml of 52% perchloric acid reagent was added, stirred and the mixtureagitated,then distilled waterwas added to make it up to 100ml. The solution was filtered into a 250ml volumetric flask and distilled water used to make it up to mark. 0.2ml of the extract was pipette into a 10ml test tube and 0.8ml of distilled water was added. Then1ml of 5% phenol reagent and 5ml 96% volume (H_2SO_4) were added. After cooling, the absorbance was measuredat 490mm against the blank.

Calculation: Titre value x blank =

Multiply the answer by 50 = mg/100g Total starch

3.8 Experiment 1: Effect of feedinggraded levels of Parkia pulp to broiler chickens

3.8.1 *Experimental diets*

The birds were fed diets containing 0, 10, 20, 30 and 40% graded levels of Parkia pulpin the diets, both at starter and finisher phases. The experimental diets are presented in Tables 3.1&3.2. Diets were formulated to meet the NRC, (1994) standard requirements. The birds were supplied with water and feeds *ad libitum* throughout the experimental period.

3.8.2 *Experimental design and management of birds*

Two hundred and twenty-five day-old Arbour acre broiler chicks purchased from Ajanla Farms, through Zatech Ltd branch office in Jos, were used for the study. The birds were weighed at the beginning of the experiment and randomly assigned to five dietary treatments. The treatments were replicated three times with fifteen birds in each replicate and a total of forty-five birds per treatment in a completely randomised design. The chicks were brooded conventionally in a deep litter floor pen; using electric bulbs (200watts) as source of heat and light. Feed and water were supplied *ad libitum* to the birds throughout the experimental period. Routine vaccines and drugs were administered as at when due. Feed intake, weight gain, feed conversion ratio, cost per kg gain andpercent mortality were calculated. The experiment lasted for 63 days.

3.8.3 *Data collection*

Feed intake, weight gain and feed cost/kg gain were determined. Mortalities were recorded as they occurred. Weighed leftover feed was also subtracted from the total feed supplied for the week to obtain feed consumption per week for each of the replicates. The birds were weighed at the beginning of each of the experiments for the initial weight and thereafter on weekly basis.

3.8.4 *Carcass Evaluation*

At the end of the experiment six birds from each treatment (two birds per replicate) were randomly selected based on average group weight. The selected birds were bled, dressed and eviscerated similar to the method for dissection of turkey carcases described by Hann and Spindler (2002); and values were expressed as a percentage of live weight.

$$\frac{\text{Carcass Weight}}{\text{Live weight}} \times 100$$

Table 3.1 Ingredient Composition of Broiler Starter Diets (Experiment 1)

	Graded levels of Parkia pulp (%)				
Ingredients	**0**	**10**	**20**	**30**	**40**
Maize	46.45	37.18	27.67	18.54	9.54
Parkia	-	10	20	30	40
Soyabeanmeal	35.05	34.32	33.83	32.96	31.96
Wheat offal	9.00	9.00	9.00	9.00	9.00
Fishmeal	2.50	2.50	2.50	2.50	2.50
Bonemeal	2.00	2.00	2.00	2.00	2.00
Lime stone	1.00	1.00	1.00	1.00	1.00
Lysine	0.20	0.20	0.20	0.20	0.20
Methionine	0.25	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25	0.25
Palm oil	3.00	3.00	3.00	3.00	3.00
Salt	0.30	0.30	0.30	0.30	0.30
Total %	100.00	100.00	100.00	100.00	100.00
Calculated Analysis					
Cost/kg	76.34	73.39	70.48	67.52	64.54
ME kcal/kg	2870	2849	2820	2796	2773
Crude protein %	23	23	23	23	23
Crude fibre %	4.46	5.34	6.23	7.10	7.99
Ether extract%	3.66	3.31	2.93	2.56	2.19
Calcium %	1.38	1.37	1.37	1.37	1.37

Phosphorus %	0.63	0.63	0.62	0.62	0.61
Cystine %	0.31	0.30	0.31	0.31	0.30
Lysine %	1.45	1.67	1.89	2.11	2.33
Methionine	0.63	0.69	0.74	0.81	0.86

*Optimix premix supplied /kg of diet: Vit A- 13340 i.u; Vit. D_3-2680 i.u; Vit. E- 10 i.u; Vit.K- 2.68mg; Calcium pantothenate- 10.68mg; Vit.B_{12}-0.022mg; Folic acid- 0.668mg; Choline chloride- 400mg; Chlorotetracycline- 26.68mg; Manganese- 13mg; Iron- 66.68mg; Zinc, 53.34mg;Copper- 3.2mg; Iodine- 1.86mg; Cobalt- 0.268mg; Selenium- 0.108mg.
ME – MetabolisableEnergy

Table 3.2 Ingredient Composition of Broiler Finisher Diets (Experiment 1)

	Graded levels of Parkia pulp (%)				
Ingredients	**0**	**10**	**20**	**30**	**40**
Maize	53.60	44.80	35.40	26.00	16.80
Parkia	-	10	20	30	40
Soyabeanmeal	26.40	25.20	24.60	24.00	23.20
Wheat offal	10.50	10.50	10.50	10.50	10.50
Fishmeal	2.50	2.50	2.50	2.50	2.50
Bonemeal	2.00	2.00	2.00	2.00	2.00
Lime stone	1.00	1.00	1.00	1.00	1.00
Lysine	0.20	0.20	0.20	0.20	0.20
Methionine	0.25	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25	0.25
Palm oil	3.00	3.00	3.00	3.00	3.00
Salt	0.30	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analysis					
Cost/kg	73.78	69.77	65.87	61.97	58.03
ME kcal/kg	2928	2898	2881	2854	2829
Crude protein%	20	20	20	20	20
Crude fibre	4.25	5.11	5.99	6.87	7.74
Ether extract %	3.74	3.37	3.01	2.64	2.28
Calcium %	1.35	1.35	1.35	1.35	1.34
Phosphorus %	0.58	0.57	0.57	0.56	0.56
Cystine %	0.25	0.26	0.26	0.26	0.25
Lysine %	1.24	1.45	1.67	1.90	2.12
Methionine	0.59	0.64	0.70	0.77	0.83

*Optimix premix from Animal care supplied/kg of diet: Vit A- 13340 i.u; Vit. D_3- 2680 i.u; Vit.E- 10 i.u; Vit.K- 2.68mg; Calcium pantothenate- 10.68mg; Vit.B_{12}-0.022mg; Folic acid- 0.668mg; Choline chloride- 400mg; Chlorotetracycline- 26.68mg; Manganese- 13mg; Iron- 66.68mg; Zinc, 53.34mg; Copper- 3.2mg; Iodine- 1.86mg; Cobalt- 0.268mg; Selenium- 0.108mg.
ME – Metabolisable Energy

3.9 Experiment 2: Effect of replacement levels of Parkia pulp on growth performance of broiler chickens.

3.9.1 *Starter phase (0 – 4 weeks)*

3.9.2. *Experimental diets*

The compositions of the experimental diets are presented in Table 3.3. The birds were fed replacement levels of Parkia pulp at 0, 25, 50, 75 and 100%. The 100% level of inclusion replaced maize completely in the diet. Diets were formulated to meet the NRC, (1994) standard requirements. The birds were fed with the experimental diets *ad libitum* throughout the experiment.

3.9.3 *Experimental design and management of birds*

Day old Marshall Breed chicks numbering 225 were purchased for the purpose of this experiment from Zarm farms, through Zatech Ltd branch office in Jos.The management of the birds and experimental design in this experiment were as described in experiment 1.

3.10 Finisher phase (5 – 8 weeks)

3.10.1 *Experimental diets*

The compositions of the experimental diets are presented in Table 3.4 Treatment 1 was the control diet without Parkia pulp. Treatment 2 to 5 had maize in the control diet replaced by 25, 50, 75 and 100% respectively. Diets were formulated to meet the NRC, (1994) standard requirements. The birds were supplied with water and feeds *ad libitum* throughout the experimental period.

3.10.2 *Experimental design and Management of birds*

Two hundred and eleven birds were brought forward from the starter phase and used for the finisher phase experiment. The birds were randomly selected and allotted in to the five dietary treatments as it was in the starter phase, each treatment had 3 replicate (14 birds per replicate). The management of birds were as described in experiment 1.

3.11 Blood sample collection

On the final day of both experiments (1&2) that is, at the end of the finisher phases, blood was collected from the wing vein of the birds. Two birds from each replicate were bled giving a total of thirty (30) blood samples. The birds were randomly selected and a 5ml disposable syringe and needles were used in collecting the blood (bleeding). The blood parameters considered include; Red Blood Cell (RBC) count, Packed Cell Volume (PCV), Haemoglobin (Hb),Mean Corpuscular Volume (MCV), Mean Corpuscular Heamoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC) andPlatelets (Plt) for haematological parameters and were analysed by an auto Haemoanaliser (BC- 3000^{plus}Mindray Auto Haematology analyser). The serum biochemistry parameters analysed included; total protein; Biuret method (Reinhold, 1953), glucose; glucoseoxidase method (Trinder, 1969) and cholesterol; enzymatic method as described by (Randox kit 2002).

3.12 Haematological analysis

The blood samples were collected in Ethylenediaminetetraacetic acid (EDTA)embedded bottles while those for chemistry were collected in plain bottles. The analyses were carried out at the

Haematology laboratory section of the Central Diagnostic Department, National Veterinary Research Institute (NVRI), Vom.

3.13 Carcass Evaluation

At the end of the experiments, six birds from each treatment (two birds per replicate) were randomly selected based on average group weight. The selected birds were bled, dressed and eviscerated similar to the method used for dissection of turkey carcases described by Hann and Spindler (2002); and values were expressed as a percentage of live weight.

$$\frac{\text{Carcass Weight}}{\text{Live weight}} \times 100$$

3.14 Biochemical analysis

The blood samples were collected in clean, dry plain bottles. The blood was allowed to clot and serum collected for biochemical analysis. The analyses were carried out at the Biochemistry laboratory sectionof the Central Diagnostic Department, National Veterinary Research Institute (NVRI), Vom.

3.15 Statistical Analysis

All the data collected from experiments 1 and 2 were subjected to Analysis of Variance (ANOVA) using SAS (1995) software package and the mean separation was done using Duncan multiple range test.

Table 3.3 Ingredient composition of broiler Starter Diets (Experiment 2)

	(%) maize replaced				
Ingredients	**0**	**25**	**50**	**75**	**100**
Maize	46.45	34.83	23.22	11.60	-
Parkia	-	11.62	23.23	34.85	50.53
Soyabean meal	35.05	35.05	35.05	35.05	30.97
Wheat offal	9.00	9.00	9.00	9.00	9.00
Fishmeal	2.50	2.50	2.50	2.50	2.50
Bonemeal	2.00	2.00	2.00	2.00	2.00
Lime stone	1.00	1.00	1.00	1.00	1.00
Lysine	0.20	0.20	0.20	0.20	0.20
Methionine	0.25	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25	0.25
Palm oil	3.00	3.00	3.00	3.00	3.00
Salt	0.30	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analysis					
Cost/kg	96.16	90.93	86.64	81.88	72.34
ME kcal/kg	2870	2836	2797	2759	2749
Crude protein%	23	23	23	23	23
Crude fibre	4.46	5.52	6.57	7.62	9.15
Ether extract %	3.94	3.23	2.80	2.38	1.83
Calcium %	1.38	1.38	1.38	1.38	1.36
Phosphorus %	0.63	0.63	0.63	0.63	0.61
Cystine %	0.31	0.32	0.31	0.32	0.30
Lysine%	1.45	1.73	2.00	2.28	2.55
Methionine	0.63	0.70	0.77	0.84	0.92

*Optimix premix from Animal care provide/kg of diet: Vit A- 13340 i.u; Vit. D_3- 2680 i.u; Vit.E- 10 i.u; Vit.K- 2.68mg; Calcium pantothenate- 10.68mg; Vit.B_{12}-0.022mg; Folic acid- 0.668mg; Choline chloride- 400mg; Chlorotetracycline- 26.68mg; Manganese- 13mg; Iron- 66.68mg; Zinc, 53.34mg; Copper- 3.2mg; Iodine- 1.86mg; Cobalt- 0.268mg; Selenium- 0.108mg.
ME –Metabolisable Energy

Table 3.4 Ingredient Composition of Broiler Finisher Diets

	(%) maize replaced				
Ingredients	**0**	**25**	**50**	**75**	**100**
Maize	53.60	40.20	26.80	13.40	-
Parkia	-	13.40	26.80	40.20	58.10
Soyabean meal	26.40	26.40	26.40	26.40	21.90
Wheat offal	10.50	10.50	10.50	10.50	10.50
Fishmeal	2.50	2.50	2.50	2.50	2.50
Bonemeal	2.00	2.00	2.00	2.00	2.00
Lime stone	1.00	1.00	1.00	1.00	1.00
Lysine	0.20	0.20	0.20	0.20	0.20
Methionine	0.25	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25	0.25
Palm oil	3.00	3.00	3.00	3.00	3.00
Salt	0.30	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analysis					
Cost/kg	73.81	68.73	63.63	56.54	51.77
Me kcal/kg	2928	2884	2840	2796	2783
Crude protein%	20	20	20	20	20
Crude fibre	4.25	5.47	6.67	7.88	9.33
Ether extract %	3.73	3.24	2.74	2.26	1.62
Calcium %	1.35	1.35	1.35	1.35	1.34
Phosphorus %	0.58	0.58	0.58	0.58	0.55
Cystine %	0.25	0.26	0.27	0.26	0.26
Lysine%	1.24	1.56	1.88	2.20	2.51
Methionine	0.59	0.67	0.76	0.84	0.93

*Optimix premix from Animal care provide/kg of diet: Vit.A- 13,340 i.u; Vit. D_3,-2680 i.u; Vit. E- 10 i.u; Vit.K- 2.68mg; Calcium pantothenate- 10.68mg; Vit.$B_{12,}$- 0.022mg; Folic acid- 0.668mg; Choline chloride- 400mg; Chlorotetracycline- 26.68mg; Manganese- 13mg; Iron- 66.68mg; Zinc- 53.34mg; Copper- 3.2mg Iodine- 1.86mg; Cobalt- 0.268mg; Selenium- 0.108mg.

ME – Metabolisable Energy

CHAPTER FOUR

RESULTS

4.1 Chemical Analysis

The results of the proximate composition, nutritional composition and the anti-nutritional factors of Parkia pulpare presented in Tables 4.1, 4.2 and 4.3. The crude protein content was found to be(11.52%), crude fibre(12.49%), ether extract(3.09%), ash (4.08%) and Nitrogen free extract – (68.32%), calcium (0.48g/100g) and phosphorus(0.10g/100g).Levels of the anti-nutritional factors in the Parkia pulp were: oxalate (150.00mg/100g),phytic acid (219.10mg/100g) and tannins(3.23mg/100g).The reducing sugar content was (4.56mg/100g), ascorbic acid (24.22mg/100g) and total starch (5.84mg/100g).

Table: 4.1 Proximate and Nutritional composition of Parkia pulp

Nutrient	composition
Dry matter (%)	98.04
Crude protein (%)	11.52
Crude fibre (%)	12.49
Ether extracts (%)	3.09
Ash (%)	4.08
NFE	68.32
Reducing sugar(mg/100g)	4.56
Ascorbic acid (mg/100g)	24.22
Total starch (mg/100g)	5.84

NFE = Nitrogen Free Extract

able 4.2 Anti-nutritional factors present in Parkia pulp

Parameter	-	Composition
Oxalate mg/100g	-	150.00
Phytic acid mg/100g	-	219.10
Tannins mg/100g	-	3.23

4.2 Experiment 1:Growthperformance of Broiler chickens fed graded levels of Parkia pulp (0 – 9weeks)

4.2.1 *Growth performance of birds*

The growth performance indices of the birds in experiment 1 are presented in Table 4.4. The birds fedfeed containing 10% Parkia pulp inclusion in their diethadnegative effect in feed intake,final weight, and weight gain andfeed conversion ratio across the dietary treatments as the level ofParkia pulp increased.However, there was no statistical difference between birds fed feed containing 10% Parkia pulp (diet 2) and the control diet. Birds fed feed containing 10% African locust bean pulp had the least feed cost/kg gaincompared to birds fed other dietary treatments as the level of Parkia pulp increased.There was no mortality recorded during the experiment.

4.2.2 *Haematological parameters*

The results obtained from the analysis of blood parameters of broilers fed diets containing graded levels of Parkia pulp are presented in Table 4.5. There was no particular pattern observed, however, glucose, total protein, PCV,Hb, MCHC, Plateletand RDW-sd obtained from birds across the dietary treatments had significant ($P<0.05$) effect.Thebirds did not show any effect incholesterol, RBC, MCV, MCH andRDWcvacross the dietary treatments as the level of Parkia pulp increased among birds fed the control and other diets.

4.2.3 *Carcass Evaluation*

The results of the carcass analysis of birds fed diets containing graded levels of Parkia pulp are presented in Table 4.6.Live weight, carcass weight and dressing percentage decreasedacross the dietary treatments as the level of Parkia pulp increased. However, the performance of birds fed feed containing 10% Parkia pulp can be compared to the birds fed the control diet.The prime cuts expressed as a percentage of live weight are presented in Table 4.7 and itshowed that back, breast, wings, thighs, drumstickswere negatively affected by the inclusion of Parkia pulpin the diets.

Experiment 1:

Table 4.3 Effect of graded levels of Parkia pulp on the growth performance characteristics of Broilerchickens

	Graded Levels ofParkia pulp (%)							
Parameter	**0**	**10**	**20**	**30**	**40**	**SEM**	**LOS**	
Initial weight (g)	42.03	42.04	42.03	42.04	42.0	0.01	NS	
Final weight (g)	2122[a]	1961[a]	1616[b]	1486[bc]	1309[c]	80.05*		
Feed intake (g/bird/day)	87.97[a]	87.51[a]	80.75[a]	89.56[a]	77.97[b]	4.68	*	
Weight gain (g/bird/day)	33.91[a]	33.25[a]	25.90[b]	22.69[b]	20.97[b]	0.96	*	
Feed conversion ratio	2.34[a]	2.48[a]	2.97[b]	3.84[c]	3.59[c]	0.25	*	
Feed cost/kg gain (~~N~~)	303[a]	294[a]	320[a]	410[c]	359[b]	2.53	*	
Mortality (%)	0.00	0.00	0.00	0.00	0.00	0.00	NS	

a, b, c = Means in the same row having different superscript are significantly different (P<0.05).
NS = Not significant (p>0.05)
* = Significant difference (p<0.05)
SEM = Standard error of means

Table 4.4 Influence of Parkia pulp on some blood components of Broiler chickens

	Graded Levels of Parkia pulp (%)						
Parameter	**0**	**10**	**20**	**30**	**40**	**SEM**	**LOS**
Glucose (mmol/l)	7.10^{b}	6.57^{c}	7.60^{a}	6.68^{c}	7.62^{a}	0.17	*
Total protein (g/dl)	29.77^{b}	31.85^{ab}	35.32^{ab}	35.22^{ab}	36.52^{a}	0.81	*
Cholesterol(mmol/l)	1.18	1.33	1.08	1.10	1.07	0.15	NS
RBC ($x10^{12}$/l)	2.76	2.66	2.88	2.84	3.01	0.28	NS
PCV (%)	35.78^{b}	33.98^{b}	36.57^{a}	36.58^{a}	38.48^{a}	1.65	*
Haemoglobin (g/l)	131^{ab}	129^{b}	137^{ab}	142^{ab}	148^{a}	1.74	*
MCV (fl)	131	129	129	130	128.1	80.94	NS
MCH (pg)	48.08	48.70	47.88	50.27	49.12	0.76	NS
MCHC (g/l)	366^{b}	380^{ab}	374^{ab}	388^{a}	384^{a}	1.57	*
PLT ($x10^{9}$/l)	12.00^{a}	11.50^{a}	9.33^{a}	10.50^{a}	7.83^{b}	1.84	*
RDW –cv (%)	8.78	9.63	9.43	8.27	8.88	0.51	NS
RDW – sd (fl)	46.68^{a}	48.77^{a}	48.23^{a}	43.75^{b}	45.13^{a}	1.84	*

a, b, c = Means in the same row having different superscript are significantly different (P<0.05).
NS = Not significant (p>0.05)
* = Significant difference (p<0.05)
SEM =Standard error of means
RBC = Red blood cells
PCV = Packed Cell Volume
Hb = Haemoglobin
MCV = Mean corpuscular volume
MCH = Mean corpuscular haemoglobin
MCHC = Mean corpuscular haemoglobin concentration
PLT = Platelets
RDW-cv = Red blood cell (erythrocyte) distribution width coefficient of variation
RDW-sd = Red blood cell (erythrocyte) distribution width standard deviation

Table 4.5 Carcass characteristics of Broiler Chickens fed diets containing graded levels of Parkia pulp

	Graded Levels of Parkia pulp(%)						
Parameter	**0**	**10**	**20**	**30**	**40**	**SEM**	**LOS**
Live weight (g)	2100[a]	1950[a]	1637[b]	1483[b]	1207[c]	67.73	*
Carcass weight (g)	1488[a]	1337[b]	1042[c]	848[d]	727[d]	43.77	*
Dressing %	70.85[a]	70.21[a]	63.36[b]	56.90[c]	60.23[bc]	1.56	*

a, b, c = Means in the same row having different superscript are significantly different (P<0.05).
NS = Not significant (p>0.05)
* = Significant difference (p<0.05)
SEM = Standard error of means

Table: 4.6 Prime cuts expressed as percentage of live weight

	Graded Levels of Parkia pulp(%)							
Parameter	**0**	**10**	**20**	**30**	**40**		**SEM**	**LOS**
Back	15.23[a]	14.79[a]	12.85[b]	11.38[b]	12.78[b]	0.57*		
Breast	24.61[a]	24.21[a]	20.92[b]	18.86[b]	18.27[b]	0.92	*	
Wings	8.66[ab]	9.14[a]	8.61[b]	7.76[c]	9.51[a]	0.23	*	
Thigh	11.12[a]	10.16[ab]	9.53[b]	9.53[b]	9.38[b]	0.32	*	
Drumsticks	11.43[a]	10.53[ab]	10.24[abc]	9.21[c]	9.88[bc]	0.36	*	

a, b, c = Means in the same row having different superscript are significantly different (P<0.05).
NS = Not significant (p>0.05)
* = Significant difference (p<0.05)
SEM = Standard error of means

Table: 4.7 Organ partsexpressed as percentage of live weight

	Graded Levels of Parkia pulp(%)							
Parameter	**0**	**10**	**20**	**30**	**40**		**SEM**	**LOS**
Liver	2.15[b]	2.53[ab]	2.69[ab]	2.55[ab]	3.18[a]	0.21	*	
Heart	0.68[b]	0.90[a]	0.92[a]	0.91[a]	0.94[a]	0.06	*	
Gizzard	2.34[b]	2.44[b]	2.50[a]	2.53[a]	2.58[a]	0.21	*	
Proventriculus	0.52[b]	0.90[a]	0.92[a]	0.91[a]	0.93[a]	0.03	*	
Spleen	0.56[b]	0.60[b]	0.53[b]	0.51[b]	0.74[a]	0.04	*	

a, b, c = Means in the same row having different superscript are significantly different (P<0.05).
NS = Not significant (p>0.05)
* = Significant difference (p<0.05)
SEM = Standard error of means

across the dietary treatments. Consequently, organ parts presented in Table 4:8; liver, heart; gizzard, proventriculus and spleen were also affected negatively by higher level of Parkia pulp inclusion in the diets.

4.3Experiment 2:The effects of replacing maize withParkia pulp on growth performance ofbroiler chickens.

4.3.1 *Starter phase (0 – 4 weeks)*

4.3.2 *Growth performance of birds*

The growth performance of chicks fed Parkia pulp which replaced maize in their dietsis presented in Table 4.9. The birds fed feed containing 25%Parkia pulp in place ofmaize (diet 2) in their diets have severe decrease in feed intake across the dietary treatments as the level of African locust bean pulp increased.However, the birds could compete favourably with birds fed the control diets.Final weight and weight gain were significantly($P<0.05$) loweracross the dietary treatments with birds fed the control diet having a better performance.Birds fed 25% Parkia pulp had significant ($P<0.05$) betterfeed conversion ratiocompared toother dietary treatments.They also had the least feed cost/kg gain across the dietary treatments.

There was significant($P<0.05$) increase in percent mortality among the experimental birds as the level of Parkia pulp replacing maize increase across the dietary treatments.Birds fed feed containing 100% Parkia pulp replacement level had the highest percent mortality when calculated.

Experiment 2:

Table 4.8 The effect of replacing maizewith Parkia pulp on the growthperformance characteristics of Broiler starter (0 – 4weeks)

	(%) maize replaced						
Parameter	**0**	**25**	**50**	**75**	**100**	**SEM**	**LOS**
Initial weight (g)	40.45	40.62	40.2	40.33	40.45	0.19	NS
Final weight (g)	804^{a}	709^{b}	563^{c}	469^{d}	302^{e}	4.14	*
Feed intake (g/bird/day)	54.31^{a}	53.08^{a}	49.41^{b}	46.64^{b}	46.47^{c}	0.99	*
Wtgain(g/bird/day)	22.13^{a}	19.11^{b}	14.71^{c}	11.56^{d}	7.28^{e}	0.47	*
Feed conversion ratio	2.46^{d}	2.78^{d}	3.37^{c}	4.05^{b}	6.16^{a}	0.13	*
Feed cost/kg gain (=N=)	236^{c}	252^{c}	292^{bc}	331^{b}	405^{a}	17.86	*
Mortality (%)	0.00^{b}	0.33^{b}	0.33^{b}	0.33^{b}	4.33^{a}	0.39	*

a, b, c, d, e = Means in the same row having different superscript are significantly different (P<0.05).
NS = Not significant (p>0.05)
* = Significant difference (p<0.05)
SEM =Standard error of means
FI = Feed intake
WT =Weight gain

Table 4.9 The effects of replacing maizewithParkia pulp on growth performance characteristics of Broilers finisher (5–8weeks)

	(%)maize replaced						
Parameter	**0**	**25**	**50**	**75**	**100**	**SEM**	**LOS**
Intial weight (g)	644	644	645	644	645	0.77	NS
Final weight (g)	1392[a]	1388[a]	1008[b]	880[c]	763[d]	5.35	*
Feedintake (g/bird/day)	112[a]	110[a]	97.90[b]	93.55[b]	81.16[c]	1.71	*
Weight gain (g/bird/day)	36.30[a]	37.36[a]	20.62[b]	13.43[c]	7.58[d]	1.51	*
Feed conversion ratio	3.07[a]	2.96[a]	4.31[b]	4.35[b]	5.46[c]	0.38	*
Cost/kg gain (=N=)	249[a]	225[a]	348[b]	446[c]	440[c]	28.98	*
Mortality (%)	0.00[b]	0.33[b]	0.33[b]	1.00[b]	4.00[a]	0.56	*

a, b, c = Means in the same row having different superscript are significantly different (P<0.05).
NS = Not significant (p>0.05)
* = Significant difference (p<0.05)
** = Highly significant (p<0.01)
SEM =Standard error of means

4.4 Finisher phase(5 – 8weeks).

4.4.1 *Growth performance of birds*

The performance of broiler finishers fed diets in which Parkia pulp replacedmaize are presented in Table 4.10. There was significant (P<0.05) decreasein feed intake between the dietary treatments in birds fed diets containing Parkia pulp. Birds fed diets where African locust bean pulp replaced 25% of maizehad significant (P<0.05) betterperformance in feed intakewhich was similar to the performance of the control compared to other dietary treatments; however, the birds fed diets containing 100% Parkia pulp recorded the least value.Final weight and weight gain significantly (P<0.05)decreasedacross the treatments, birds fed diets containing 25% Parkia pulp and the control had the highest values when compared to other birds across the dietary treatments as the level of Parkia pulp increased. The birds fed diets containing 25% Parkia pulp and the control performed significantly (P<0.05) better in feed conversion ratio compared to the birds fed other dietary treatments. Similarly, the birds fed diets containing 25% Parkia pulp had the least cost per kg gain compared to birds fed other diets.

Mortality was observed to have increase across the dietary treatments as the level of Parkia pulp increased, with highest mortality recorded in birds fed diets containing 100% Parkia pulp.

4.4.2 *Haematological parameters*

The results of the blood serum chemistry and the other blood parameters of broiler chickens fed replacement levels of Parkia pulp are presented in Table 4.11. The blood serum chemistry(glucose and cholesterol)platelets, RDW-cv and RDW-sdshowed no deleteriouseffect on birds fed Parkia pulp across the dietary treatments. However, total protein and haematological parameters(RBC, PCV, Hb, MCV, MCH andMCHC)were observed to have had someeffect in birds as the level of African locust bean pulp increased.

Table 4.10 Influence of Parkia pulp on some blood parameters of Broiler chickens

	(%) maize replaced)						
Parameter	**0**	**25**	**50**	**75**	**100**	**SEM**	**LOS**
Glucose (mmol/l)	7.97	7.70	6.65	5.85	6.90	0.38	NS
Protein (g/dl)	46.33^{c}	51.60^{a}	45.22^{c}	48.59^{b}	45.48^{c}	0.64	*
Cholesterol (mmol/l)	2.20	1.95	1.87	2.13	1.67	0.37	NS
RBC ($x10^{12}$)	2.92^{b}	2.99^{ab}	3.47^{a}	3.30^{ab}	3.20^{ab}	0.31	*
PCV (%)	35.10^{c}	37.03^{bc}	43.40^{a}	40.98^{ab}	37.93^{bc}	0.95	*
Hb (g/l)	146^{b}	152^{ba}	173^{a}	161^{ba}	151^{ba}	2.02	*
MCV (fl)	121^{b}	124^{a}	125^{a}	122^{a}	120^{b}	1.76	*
MCH (pg)	50.03^{a}	50.93^{a}	49.72^{a}	49.08^{a}	47.27^{b}	1.06	*
MCHC (g/l)	415^{a}	409^{ab}	398^{b}	403^{ab}	394^{b}	1.73	*
Platelet ($x10^{9}$)	8.50	10.50	10.00	11.67	8.50	0.74	NS
RDW-cv (%)	7.95	8.17	8.38	8.18	8.62	0.44	NS
RDW-sd (fl)	37.73	40.87	39.72	39.20	38.82	1.81	NS

a,b,c = Means within the same row having different superscripts are significantly different (P<0.05).
NS = Not significant (P>0.05)
* =Significant difference (P<0.05)
RBC = Red blood cells
PCV = Packed Cell Volume
Hb = Haemoglobin
MCV = Mean corpuscular volume
MCH = Mean corpuscular haemoglobin
MCHC = Mean corpuscular haemoglobin concentration
PLT = Platelets
RDW-cv = Red blood cells (erythrocyte) distribution width coefficient of variation
RDW-sd = Red blood cells (erythrocyte) distribution width standard deviation

4.4.3 ***Carcass Evaluation***

The results of the carcass analysis of broiler chickens fed diets containingAfrican locust bean pulp in place of maize are presented in Table 4.12. Live weight, carcass weight and dressing percentage expressed as percentage of live weight wereobserved to have significantly (P<0.05) decreased as the level of Parkia pulp fed to broilers increased across the treatment means. The birds fed 25% Parkia pulp diet where Parkia pulp replaced maize competed favourably with birds fed the control diet in the performance characteristic records. ThePrime cutsare presented in Table 4.13;breast, wings and drumsticks showed a decrease, back and thighs decreased non significantly (P>0.05) as the level of Parkia pulp increased across the dietary treatments. Organ parts are presented in Table 14;proventriculus, small intestine and large intestine were observed to havehad negative effectin birds fed Parkia pulp diets as the level increasedacross the dietary treatments. However,liver, heart, gizzard and spleen did notshow negativeeffect on birds across the dietary treatments as the level of Parkia pulp increased.

Table 4.11 Carcass Evaluation of Broiler Chickens fed replacement levels of Parkia pulp

	(%) maize replaced							
Parameter	**0**	**25**	**50**	**75**	**100**		**SEM**	**LOS**
Live weight (g)	1314^{a}	1253^{a}	949^{b}	789^{c}	678^{c}	47.80		*
Carcass weight (g)	891^{a}	818^{a}	599^{b}	436^{c}	312^{d}	33.06	*	
Dressing percentage (%)	67.80^{a}		65.31^{a}	63.10^{a}	54.97^{b}	46.26^{c}	1.90	*

a,b,c = Means within the same row having different superscripts are significantly different (p<0.05).
NS = Not significant (p>0.05)
* =Significant difference (p<0.05)
SEM = Standard error of mean

Table 4.12 Prime cuts expressed as percentage of live weight

	(%) maize replaced						
Parameter	**0**	**25**	**50**	**75**	**100**	**SEM**	**LOS**
Back	12.35 11.37	11.94	11.69	10.67		0.71	NS
Breast	24.55[a]	20.84[b]	19.22[c]	14.65[d]	10.36[e]	0.55	*
Wings	10.14a 9.26[ab]	9.57[ab]	8.22[bc]	7.00[c]		0.56	*
Thighs	10.46	10.41	10.31	9.30	9.19	0.67	NS
Drumsticks	9.51[ab] 11.02[a]	10.89[a]	10.34[ab]	8.34[b]		0.74	*

a,b,c = Means within the same row having different superscripts are significantly different ($p<0.05$).
NS = Not significant ($p>0.05$)
* =Significant difference ($p<0.05$)
SEM = Standard error of mean

Table 4.13 Organ Partsexpressed as percentages of live weight

	(%) maize replaced							
Parameter	**0**		**25**	**50**	**75**	**100**	**SEM**	**LOS**
Liver	2.78	2.77	2.55	3.05	2.91	0.18		NS
Heart	0.66	0.67	0.70	0.84	0.83	0.06	NS	
Gizzard	2.51	2.11	2.13	1.90	2.14	0.18	NS	
Proventriculus	0.63^{ab}	0.54^{ab}	0.53^{b}	0.69^{a}	0.56^{ab}	0.05	*	
Spleen	0.14	0.13	0.15	0.07	0.08	0.03	NS	
Small intestine	6.26^{d}	6.58^{cd}	8.22^{bc}	9.59^{b}	11.80^{a}	0.56	*	
Large intestine	0.59^{b}	0.56^{b}	1.23^{a}	0.87^{ab}	1.11^{a}	0.27	*	

a,b,c = Means within the same row having different superscripts are significantly different ($p<0.05$).
NS =Not significant ($p>0.05$)
* =Significant difference ($p<0.05$)
SEM = Standard error of mean

CHAPTER FIVE

DISCUSSION

5.1 Proximate composition of Parkia pulp

The result of the laboratory analysis obtained showed that Parkia pulp has a high crude protein content of 11.52g/100g compared to literature available. This high crude protein content of Parkia pulp is not comparable with 6.70% (6.70g/100g) reportedbyKwari and Igwebuike (2002);5.25g/100g (Bello *et al.*2008); 6.62mg/100g (0.00662g/100g)(Alabi*et al* 2005) and 4.81%(4.81g/100g) reported by Hassan and Umar (2005). The difference may be due to thedifferent geographical locations and soilsin which they were cultivated, manorial treatment they may have received, differences in cultivars or difference in method of processing.

The crude fibre content of Parkia pulp was 11.49g/100g (11.49%) which is comparable to 12.00g/100g reported by Bello *et al.* (2008); but lower than 18.00% (18g/100g)of Kwari and Igwebuike (2002) and higher than 30.65mg/100g (0.03065g/100g) of Alabi*et al.* (2005). The amount of crude fibre obtained may be due to tough texture, especially at maturity and probably due to the presence of waxy substances (Zoberi, 1973). According to Shiawoya and Adeyemi (2003), low fibre content of feeds could stimulate feed intake as well as enhance the quality and digestibility of the feed. Viscosity–promoting potential of crude fibre has also been shown to reduce the overall digestive absorptive efficiency by preventing nutrients from being available at the absorptive sites in the intestinal mucosa (Webel*et al.* 2003).

The crude fat content of the Parkia pulp obtained was 3.09g/100g (3.09%) which was higherthan 1.80% reported byGernah*et al*. (2005) and significantly lower than 18% by Bello *et al.* (2008). It is comparable to 3.00% reported by Kwari and Igwebuike (2002) and 3.30% by Hassan *et al.* (2007). However, it is higher than2.96mg/100g (0.00296g/100g) reported by (Alabi*et al.* 2005). The low fat content of Parkia pulp has a tendency to give a long shelf life to the Parkia pulp during storage under the right temperature without spoilage by rancidity, and can also be recommended for

inclusion in weight reducing diets. According to Leeson (1997) fats are widely used energy sources in addition to improving the consistency and palatability of mash feed.

The ash content of Parkia pulp showed 4.08g/100g (4.08%), which agreed with the value of 4.00g/100greported by Bello *et al.* (2008) and 4.18% reported by Gernah*et al.*(2007). It is also comparable to Kwari and Igwebuike (2002) who reported a value of 3.00%, but disagreed with Alabi*et al*. (2005) who reported 13.00% content. Akintayo (2004) reported that ash content in feed ingredients to be used in compounding feed should be greater than 25. Nevertheless, the ash content could be brought within the range when mixed with other low ash containing feed ingredients. However, the ash content reported here compares favourably with the values of ash in some feed stuffs such as groundnut meal 6.00%, cotton seed meal 5.82% and soya bean 4.86% (Nzekwe and Olomu, 1982, and Fasoyiro*et al.* 2006). The ash content of a substance gives an idea about the inorganic or mineral content of such a feed ingredient.

The Nitrogen free extract of the Parkia pulp contained 68.32g/100g (68.32%) which is higher than 58.00%reported by Kwari and Igwebuike (2002). Other findingsthat were reported revealed carbohydrate content of 67.30% by Gernah *et al.* (2005) and68.75g/100g by Bello *et al.* (2008).

The anti-nutritional factors of Parkia pulp obtained from the laboratory analysis showed that oxalate had a content of 150mg/100g. This result disagreed with the value obtained by Bello *et al.* (2008) which was 0.93g/100g (930mg/100g),however, Alabi*et al.* (2005)obtained 3.40mg/100g. The phytic acid content of Parkia pulp was found to be 219.10mg/100g which differed from 0.20mg/g obtained by Bello *et al.*(2008)and 60.00mg/100g by Gernah*et al.*(2005), respectively. Tannin content of Parkia pulp obtained in this study was 3.23mg/100g which is significantly lower than 1.08mg/g (108mg/100g) reported by Bello *et al.*(2008) and 81.00mg/100g reported by Gernah*et al.*(2005). These differences could be due to the geographical zone and probably difference in soil profile and its chemical composition.

The reducing sugar content was found to be 4.56mg/100gwhichdiffered from4.27mg/g content obtained by Bello *et al.* (2008).However, the result is comparable with3.37mg/100g reported by(Alabi et al. 2005).The ascorbic acid value obtained was 24.22mg/100gwhich is significantly lower than the 215.00mg/100greported byBello *et al.* (2008), however, it is significantly higher than 9.85mg/100g obtained by (Alabi*et al.*2005). Total starch value was5.84mg/100g. Thisdiffered from151.88mg/g obtained by Bello *et al.* (2008)and 25mg/100g stated by (Alabi et al. 2005). However, the differences in results probably may be due to the different geographical locations, processing methods, cultivars and probably seed type.

5.2 Experiment 1

Feed intake wassignificantly (P>0.05) low as the level of Parkia pulp increased in the diets. The birds fed 10% Parkia pulp consumed the feed equally well when compared with birds' consumption in the control. The decrease in feed intake across the dietary treatments may probably be because of increase in the fibre level and decrease in the energy level as the Parkia pulp increased in the dietary treatments which may have affected the palatability of the feed.Kwari and Igwebuike (2002) had earlier reported a decreased in feed intake with increase in the dietary levels of Parkia pulp.

There was significant (P<0.05) decreasedacross the dietary treatments in final weight and weight gain. Birds fed control and10% Parkia pulp diets had significant (P0<0.05) higher final weight and weight gain compared to birds fed 20, 30 and 40% Parkia pulp diets, respectively. The final weight and weight gain of birds feddiets containing 10% African locust bean pulp could be an indication that it can be used up to 10% in broiler diets. There was competition between birds fed 10% inclusion of Parkia pulp and birds fed the control diet. Kwari and Igwebuike (2002) had earlier reported a satisfactory performance of broiler chickens fed diets containing up to 15% African locust bean pulp replacing maize.

Birds fed control and diet containing 10% Parkia pulp had a better feed conversion ratio compared toother Parkia pulpdietary treatments,probably because they could utilise the feed consumedefficiently and it was not to negatively affect their production.The better feed conversion ratio observed in birds fed diet containing 10% Parkia pulp in the diet implies that more feed was being retained in the animals and less waste into the environment (Gebhart, 2001).Thisis in agreement with Kwari and Igwebuike (2002) who had earlier reported an increase in Feedconversion ratio value as the dietary level of Parkia pulp increased. Birds fed 10% Parkia pulp diet hadthe least cost per kg gain across the dietary treatment which was similar to the control and 20%Parkia pulp diet. As the level of Parkia pulp increased across the dietary treatments, the cost/kggain increased. The birds fed 10%Parkia pulp diet had the least cost probably because they could utilise the feedconsumed and convert the nutrients efficiently into flesh. And the birds that were fed diet containing 40% Parkia pulpwhich recorded the highest feed cost was probably because the nutrients were not available to thembecause of the increase in fibre level and decrease in energy level as the level of Parkia pulpinclusion increased.The general performance of the birds on high Parkia pulp inclusion in thediets in this study could be an indication that the nutritive value of Parkia pulp as an energy sourceis not as good as maize in supporting growth performance in broiler chickens.There was no mortality observed across the dietary treatments. This could suggest that the use ofParkia pulp up to 40% may not result in adverse effect on the health status of the birds whencompared with the results obtained in the starter and finisher phases. However, the cost efficiencyof production at 40% level of inclusion is lower than the other dietary treatments, probablybecause of the birds' low feed intake and poor growth observed.

It was observed that some of the blood parameters; glucose,Platelet, MCHC and RDW-sdshowed that Parkia pulp hadpartialeffecton the birds without taking any particular trend among the treatment groups. However, total protein, PCV and Hb production increased as the level of Parkia pulp increasedacross the dietary treatments.Theeffect of Parkia pulp fed to broiler chickens lowered the levels of Cholesterol and MCV, however, the level of RBC production increased, MCH and

RDW-cvwere not negativelyaffected without any particular patternas the level of Parkia pulp increased across the dietary treatments. However, it was generally observed that thevalues of the blood parameter analysed were within normal ranges. This may suggest that Parkia pulp encourages glycolysis, protein synthesis and haemopoesis. It can be concluded thatfor optimum growth performance,up to 10% African locust bean pulp could be recommended in the diets of broiler chickens. This is because the birds fed 10% Parkia pulp diet performed better than the birds fed other pulp diets and it competed favourably with the birds fed the control diet.

Live weight, carcass weight and dressing percentage showed significant ($P<0.05$) decreased across the dietary treatments as the level of Parkia pulp replacing maize increased, probably because as the level of Parkia pulp increase the fibre increased and the energy decreased which may have affected their performance negatively. Onifade (1993) and Onifade and Babatunde (1997) reported that high fibre content was found to interfere with nutrient availability for growth and maintenance.The result obtained from the carcass evaluation indicates that birds fed 10% Parkia pulpdiet had good growth performance as birds fed the control diet.Kwari and Igwebuike (2002) recorded a decreased in live weight, carcass weight and dressing percentage as the amount of Parkia pulp increased in the dietary treatments.

The prime cuts and organ parts expressed as a percentage of live weight showed that back, breast, wings, thighs, drumsticks, liver, heart, proventriculus and spleen were negativelyaffected by Parkia pulp inclusion in their diets across the dietary treatments. Mohammed *et al.* (2009) reported severe effectin theprime cuts and organ parts when broiler chickens were fed yam peels to replace maize.

5.3 Experiment 2

5.3.1 Starter phase (0 – 4 weeks)

Birds fed diet containing 25% Parkia pulp (diet 2) had comparative performance with birds fed the control diet in feed intake; consequently, the birds fed diet containing 25% Parkia pulp replacing maize hada better performance in feed intake compared to birds fed other dietary treatments. This observation may be due to low energy and high level of fibre in the diets as the level of African locust bean pulp increased. Final weight and weight gain showed significant ($P<0.05$) decreasedat four weeks across the treatment means. This trend was observed by Kwari and Igwebuike (2002) when the level of Parkia pulp increased across the dietary treatments. Onifade (1993) and Onifade andBabatunde (1997) reported that high fibre content was found to interfere with nutrient availability for growth and maintenance. The level of dietary fibre increased and the energy decreased with increase in level of Parkia pulp in this study, which probably affected the growth performance of the young birds.

Birds fed diet containing 25% Parkia pulp replacing maize had a comparable feed conversion ratio to birds fed the control diet. However, as the level of Parkia pulp increase across the dietary treatments, the value of the feed conversion ratio increased. The better feed conversion ratio observed in birds fed diet containing 25%Parkia pulp in the diet implies that more feed was being retained in the animals and less waste into the environment (Gebhart, 2001). This observation agrees with Kwari and Igwebuike (2002) who reported that feed conversion ratio of broiler chickens was negatively affectedas the levels of Parkia pulp increased across the dietary treatments.

The cost per kg gain differed significantly ($P<0.05$) across the dietary treatments. The birds fed up to 25% Parkia pulp in the diet had significant ($P<0.05$) lower cost per/kggaincompared to other dietary treatments which made them to compete favourably with birds fed the control diet. This result disagrees with the report of Abeke (2005) that the utilization of unconventional feed ingredients in livestock diets has been known to lower cost of production because they are cheaper,

readily available and of no competition with humans; itis also in agreement with Onimisi (2005) who reported that the cost/kg gain of raising broiler starters fed with ginger waste meal increased as the level of ginger waste meal increased across the dietary treatments.

There was no significant (P>0.05) increase in the percent mortality of the experimental birds across the dietary treatments, except for birds fed 100% Parkia pulp in their diet.

The results obtained from this experiment suggest that African locust bean pulp can be used to replace up to 25% of maize in broiler starter diets;however, higher amount may probably affect the growth performance and give rise to higher mortality of birds.

5.4 Finisher phase (5 – 8 weeks)

There was significant (P<0.05) decreased in feed intake in birds between the dietary treatments. Birds fed control diet and25% Parkia pulp diet showed better utilisation of the feed compared to other dietary treatments. Consequently,birds'feddiet containing 100%Parkia pulphad the least value in feed intake. This could probably be due to low energy and high fibre in the diets which may have affected the palatability of the feed. It is an established fact that feed intake is based primarily on the amount of energy in the diets (Smith, 2001). Kwari and Igwebuike (2002) had earlier reported a decreased in feed intake as the level of Parkia pulp increased across the dietary treatments.

The final weight and weight gain for birds fed control diet and diet containing 25% Parkia pulpdecreased across the dietary treatments as the level of Parkia pulp increased in their diets. Probably the palatability of the feed may have beenlowered because of the increase in Parkia pulp across the dietary treatments. However, birds fed 100% Parkia pulp diet obtained the least numerical values in final weight and weight gain. Final weight is a reflection of feed intake and weight gain of birds fed *ad libitum.* Birds fed control diet and 25%Parkia pulp diet had the highest weight gain compared to other birds across the dietary treatments. It was observed that as the level of inclusion of African locust bean pulp increased, the dietary levels of crude fibre was increasing and the energy level was decreasing. Kandra*et al.*(1974) had earlier reported that body weights in

meat type birds were decreased when birds were fed higher fibre levels in the diets.The observation from final weight and weight gain agreed with Kwari and Igwebuike (2002) who reported a decrease across the dietary treatments as the levels of Parkia pulp increased.

The birds fed diet containing up to 25%Parkia pulp showedincreased in feed conversion ratio which had a range of 3.07-5.46 across the dietary treatments. This result disagrees with the findings of Egbegale*et al.* (2008) who reported that feed conversion ratio for broilers ranges between 2.77-2.99. This confirms the fact that the lower the feed conversion ratio, the better it is for optimum growth performance. The birds fed diet containing 100% Parkia pulp had high feed conversion ratio, probably because they could not utilise the feed consumed and may be nutrients were not available to the birds to be utilised by the birds for efficient growth performance.

Similarly, birds fed up to 25% Parkia pulp diethadthe least feed cost/kg gainwhich was similar to the control. This was bettercompared to the birds fed the other diets. And the birds fed 100% Parkiapulp diet had the highest feed cost may be because of the reasons already highlighted. This observation was probably due to the low weight gain and final weights that were earlier reported. The observation agreed with the findings of Frank (1984) that reported a similar observation when maize was replaced with brewers dried grain in the diets of broiler finisher where feed cost of production significantly increased with higher levels of brewers dried grain.

Increase in percent mortality was observed acrossthe dietary treatments with birds fed 100% Parkia pulp diet recording the highest mortality, as the level of Parkia pulp increased the fibre level of the feed decreased. The palatability of the feed may have been negatively affected and there could have been non availability of nutrients to the birds which may have marredtheir immunity level.

The blood parameters analysed from broilers fed replacement levels of Parkia pulp to replace maize in the finisher phase are presented in Table 4.11. The blood serumchemistry (glucose and cholesterol) platelet, RDW-cv and RDW-sd had no negativeeffectas Parkia pulp replaced maize across the dietary treatments. However, RBC, PCV, Hb, MCV, MCH and MCHC were partially

affectedacross the dietary treatments as the level of Parkiapulp increased.The decrease in energy and the increase in fibre levels across the dietary treatments observed probably caused the statistical differences in these blood parameters. It was observed that though values were within normal ranges but they were higher compared to the values obtained in experimentone.This suggests that Parkia pulp may not have had much negative effect on the biochemistry and haematology of birds in this experiment, and may be it supported increase in production of more blood cells in the broilers.

Live weight, carcass weight and dressing percentage expressed as a percentage of live weight had significant ($P<0.05$) decreased across the dietary treatments. This may probably be due to the high amount of Parkia pulp replacing maize across the dietary treatments, as it was earlier reported that as fibre level was increasing energy level was decreasing with increase in the level of Parkia pulp across the dietary treatments. Both Hedge *et al.* (1978), and Trait and Write (1990) observed that high fibre in the diet could be the cause of decrease in the availability of nutrients which is as a result of reduction in the period of exposure of the feed to digestive enzymes which in turn impairs absorption of nutrients.These results concord with the observation of Onimisi (2005) who recorded decreased values of live weight, carcass weight and dressing percentage between the treatments as the level of ginger waste meal increased in the diets of broiler chickens. The Prime cuts; breast, wings and drumsticks showed that they decreased, back and thighs decreasednon significantly ($P>0.05$) as the level of Parkia pulp increased across the dietary treatments. Thismeans probably that Parkia pulp had a little or no negative effect on these parameters. Organ parts; proventriculus, small intestine and large intestine were observed to haveshown negative effect in birds fed increase level of Parkia pulp in diets across the dietary treatments. However, liver, heart, gizzard and spleen did not show negative effect on birds. This observation probably may be because increases in the level of Parkia pulp across the dietary treatments which caused the fibre level to increase and the energy level to decrease affected the organs negatively.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 Summary

The proximate composition of Parkia pulp was found to be crude protein 11.52%, crude fibre – 12.49%, crude fat/oil – 3.09%, ash – 4.08% and Nitrogen free extract – 68.32%, calcium – 0.48g/100g and phosphorus – 0.10g/100g. The proximate analysis of anti-nutritional factors; oxalate (150mg/100g) and phytic(210mg/100g) acid were considerably high and tannins(3.23mg/100g) were relatively low.The nutritional composition of Parkia pulp determined was total starch (5.84mg/100g), ascorbic acid (24.22mg/100g) and reducing sugar (4.56mg/100g).

Two experiments were conducted to evaluate the Nutritive value of Parkia pulp for Broiler chickens as an energy source. The first experiment was conducted to evaluate the effect of graded levels of 0, 10, 20, 30 and 40% Parkia pulp levels of inclusion on the performance of broiler chickens.At the end of the first experiment, it was observed that 10% level of inclusion in the diet gave the best performance; however, growth performance in this experiment had significant ($P<0.05$)decreasedin most of the parameters.Glucose, total protein, PCV, Hb, MCHC, Plt and RDW-sd were partiallyaffected across the treatments. However, cholesterol, RBC, MCV, MCH and RDW-cv were not affected by the inclusion of Parkia pulp in the diets.All the carcass characteristics were significantly depressed by the inclusion of Parkia pulp in the diets across the treatments means, the carcass evaluation of birds fed 10% Parkia pulp competed favourably with that of the birds fed control diet. The prime cuts and organs wereseverely affected across the treatments means.The second experiment was carried out to evaluate the effect of replacing maize with Parkia pulp at replacement levels of 0, 25, 50, 75 and 100% on the performance of broiler chickens (starter and finisher phases). In this experiment, the best results obtained in starter phase were from birds fed control diet and diet where Parkia pulp replacedmaize at 25%, the performance were significantly ($P<0.05$)lower as the level of Parkia pulp increased in the birds fed other levels

of Parkia pulp .The results obtained in the finisher phase showed that there was significant ($P<0.05$) decrease in the performance of birds across the dietary treatments as the level of Parkia pulp increased compared to the first experiment. The birds fed 25% Parkia pulp had a favourable competition with the birds fed control diet.The results obtained from blood chemistry:glucose, cholesterol and Platelet, RDW-cvand RDW-sd showed no negative effect. However, total protein, RBC, PCV, Hb, MCV, MCH, and MCHC were partiallyaffected across the dietary treatments.

The carcass evaluation results showed that the live weight, carcass weight and dressing percentage decreased significantly($P>0.05$) across the treatment means.The prime cuts and organ parts: wings, drumsticks, proventriculus, small and large intestines were observed to have been significantly ($P<0.05$) depressed by the inclusion of Parkia pulp in the diets of birds fed the other dietary treatments. However, some of the prime cuts and organ parts; back, thighs, liver, heart, gizzard and spleen showed that Parkia pulp did not have anynegative effect on them.

6.2 Conclusion

It can be concluded that for optimum performance at the least cost, African locust bean pulp can be included up to10% in the broiler diets in the first experimentand can replace25% of maize in both chick and finisher phases of broiler diets in the second experiment. The anti-nutritional factors would not have had negative effects on the birds at these optimal levels based on the result obtained. Reducing sugar, total starch and ascorbic acid may have been supportive of the growth performance of the birds. Generally,blood components of birds fed diets containingParkia pulp are within the normal ranges.

6.3 Recommendations

From the findings obtained from this work, the following recommendationscan be made:

Parkia pulp can replace maize in broiler diets by not more than 25% for optimum growth performanceand also reduce the cost of broiler production.Since cost of production is usually within the range of 70 – 80%. Rural farmers should be encouraged to use Parkia pulp in season and out of season to raise broilers since it ischeaper as an alternative source of energy.

African locust bean pulp can be included in broiler diets by up to 10% without any detrimental effects on growth performance.

Further investigation can be carried out to determine the reason for the birds not tolerating up to 100% Parkia pulp in their diet.

Investigations need to be carried out to ascertain the reason why broiler birds fed diets containing Parkia pulp pass-out sticky-like and muddy-like fetid faeces especially at the finisher phases.

Research can be carried out to see the level at which other monogastrics can tolerate African locust bean pulp in their diets. More research on other anti-nutritional factors and digestibility studies will provide more insights on the use of Parkia pulp.

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