

**PERFORMANCE OF RABBITS FED GRADED LEVELS OF TOASTED
BAMBARA NUT *Voandzeia subterranea* SIEVATE MEAL AS REPLACEMENT
FOR MAIZE OFFAL**

**BY
ANTYEV, MBA'A SHILIGHGA
M.TECH/AS/08/0134**

AUGUST, 2012

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**A THESIS SUBMITTED TO THE DEPARTMENT OF ANIMAL SCIENCE AND
RANGE MANAGEMENT, POSTGRADUATE SCHOOL, MODIBBO ADAMA
UNIVERSITY OF TECHNOLOGY, YOLA IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTERS OF
TECHNOLOGY (ANIMAL PRODUCTION AND RANGE MANAGEMENT)**

AUGUST, 2012

DECLARATION

I hereby declare that this thesis was written by me and it is a record of my own research work. It has not been presented before in any previous application for a higher degree. All references cited have been duly acknowledged.

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Sign

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Date

DEDICATION

This work is specially dedicated to my late father Zaki-Kwaghlaade Antyev Abaivo who witnessed the starting of this programme but could not see its end, Daddy may your soul rest in perfect peace.

APPROVAL PAGE

This thesis entitled “Performance of rabbits fed graded levels of toasted bambara nut (*Voandzeia subterranean*) sievate meal as replacement for maize offal” meets the regulations governing the award of Master of Technology in Animal Science and Range Management, Modibbo Adama University of Technology, Yola and is approved for its contribution to knowledge and Literary presentation.

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ACKNOWLEDGMENTS

My appreciation goes to the Almighty God for sparing my life and seeing me through the programme successfully. I would like to express with deep sense of humility, my heart-felt appreciation to my supervisor Prof. Abubakar Kibon for the encouragement and understanding he accorded me during the period, Words cannot express my total feelings but God Almighty will continue to bless you.

I am indebted to Dr. Yakubu Bobboi for contribution greatly to the success of this work.

I acknowledged Dr. Toma F. Mbahi, uncle Zakariya Gworgwor, Dr. Nyako H. D., Mr. Hassan B. Yusuf, Mallam Muktar Y. Magaji, Dr. G. A. Bobbo, Dr. M. B. Ardo and all other Lecturers in the department of Animal Science and Range Management.

Special appreciation goes to Mr. D. O. Nev, Mr. Iliya Wanpiya, Uncle J. M. Lucas, Dr. Kate Ashashim, P. I. Ananum, Dr. Felix T. Akade and Macson Mamman for their assistance.

My heart-felt thanks are due to my parents Mr. and Mrs. Kwaghlaade Antyev for their untiring efforts to bring me to this stage of life.

I am grateful to Mr. Danjuma Zaklag of college of Agriculture, Jalingo for his assistance during this research.

My special thanks goes to Sis. Bongsi Yusuf Auta for her invaluable support in many ways and also my younger sister and her husband Mr. & Mrs. Gbashi D. Aaron for their moral and spiritual support.

I will not conclude without acknowledging my special friend Andrew Zackariya who gave me all the encouragement during my trying period.

Finally, my special thanks goes to Victoria Victor and Success Tom who took time to read and typeset this manuscript, without which this work will not be a success.

ABSTRACT

A Fifty-six days feeding trial involving fifty rabbits aged 6 ± 0.4 weeks and weighing 681.70g was conducted to determine dry matter intake, nutrient digestibility, growth performance, carcass yield, haematological and biochemical indices. The rabbits were divided into five groups of ten rabbits each replicated five times. The rabbits were fed toasted bambara nut sievate meal to replaced maize offal at 0%, 10%, 20%, 30% and 40% for diets 1, 2, 3, 4, and 5 respectively. In a Randomized Complete Block Design (RCBD). The average daily feed intake, weight gain and feed conversion ratio were significantly ($P < 0.05$) different among the treatment groups with the following values 51.67g, 55.90g, 59.58g, 65.87g and 67.11g for feed intake, while feed conversion ratio were 7.20, 5.08, 5.17, 5.86 and 6.03. The average live weight, slaughter weight, dressed weight, dressing percentage, loin, rack/ribs, stomach and body length were significantly ($P < 0.05$) different among the treatment groups except the thigh/hind legs, shoulder, hand, skin, liver, lungs, small intestine, large intestine, kidney and caecum which did not differ significantly ($P > 0.05$) among treatments. All the biochemical parameters did not differ significantly ($P > 0.05$) among treatment i.e. creatinine, cholesterol, albumin, protein and globulin. Packed cell volume and red blood cell differ significantly ($P < 0.05$) among treatment groups, while MCH, Hb, WBC, MCV and MCHC were not significantly ($P > 0.05$) different among treatments. Feed cost per kilogram weight gain decreased steadily as the levels of toasted bambara nut sievate meal increased. Feed cost per kg weight gain were better in T₅ than the rest of the treatments. The digestibility result obtained in the study were significantly ($P > 0.05$) different among treatment for dry matter, crude protein ether extract, crude fibre and nitrogen-free extract. Based on the results of this study, it is obvious that diets containing 40% toasted bambara nut sievate could be fed to growing rabbits without compromising the growth, haematological and biochemical values and with less cost of production.

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CHAPTER ONE

1.0 Introduction

1.1 Background of the Study

Nigeria's rapidly growing population has created the need to increase livestock population to satisfy her animal protein requirement. Contribution of beef and poultry products to this national dilemma has been indeed marginal, providing succor to only a select few who mostly are urban and peri-urban dwellers, while leaving about 90% of the populace who reside in the hinter lands on consumption of less than 10g as against recommended 35g animal protein per day (Ahamefule *et al.*, 2000). This wide nutritional gap has fuelled the need to intensify the production of some livestock species to address the low per capita animal protein intake by Nigerians.

Among the livestock of interest is rabbit, a caprophagous herbivore whose production before now has been low (Ahamefule *et al.*, 2000). Intensive approach to rabbit production would however entail the use of alternative plant protein sources other than the conventional ones to enable "keepers" produce meat at affordable price. It is in the light of the above that bambara nut sievate a legume by product is being assayed for its feed value (Amaefule, 2002).

Of importance however, is the fact that most of these legumes seeds used in animal nutrition contain some antinutritional factors which affect their utilization in the raw (unprocessed) form by livestock (Balogun and Fetuga, 1986). Akinmutimi (2004) had observed that most processing methods employed in improving the feed value of non-conventional feed stuffs do not completely eliminate anti nutritional substances, but only reduces their concentrations to tolerable levels in feed stuffs. Quantities of anti nutritional factors present in formulated rations therefore will depend on the concentration (remnants) of these substances in feed stuffs which invariably is determined by processing methods.

Onwudike and Eguakun (1994) had reported that raw Bambara groundnut seeds did not support weight gain of broiler chicks but gave a negative protein efficiency value. This was attributed to the presence of trypsin inhibitor, haemagglutinin, tannic acid, phytic acid and oxalate present in the raw seeds (Onwudike and Eguakun, 1992; Apata and Ologhobo, 1997). However, the proximate composition and nutrient quality of the offal is expected to be affected by the processing method used when preparing the flour for human food.

1.2 Statement of the Problem

The continuous increase in population growth and inadequate supply of animal protein lead to malnutrition among people in developing countries including Nigeria. Feed accounts for the major cost in any intensive animal production (Church, 1991). The shortage of cereal products in developing countries is one of the constraints of animal production in particular because of the competition that exist between man and his livestock (Smith, 2001). Therefore efforts to substitute it, in livestock feed will greatly reduce cost and intensify production.

Consequently, Esonu *et al.* (2001) stated that more than 50% of Nigeria poultry farms have closed down and another 30% forced to reduce their production capacity. Ekenyem *et al.* (1999), had advocated cheaper feed ingredients to reduce the production cost and make the product affordable for people while Esonu *et al.* (2003) have called for cheaper and readily available sources of animal protein.

1.3 Justification of the Study

Nigeria, like many other developing countries of the world has protein deficiency gap, especially of high quality animal protein. The inadequate supply of protein from the traditional livestock such as cattle, sheep and goat has led to the intensification of efforts to improve on the productivity of other livestock (Odubote and Akinokun, 1991), the NRC (1984) reported that rabbit utilizes green feed efficiently and under ideal condition it has growth that is only slightly lower than that of broiler chickens. Apart from green feeds rabbits utilizes cereal crops and crops residues such as maize, sorghum, millet i.e. both seeds and offal of these crops. These crops utilized by rabbits are also utilized by traditional livestock which leads to competition and scarcity.

In this vain Bambara nut Sievate (offal), because of its availability, cheapness, high profile of nutrients can substitute the conventional offal from maize or sorghum.

There is the need to determine if the feed would be efficiently utilized in the diet of rabbit without any deleterious effect and also to know the optimum level of inclusion.

1.4 Objectives of the Study

- i) To determine dry matter intake and nutrient digestibility of rabbits fed bambara nut sievate meal.
- ii) To determine the growth performance of rabbit (*Orytolagus Cuniculus*) fed graded levels of Bambara nut sievate meal.
- iii) To evaluate the effect of graded levels of bambara nut sievate meal on carcass yield and internal organ characteristics of rabbits.
- iv) To asses the influence of the diets on heamatological and biochemical indices of rabbits.
- v) To determine the economy of production of rabbits fed diets containing graded levels of Bambara nut sievate meal.

CHAPTER TWO

2.0 Literature Review

2.1 Bambara Nut and Bambara Nut Sievate (Offal)

Bambara groundnut (*Voandzeia subterranean*) is a legume grown mainly in the middle belt and Enugu state of Nigeria (Doku and Karikari, 1991). Bambara seeds have been reported to contain 24% CP, 6.60 and 1.30% lysine and methionine, respectively (Poulter, 1981; Temple and Aliyu, 1994). The seeds are normally milled and sieved several times to obtain the flour locally called 'Okpa', which is a nutritive human food.

The sievate which is a bye-product of the babamra nut is available throughout the year and cheap, has no industrial or other uses as at now. The offal contains 21.16% CP, 5.29% CF and 12.44MJ/kg gross energy (Amaefule and Iroanya, 2004).

Scientific information on the feeding of bambara groundnut offal to poultry has been with pullet growers (Onyimonyi and Onukwufor, 2003) and broilers (Amaefule and Iroanya, 2004). There is dearth of information available literatures regarding the performance of pullet chicks fed bambara groundnut offal from day-old. Thus, with 15.75% crude protein, moderate energy 2478.63, crude fibre 6.75% and good mineral and amino acid profiles, bambara nut sievate appears to possess the potentials as good replacement for maize offal, hence the offal can support growth in monogastric animal such as rabbit (Ekenyem and Onyeagoro, 2006).

2.2 Agronomical Practices of Bambara Nut Production

Cultivation of bambara groundnut on a large scale and in pure stand is not very common. The crop is mostly grown by women, intercropped with major commodities such as maize, millet, sorghum, cassava, yam, peanut and cowpea. Grown in rotation, bambara groundnut improves the nitrogen status of the soil (Mukurumbira, 1985).

Bambara groundnut thrives better in deep, well-drained soils with a light, friable seedbed (Somasegaran *et al.*, 1999). Many farmers grow the crop on a flat seedbed, but the use of ridges or mounds is also common in a few countries. Planting density is usually low in farmers' fields, especially when crops are not in rows. In experimental plots, recommended plant density ranged from 6 to 29 plants/m² (Somasegaran *et al.*, 1999). Farmers do not normally apply chemical fertilizers to bambara groundnut fields. The nitrogen requirements is met by natural

N₂ fixation, as indicated by several nodulation studies (Somasegaran *et al.*, 1999). Yield increase as a result of phosphate or potassium application has not always been confirmed (Somasegaran *et al.*, 1999).

Bambara groundnut has a reputation for resisting pests, and compares favourably with other legumes such as groundnut or cowpea in this regard. In humid environments, however, fungal diseases such as *cercospora leafspot*, *fusarium* wilt and *sclerotium* rot are common (Billington, 1970; Begemann, 1986b). In such circumstances, spraying with the fungicide benlate (1kg/ha) has proved beneficial.

Viral diseases are widespread in most environments, especially in areas where other grain legumes such as cowpea are grown. Common diseases are cowpea mottle virus (CMV) and cowpea aphid-borne mosaic virus (CABMV) (Ng *et al.*, 1985). A combination of unusually heavy virus attack and cercospora leaf spot on one particular accession (TVSU 218) resulted in zero yield during a trial at kaboinse, Burkina Faso (Goli *et al.*, 1991).

Harvesting of bambara groundnut is done by pulling or lifting the plant. For the bunched-habit type, most pods remain attached to the root crown. Detached pods left in the ground are collected manually. In a dry environment, harvesting takes place when the entire foliage dries up. In humid ecosystems, however, pod-rotting or early seed germination (in the pod) may take place while the leaves are still partially green. Harvesting is then recommended before full foliage drying.

Harvested pods are air-dried for several days before threshing. The raw product is sold at markets, as pods or seeds. In dry areas, materials for planting the following season are usually kept by farmers as pods. This reduces or eliminates attacks by insects.

2.3 Uses of Bambara Nut

Bambara groundnut is essentially grown for human consumption. The seed makes a complete food, as it contains sufficient quantities of protein, carbohydrate and fat. Several workers have examined the biochemical composition of the seed (Owusu Domfeh *et al.*, 1970; Oluyemi *et al.*, 1976; Oliveira, 1976; Linnemann, 1987). On average, the seeds were found to contain 63% carbohydrate, 19% protein and 6.5% oil. Despite the relatively low oil content, some tribes in Congo reportedly roasted the seeds and pounded them for oil extraction (Karikari, 1971).

The gross energy value of bambara groundnut seed is greater than that of other common pulses such as cowpea, lentil and pigeonpea (FAO, 1982).

Bambara groundnut seeds are consumed in many ways. They can be eaten fresh or grilled while still immature. At maturity, they become very hard, and therefore require boiling before any specific preparation. In many West African countries, the fresh pods are boiled with salt and pepper, and eaten as a snack. In Coted'Ivoire, the seed is used to make flour, which makes it more digestible. In East Africa, the beans are roasted, then pulverized, and used to make a soup, with or without condiments. Bread made from bambara groundnut flour has been reported in Zambia (Linnemann, 1990).

Bambara groundnut can also be pounded into flour and used to make a stiff porridge, which is often kept for a long period. Roasted seeds can be boiled, crushed and eaten as a relish. Another common use of bambara groundnut is to make a paste out of the dried seeds, which is then used in the preparation of various fried or steamed products, such as 'akara' and 'moin-moin' in Nigeria (Obizoba, 1983). Another favorite Nigerian dish is 'okpa', which is a doughy paste that is wrapped in banana leaves and boiled.

Recently, a trial of bambara groundnut milk was carried out which compared its flavour and composition with those of milks prepared from cowpea, pigeonpea and soybean (Brough *et al.*, 1993). Bambara groundnut was ranked first, and while all milks were found to be acceptable, the lighter colour of the bambara groundnut milk was preferred. Bambara groundnut has long been used as an animal feed, and the seeds have been successfully used to feed chicks.

2.4 Nutritive Value of Bambara Nut and Bambara Nut Sievate (Offal)

Bambara nut (*voandzeia subterranea*) is a legume grown mainly in the middle belt, Enugu and some Northern states e.g. Borno, Sokoto, Katsina and Kano of Nigeria (Doku and Karikari, 1991). Bambara seeds have been reported to contain 24% cp, 6.60 and 1.30% lysine and methionine, fat 6.54, fiber 5.04, calcium 0.09, phosphorus 0.01 and ash 3.78, respectively (Poulter, 1981; Temple and Aliyu, 1994). The seeds are normally milled and sieved several times to obtain the floor locally called okpa, which is a nutritive human food and mostly cherished by diabetic patients. The offal, which is available throughout the year and cheap, has no industrial or other uses as at now. The offal contains 21.16% CP, 5.29% CF and 12.44 MJ/kg gross energy (Amaefule and Iroanya, 2004). Ekenyem and Onyeagoro

(2006). In another study revealed that in a proximate analysis of bambara nut sievate it contains 15.75% CP, 6.75 crude fibre, 4.75 EE, 1.95 Ash, 60.89 NFE, 9.91 Moisture and 2478.63 (Kcal/kg) gross energy

2.5 Phyto Chemical Properties of Bambara Nut

Bambara nut like most legumes contains some antinutritional factors and which Ensiminger *et al.* (1990) listed as cyanogens, flatulence factors, tannins and trypsin inhibitors. Liener (1980) has stated that antinutritional factors are thermo-labile and for which bambara nut seeds was toasted to detoxicate the product and make nutrients available to the rabbits.

2.6 Feeding Value of Maize Offal

Maize offal is a maize by-product consisting of maize pericap and testa usually obtained during the processing of maize into flour. Okah (2004) stated that maize offal which is fairly synonymaous with maize bran is a maize processing waste which is obtained from small scales milling industries. It is relatively available in both rural, peri-urban and urban communities. And is one of the readily available and cheap feed substitutes in Nigeria. It is fairly high in energy content, rich in vitamin B-series and has 88% of the feeding values of maize (Otar *et al.*, 1990). The offal is commonly relished by most livestock. The product has not been extensively investigated in feeding trials in Nigeria although many feed millers have been using it to replace wheat offal which is now becoming expensive.

According to Ogundipe (2002) maize offal contains 89.41% DM, 11.0% CP, 8.89% EE, 6.6% CF, 68.07% NFE, 62% TDN, 1.9% ash, 0.03% Ca and 0.16% P. Studies have shown that all animals require energy and the amount required depends on the physiological state of the animal. The common and cheapest energy sources for livestock are forages, grasses, maize offal, guinea corn offal etc.

2.7 Role of Rabbits in Meat Supply and Production Trend

Food and Agriculture Organization (FAO, 1982) has estimated an annual growth rate of five to seven percent of meat consumption. Such increase cannot be met easily by large animals because of their slow production cycle. They may however be met by short production cycle animals such as rabbit, poultry and pigs. Poultry and pigs required food sources which are in serious competition with man (Aduku and Olukosi, 1990). Rabbit can be produced on forage alone although, production can be improved by addition of other food by-product. Increased rabbit

production could bridge the supply demand of protein gap and it is by far the most appropriate type of production for subsistence meat (Igwebuike, 2001).

The rabbit is also a perfect size for home consumption requiring no refrigeration, during curing or other means of preservation. Compared with the meat of other small species, rabbit meat is richer in protein, certain vitamins and minerals. Aduku and Olukosi (1990) stated that the meat contains little fat and has higher proportion of essential poly saturated Linoleic and Linolenic fatty acid. According to Okorie (1977) domestic rabbit are raised mainly for meat and secondly for skin. The meat is all white; fine grained delicately favoured, nutritious, appetizing, and low in fat and caloric value but high in protein. Only about 20% of dressed carcass is bone. Rabbit meat yield is about 74% if the rabbit is processed by scaling or roasting.

The small and handy size of the carcass, the quality of the meat and the wide range in methods of preparation make rabbit meat an excellent and economical meat for use in any season of the year (Igwebuke *et al.*, 2001). Characteristics such as small body size (thus low daily feed requirement), short gestation interval, high reproductive potentials, rapid growth rate, and the ability to utilize forages and fibrous agricultural by products are attributes in favour of rabbit as a meat producing animals (Biobaku 1994, Joseph *et al.*, 1997).

2.7.1 World Production Trend

National statistics do not generally include rabbit production, however Lebas and Colin (1992) estimated a world output of roughly 1.2 million carcasses. A more recent estimate by the same authors, including almost all countries in the world, suggests a possible 1.5 million tones as shown in table 2.1.

In Africa there is a tradition of rabbit production in the five Mediterranean countries of Africa. Per caput production of rabbit varies from Egypt's 0.27 kg to Morocco's nearly 0.78 kg. The traditional production systems in the southern parts of these regions feature an original habitat where rabbits are group-reared in burrows dug into the earth (Lebas and Colin, 1992).

In sub-Saharan Africa, the two main producers are Nigeria and Ghana and to a lesser extent the Democratic Republic of the Congo, Cameroon, Cote d'Ivoire and Benin (Lebas and Colin, 1992).

Table 2.1: Major rabbit producing countries

Country	Estimated production (carcass weight) Thousands of tones	Country	Estimated production (carcass weight) Thousands of tones
Italy	300	Portugal	20
CIS (former USSR)	250	Morocco	20
France	150	Thailand	18
China	120	Viet Nam	18
Spain	100	Philippines	18
Indonesia	50	Romania	16
Nigeria	50	Mexico	15
United states	35	Egypt	15
Germany	30	Brazil	12
Czechoslovakia (former)	30	Others	205
Poland	25		
Belgium	24		
Hungary	23		

Source: Lebas and Colin (1992), Colin and Lebas (1994).

2.7.2 Quality of Rabbit Meat and Varieties

Compared with most consumed meats, rabbit meat has one of the lowest fat contents with a high degree of unsaturation.

Table 2.2: Chemical Characteristics of Meat from Different Animal Species

	Protein%	Fat%	Energy MJ/Kg	Dry matter%
Rabbit	20-22	10-12	7-8	20-23
Chicken	19-21	11-13	7-8	20-23
Beef	15-17	27-29	11-14	40-50
Lamb	14-18	26-30	11-14	40-50
Pork	10-12	42-48	17-20	50-55

Source: Fielding (1991)

Rabbit meat has some important characteristics which make it a good meat for consumption by humans. As shown in table 2.2, the meat is especially high in protein and low in fat. The fat in rabbit meat is mainly unsaturated, which is more healthy, compared to saturated fat common in other meats. Rabbit meat has a lower cholesterol content than most other meats, which is a health promoting characteristic (Coronary patients).

It also has less sodium content than red meat but contains about the same amount of iron and vitamins.

2.7.3 Management of Rabbits

According to Anyawu *et al.* (1992) degree of success of livestock enterprise depends on the degree of the efficiency of the management practice. Aduku and Olukosi (1990) viewed management techniques which include housing for maximum comfort, sanitation and disease control, provision of adequate ventilation, a constant supply of portable water and an ample supply of a nutritious feed, differ in different parts of the world, particularly in tropical as opposed to temperature area.

2.7.4 Housing Materials for Rabbits

Rabbit can be successfully housed in an outdoor or indoor house. Housing requirement varies with the size of rabbitry, the type of rabbitry building and the materials needed for housing, the hutches will be determined by climate condition and the amount of capital that can be put in. any building that will protect the animals from wind, rain, sunlight and provide air, light will be alright for the purpose (Okorie, 1977).

Essentially, equipment required for use in the rabbitry building include the following hutches nest boxes, water and feeding utensils.

Hutches are well designed system inside the rabbitry; the planning should be in such a way that easy management can be achieved (Aremu, 1988). The average dimension for breeding hutches is 75 x 50cm for medium breed, 75 x 12 x 60cm for giant breed and 75 x 50 x 60cm for small breed (Okorie, 1977).

2.7.5 Care and Handling of Rabbit

Rabbits are logomorphs, not rodent, they are friendly, gentle and they cannot bite easily as dogs and the rodents when handled properly. They are sensitive and easily frightened or injured, so keen attention should be given or taken to ensure that they are not mishandled. The proper way to pick up rabbit is to

smooth the ear drum over it back, place your hand on its ear and grasp as much of the loose skin on the shoulder as possible, place your other hand against the rum above the tail and slowly lift it up (Heifer international project 1978, Aduku and Olukosi, 1990).

2.7.6 Feeds and Feeding

According to Ajala (1990) feed is one of the biggest items of expense in raising rabbit. The animal is herbivorous because it eats grain and grain by product, root, tuber and vegetables. The feeding stuff for rabbit is made up of concentrates such as crops and grasses. The concentrates are to supplement the vegetable feed. The vegetable is mainly used as maintenance ratio.

Rabbits is a simple stomach animal, the stomach has an organ called caecum which help to digest the leafy material, it consume. Soft pellets feaces are produced in the caecum and passed through the rabbit. These pellets are rich in protein and vitamin B-series. Because the rabbit re-consume this pellet and this practice is called coprophagy (Ajala, 1990).

In essence, nutrition of rabbit means what the rabbit is being fed. Poor nutrition of rabbit results in small skinny rabbits who either cannot have young one or produce enough milk for them. And sometimes rabbit will eat her young ones if she is not getting balanced diet. They also chew their fur if there is no enough fibre. Okoye (1998) grouped rabbit feed stuff into roughages such as hay, succulent food such as grasses and root and tubers and concentrate, such as cereal and their by-products.

For balanced diet a rabbit needs the following nutrient to grow and produce well, the nutrients are protein, carbohydrate, fats, vitamins, fibre, mineral and water.

2.8 Nutrient Requirement of Rabbit

2.8.1 Energy Requirement

Little work has been done on energy requirement for various productive functions such as growth, lactation and digestion. However, the results by Eschiet *et al.* (1979) indicate that energy supply in the rabbit diet is critical for maximum utilization of nutrients. The NRC (1977) recommended a level 2,500kcal/kg diet of digestible energy (DE) for growing rabbits. Similarly, Aduku and Olukosi (1990) stated that the energy requirements of rabbit are met from fibrous and non fibrous

component of the feed. Energy requirement is between 2300 and 2500 kcal of digested energy. This energy will be enough to satisfy the energy needs for rapid growth, but at a level lower than this, the rabbit may not be able to consume sufficient feed to meet its energy requirement for maximum growth.

2.8.2 Protein and Amino Acid Requirement

Protein requirement of rabbit is supplied by beans, peas, peanuts and their leaves, fishmeal young grasses and some cereal grains, maize offal, rice bran etc. Heifer International Project (1978) reported that the recommended levels of protein in diet of rabbits are 12% for maintenance, 15% for growth, 16% for pregnancy and 17% for lactation. Also Aremu (1988) stated that rabbit given diet containing 12% crude protein (CP) are less and utilize feed less efficiency than those give diet with 13% or more crude protein.

Aduku and Olukosi (1990) reported that the quantity and quality of protein are not critical in rabbit as in poultry because rabbit practice coprophagy. Rabbit can adopt to low and poor protein situation but production will not be optimum. With high protein and good protein quality however, optimum production can be achieved. The quality of protein in diet is very important in rabbit nutrition because voluntary feed intake (VFI) has been found to increase with improvement in protein quality (Spreadbury, 1978). The amount of protein required in the diet is influenced not only by its digestibility but its amino acid composition and the usefulness of a protein depends on its contribution of amino acids which the rabbits needs for protein synthesis (Davidson and Spreadbury, 1975).

2.8.3 Fibre Requirement

Rabbit needs fibre in its diets because of the role of crude fibre in the prevention of enteritis. However, a dietary crude fibre level less than 10% is likely to promote enteritis and reduce growth while a crude fibre level exceeding 17% reduces performance by limiting energy intake (Cheeke, 1983). Different maximum fibre levels have been reported by several authors. Davidson and Spreadbury (1975) reported a crude fibre level of 22% whereas the NRC (1977) reported a range of 10-12% crude fibre for growth.

Alade *et al.* (2002) reported that less than 6% fibre levels causes diarrhea and higher than 17% harden faeces and decreases coprophagy and thereby reduces, the digestibility of nutrients. He also reported that dietary crude fibre levels of 7, 11 and 15% promoted similar live weight gains of 33.3, 33.6 and 35.4g/day

respectively. Jenkins (1999) states that fiber also has a soluble portion containing beta-glucan. Beta-glucan helps the rabbit's immune system stay strong and functioning correctly.

2.8.4 Fat Requirement

Dietary fat requirement by rabbit has been set at 2% of the diet (NRC, 1977). Jenny (1982) observed that a deficiency of fat would not occur when conventional feedstuff having a naturally occurring levels of 2-4% fat are used in the diet. A fat level of 3.5% is recommended by Lebas (1992). Also Jenny (1982) suggested that purified diet containing 10-25% of fat was better than 5%. Rabbits given 10% or more of fat have better live weight gain than those given 5% of fat. In rabbit raising fat is a relatively expensive component of the diet.

2.8.5 Minerals and Vitamins Requirement

Minerals are required to regulate metabolic and physiological processes. Vitamins and minerals are necessary in small amounts for growth; minerals and vitamin are supplied by giving feeds and vegetable. In addition a little salt might be helpful. The major minerals required by growing rabbits are calcium, phosphorus, potassium, magnesium, sodium and chlorine, while the minerals required in small amount are iron, iodine, manganese, copper and zinc (Jenny, 1982). These requirements can be achieved by adding growers mineral vitamin pre-mix to the diet.

2.8.6 Water Requirement of Rabbits

Jenny (1982) has shown that any restriction of water intake to the rabbit cause a decrease in feed intake. Water is essential for rabbit physiological and metabolic activities (Okorie, 1977). Rabbits can live for a relatively long time without solid feed, but lack of moisture produce, harmful effects on digestive and detoxification activities in the body. Constant supply of cool, clean water adlibitum to the rabbit is therefore very important in rabbit management (Jenny, 1982; Cheeke, 1983).

2.8.7 Physiological Characteristics of Rabbits

The rabbit is a monogastric animal a relatively proportional stomach and a small intestine of similar length and diameter as the large intestine. The caecum is, however, essentially large in comparison to the rest of the intestinal tract, with a diameter about four times that of the large intestine.

The ingested feed is digested in the stomach (gastric digestion) followed by alkaline digestion in the small intestine of sugar and starch to glucose, and protein digestion to amino acids. There is also fermentative microbial digestion in the caecum/large intestine, with production of VFA's and microbial cells. The residues from digestion in the caecum have formed into pellets and encased in a membrane as they pass down the large intestine prior to being voided (Lang, 1981).

The digestion of rabbits, guinea pigs, most other rodents, and several other mammals has a unique aspect, and that is the formation of cecotropes. Through this special mechanism, these animals can receive more nutrition from what they eat. This special digestive process has been referred to as 'cecotrophy', 'hindgut fermentation', 'coprophagy' or 'pseudorumination' (Jenkins, 1999).

Cecotropes, also called 'night feces' or 'soft feces' are the material resulting from the fermentation of food in a part of the digestive system called the 'cecum'. Cecotropes are nutrient-rich and are passed out of the body, like feces, but are reingested by the animal so the nutrients can be absorbed. Cecotropes have twice the protein, and half of the fiber of the typical hard fecal pellet. They also contain high levels of vitamin K and the B vitamins (Jenkins, 1999).

Caecotrophy regulation depends on the integrity of the digestive flora and is governed by intake rate. Experiments have shown that caecotrophy starts eight to 12 hours after the feeding of rational animals, or after the maximum feed intake of animals fed ad lib. In the latter case, the intake rate and hence the function of caecotrophy are governed by the light regime to which the animals are subjected.

Caecotrophy first starts to function in young rabbits (domesticated or wild) at the age of about three weeks, when they start eating solid feed in addition to mother's milk (Proto, 1980)

2.8.8 Effects of Bambara Groundnut/Legumes on the Performance of Rabbits.

Like most legume seeds, pigeon pea seeds contains anti nutritional factors (ANFs) which limits its use in monogastric animal feeding (Ologhobo, 1992; D'mello, 1995). D'mello (1995) reported that when the seeds were boiled it made the availability of nutrients possible. Rabbits fed boiled pigeon pea recorded a significant weight gain and carcass also appreciated over that obtained with raw seeds (Amaefule *et al.*, 2004), which could be attributed to elimination of anti-nutritional substances from the seeds by boiling in water.

Ekenyem and Oyeagoro (2006) who worked on toasted bambara nut sievate as a replacement for soyabean on performance of finisher broiler chicken reported an appreciable level of performance on carcass, haematological and biochemical indices. This report agreed with those of Onyimonyi and Okeke (2002) which used 0%, 5%, 10% and 15% levels of bambara nut offal to evaluate performance of weaner pigs. Opara (1996) and Iyayi (2001) reported a decreasing the performance in birds with additional levels of bambara nut sievate as a result of higher crude fibre levels which depressed weight gain, but rabbit can tolerate higher levels of crude fibre.

CHAPTER THREE

3.0 Materials and Methods

3.1 Site of the Experiment

The study was conducted at the college of Agriculture, Livestock and Research Farm Jalingo. Jalingo the Taraba state capital which is located between latitude 8°³ and longitude 11°⁵ east in guinea savannah zone of northern Nigeria. There are two main seasons, dry season and rainy season. Dry season starts early in November and continues until the end of March. The wet season runs from April to October. The area has a mean average annual rainfall of about 1000 – 1500mm, with a temperature that ranges from 30°C to 38°C (December and March). It has undulating topography with complex groups of mountains and hills. The soil type range from sandy to sandy loamy which makes the rural inhabitants mostly farmers (arable and livestock) (Taraba state, Diary 2008).

3.2 Source of Bambara Nut Sievate

Bambara nut sievate was obtained from local okpa (moimoi) producers in Jalingo after the Bambara nut seed has been processed into food. The sievate was properly dried and stored in secured bags to be toasted and mixed with the test diets.

The Bambara sievate was toasted in an open frying pan with mild source of heat from fire wood. The sievate was toasted for 20 – 30 mins and removed from heat source when turned brownish.

3.3 Experimental Animals and Management

Fifty (50) weaner rabbits of aged 6-7 weeks were used for the study. The rabbit were obtained from small scale producers at Jalingo and its environs. The animals were given anti stress (vitalyte) supplement on arrival and housed in well ventilated cages equipped with feeders and drinkers. During the one week acclimatization period the rabbits were fed twice a day and clean drinking water provided.

Animals were fed treatment diets twice daily (i.e. in the morning 7-8am and afternoon between 3-4pm respectively). Also routine sanitation was strickly adhered to.

3.3.1 Treatments and Experimental Design

Five experimental diets were compounded using Bambara nut sievate to replaced maize offal at 0%, 10%, 20%, 30% and 40% respectively. Other ingredients include groundnut cake, bone meal, premix, salt, methiomine, luzine, maize offal as shown in table 1: The treatment diets and clean water were supplied and lib during the study period.

Fifty (50) rabbits aged 6-7 weeks were weighed and randomly assigned to five treatment groups (T₁, T₂, T₃, T₄ and T₅) in a Randomized Completely Block Design (RCBD) with 10 rabbits per group replicated five (5) times.

3.4 Table 3.1: Percentage Composition of the Experimental Diets

Ingredients (%)	Replacement Level of TBNSM				
	0	10	20	30	40
Maize offal	70.00	60.00	50.00	40.00	30.00
TBNSM	0.00	10.00	20.00	30.00	40.00
Ground nut cake	7.00	7.00	7.00	7.00	7.00
Palm kannel cake	3.00	3.00	3.00	3.00	3.00
Fish meal	3.50	2.50	2.50	1.50	1.50
Bone meal	2.5	2.5	2.5	2.5	2.5
Maize	13.00	13.00	14.00	15.00	15.00
Salt	0.50	0.50	0.50	0.50	0.50
Premix *	0.50	0.50	0.50	0.50	0.50
Total	100	100	100	100	100
Calculated composition					
Crude protein	15.40	15.17	15.64	15.49	15.50
Crude fibre	8.35	7.80	7.27	6.73	6.26
Available calcium	1.03	1.02	1.02	1.01	1.01
Available phosphorus	0.59	0.58	0.58	0.58	0.56
ME kcal/kg	2774.88	2746.06	2719.31	2694.27	2666.20

* Premix manufactured by animal care service consult (Nig.) Ltd Lagos supply the following per kg of premix:- Vitamin A, 3,200,000 I.U; Vitamin D₃, 640,000 I.U, Vitamin E, 2,000 I.U Vitamin K, 800mg, Thamine, B₁, 600mg, Riboflavin B₂ 1,600mg, Pyridoxine B₆, 600mg, Niacin 600mg, Vitamin B₁₂, 4mg, Pantothenic Acid, 200mg, Folic Acid, 2,000mg, Biotin 8mg, Choline Chloride, 80g, Antioxidant 50g Manganese, 32g Zinc, 20g, Iron 8g, Copper, 2g Iodine 0.48g, Selenium 80mg and Cobatt, 80mg.

3.5 Duration of the Experiment

The experiment lasted for a period of 8 weeks (56 days) after an initial adjustment period of one week.

3.6 Data Collection

3.6.1 Feed Intake

Data were collected for daily feed intake by subtracting the left over feed from the amount fed per day throughout the experiment.

3.6.2 Live Weight Changes

The rabbits were weighed individually at the start of the experiment and weekly thereafter to determine live weight changes.

3.6.3 Hematological and Biochemical Analysis

Blood samples for haematological and biochemical analysis were collected on the last day of the experiment. One rabbit was randomly selected per replicate and bled from punctured jugular vein 7mls of blood was collected from each rabbit, 2mls was measured into a specimen bottle treated with ethylene diamine tetra acetic acid (EDTA) for haematological assay as described by Sirios (1995). The remaining of each blood sample was allowed to coagulate or centrifuge to produce sera for blood chemistry measurements. Blood samples were analysed for total erythrocytes (RBC), leucocytes (WBC), packed cell volume (PCV), haemoglobin (Hb). The coagulated blood was subjected to standard serum separation for total serum protein, albumin, globulin, urea, creatinine and cholesterol. The erythrocytes indices that include the mean corpuscular volume (MCV), mean corpuscular haemoglobin concentration (MCHC), and mean corpuscular haemoglobin (MCH) were calculated using the formula of Sirios (1995).

3.6.4 Digestibility Study

During week 7 and 8 of the experiment, metabolic cages were provided at the basement of the rabbits cages. Faeces were collected from each replicate for a period of 14 days and sun dried, mixed and some quantity were sampled for analysis.

Faecal samples were analysed for determination of apparent digestibility of drymatter, ether extract, nitrogen-free extract, crude protein, crude fibre and total ash according to AOAC (2000) methods.

3.6.5 Feed Conversion Ratio

Feed conversion ratio which is the ratio of dry matter intake (DMI) to weight gain was also determined as follows:

$$\text{Feed conversion ratio} = \frac{\text{Dry matter intake (g)}}{\text{Weight gain (g)}}$$

3.6.6 Carcass Measurement

At the end of the experiment three rabbits were randomly selected from each treatment based on average live weight for the group. The rabbits were weighed and then starved overnight but water was provided, their fasting weights were recorded in the morning before slaughter. The rabbits were slaughtered, dressed and weighed individually. The body components and visceral organs such as lungs, liver, kidney, heart and intestine were weighed and body, stomach and intestine lengths were measured in the laboratory using weighing balance and meter rule. The dressed carcass were splitted into retail cuts such as shoulder/forelegs, thighs/hindlegs. Rack/ribs and loin as described by Blasco *et al.* (1993).

3.6.7 Economic Analysis

The following were calculated to assess the economics of using toasted Bambara nut sievate meal as a replacement for maize offal.

- i) Cost per kilogram of each test diet
- ii) Cost of feeding rabbits on their respective test diets
- iii) Cost per kilogram weight gain by rabbits.

Procedure

- 1) Cost per kilogram of each test diet was achieved by dividing each test ingredient by the total quantity used in the diet.
- 2) Cost of feeding rabbits on their respective test diets, was achieved by multiplying the cost of each ingredient with the quantity used in the formulation e.g. premix result multiplied by the quantity of premix in each diet.
- 3) Cost per kilogram weight gain by rabbits in the total cost of feed per naira per kilogram divided by weight gain during the experimental period multiply by 1000.

3.6.8.1 Chemical Analysis

The chemical analysis of the experimental diets, toasted Bambara nut sievate meal and faeces were carried out according to AOAC (2000) methods. The dry matter was determined by drying the samples at 80°C for 48 hours until constant weight.

Crude protein, crude fibre, ash and ether extract content of the samples were determined by the method of AOAC (2000).

3.6.8.2 Crude Protein

The method of AOAC (2000) was adopted. For digestion, distillation and titration.

Procedure

- a) Digestion: 2g of the sample was weighed into a 500ml-800ml capacity. Kjeldahl flask containing 0.8g of catalyst mixture and antibumping granules 20ml concentrated sulphuric acid was slowly added and the flask was placed on a heating mantle. Digestion was carried out for 6 hours till the content was light-blue. The flask was allowed to cool and the contents transferred to a 100ml volumetric flask and the volume made up to the mark with distilled water.
- b) Distillation: 10ml of 2% Boric acid was pipette into a 100ml conical flask (receiver). 4 drops or 5-7 drops of screened methyl red indicator was then added to contents. 10ml of the dilute sample was taken and transferred into the distillation apparatus followed by 15ml/90ml of 40% NaOH (Sodium Hydroxide) solution. The mixture was distilled for 40 minutes ensuring that the end of the condenser as well as inside the content of the receiver.
- c) Titration: The distillate was titrated with 0.02m Hd to end point corrected titre value was obtained by a blank titration.

Calculation

% crude protein was calculated as N(%) 6.25 and the nitrogen (%) was calculated from the following relations $1\text{NH}_3 + 1\text{HCL} \quad - \quad - \quad 1\text{NH}_4\text{CL}$

IM1 of 0.02m Hcl = 1ml of 0.02m Nitrogen, 1N - - 0.00028gN

$$\% \text{ N}(\%) = \frac{V1 - V0}{5} \times 0.00028\text{m} \times 10 \times 100 = \frac{(V1-V0)}{5} \times 0.28$$

% crude protein = N(%) x 6.25

Where V0 = Blank titre (ml)

V1 = Volume of acid used (ml)

S1 = Amount of sample (g)

3.6.8.3 Crude Fat or Ether Extract

The apparatus used was the soxhlet extraction unit. Previously dried samples (1.0g) were weighed into a thimble. The mouth of the thimble was plugged with fat-free absorbent cotton. The receiving flask was weighed and then the thimble with sample introduced into the soxhlet. The apparatus was assembled and the soxhlet filled with petroleum ether by pouring it through the condenser at the top through a glass funnel.

The apparatus was placed in a water bath at 60°C and fixed by clamps to a retort stand. The cold water circulation in the condenser was turned on. After extraction, the thimble with the material was removed from the soxhlet. The apparatus was then reassembled and heated in a water bath to recover all the petroleum ether from the receiver flask. The flask which contained only the crude fat was disconnected, dried in a hot air oven at 100°C for 1 hour, cooled in a desiccator and weighed. Then ether extract (EE) content was calculated as follows:

$$\text{EE (\%)} = \frac{\text{wt of flask containing oil} - \text{wt of empty flask after extraction} \times 100}{\text{Wt of dried sample taken}}$$

3.6.8.4 Crude Fibre

The method used was the trichloroacetic acid method. One gram (1.0g) of the sample was weighed into a 500-ml conical flask and 100ml digestion reagent added. The digestion reagent was prepared by mixing 500ml glacial acetic acid, 450ml distilled water, 50ml conc. HNO₃ and 20.0g trichloroacetic acid.

The flask containing the sample and the digestion reagent was boiled and refluxed for exactly 40 minutes, counting from the time heater and cooled.

The solution was filtered through a 15cm No. 4 whatman ashless paper. This was washed several times with hot water, and with petroleum ether. At this stage, the filter paper was opened out and the residue was cooled in a desiccator and weighed. The residue was then ashed at 600°C, allowed to cool and weighed. The crude fibre was calculated as follows:

$$\text{Crude fibre (\%)} = (\text{wt after oven drying} - \text{wt of ash wt of paper} \times 100)$$

3.6.8.5 Determination of Ash content

The Method of the Association of Official Analytical Chemists (AOAC 2000) was adopted.

Procedure

2g of each of the sample was weighed into a porcelain crucible and was placed in a temperature controlled furnace heated at 600°C. It was held at this temperature for 2 hours. The crucible was transferred directly to a desiccators. It was cooled and weighed immediately then after the percentage of Ash content was reported to first decimal place.

Determination was done in triplicate for each sample.

Calculation

$$\frac{\text{Weight of Ash} \times 100}{\text{Weight of sample}}$$

3.6.8.6 Nitrogen – Free Extract (NFE)

This was obtained by calculation:

$$\text{NFE} = 100 - \% \text{ crude protein} + \% \text{ crude fibre} + \% \text{ Ether extract} + \% \text{ Ash} + \text{Mositure.}$$

3.6.8.7 Determination of Amino Acids by Isocratic HPLC

Procedure:

Pipette 1ml of prepared sample into a small test tube. Add 3ml of methanol-acetonitrile solvent mixture, swirl to mix. Add 1ml of 0.05M sodium phosphate buffer, swirl to mix; pass through a syringe filter to remove any particulate matter. Load the sample loop of the HPLC with a 100µL syringe. Inject the sample and record the peaks that come off the system. Compare to a standard to identify and measure the amount of amino acids in each sample (Demenna, 2010).

3.6.8.8 Determination of Dry Matter Content

The method of the Association of Official Analytical Chemists (AOAC, 2000) was adopted.

Procedure

2g of each sample was weighed into a pre-weighed clean crucible. This was dried to a constant weight in an oven maintained at a temperature of 100°C for about 24 hours. The weight was expressed as percentage of the whole weight. This was determined in triplicate.

Calculation

$$\% \text{ dry mater} = \frac{\text{weight of sample after drying (g)}}{\text{Weight of fresh sample (g)}} \times 100$$

3.6.8.9 Statistical Analysis

All data collected were subjected to analysis of variance (steel and Torrie, 1980), using complete randomized block design and significant differences between treatment means were compared using Duncan's Multiple Range Test (Duncan, 1955).

CHAPTER FOUR

4.0 Results

4.1 Proximate Composition of the Experimental Diets

Proximate composition of the formulated diets is presented in table 4.1: The analysis shows that dry matter ranges from 80.65 - 93.34% for the various treatments, crude protein level 11.20% - 13.50%, the crude fibre values ranges from 6.20% - 6.60%, ether extract 5.00 – 5.60%, ash 2.30% - 2.60%, nitrogen free extract was 70.00% - 72.60% and metabolizable energy ranges from 3366.50Kcal/kg/Dm – 3427.38Kcal/kg/Dm.

Table 4.1: Proximate Composition of Experimental Diet and Minerals Content.

Nutrients (%)	Replacement levels of bambara nut sievate for maize offal				
	0	10	20	30	40
Dry matter	93.34	86.70	87.30	82.70	80.65
Crude protein	11.20	11.40	11.60	12.30	13.50
Crude fibre	6.20	6.30	6.40	6.40	6.60
Ether extract	5.60	5.40	5.30	5.20	5.00
Ash	2.30	2.40	2.50	2.50	2.60
Nitrogen-free- extract	72.60	72.30	72.20	71.40	70.00
Energy(kcal/kg)	3427.38	3407.37	3402.64	3390.56	3366.50
Calcium (ca)	0.20	0.23	0.20	0.30	0.31
Phosphorous (P)	0.60	0.60	0.62	0.61	0.60
Potassium	0.40	0.40	0.45	0.50	0.43

4.2 Proximate Composition of the Feecal Samples

The proximate composition of the feecal samples for all treatments is presented in table 4.2. The result shows that dry matter values ranges from 38.75 for treatments one to 24.38 for treatment four and 33.00 for treatment five, crude protein values ranging from 2.40 to 2.50 were obtained for all treatments. A value of 1.00% was obtained for ether extract across the treatments and the range of 57.10 to 58.4% was obtained for nitrogen-free extract.

Table 4.2: Chemical Composition of Feecal Samples

Nutrients (%)	Replacement levels of bambara nut sievate for maize offal				
	0	10	20	30	40
Dry matter	38.75	26.70	24.40	24.38	33.00
Crude protein	2.50	2.50	2.40	2.50	2.40
Crude fibre	1.39	1.40	1.10	1.02	1.11
Ether extract	1.00	1.00	1.00	1.00	1.00
Ash	1.10	1.10	1.20	1.10	1.20
Nitrogen free-extract	58.40	57.40	58.10	57.30	57.10

4.3 Proximate Composition of Toasted Bambara Nut Sievate

The proximate composition of toasted bambara nut sievate is presented as shown in table 4.3. The dry matter content is 90.09%, moisture 9.91%, crude protein 16.22%, crude fibre 6.75%, ether extract 4.75%, nitrogen-free-extract 60.89, ash 1.95 and metabolizable energy 3117.88 kcal/kg respectively.

Table 4.3: Proximate Composition of Toasted Bambara Nut Sievate

Nutrient	Composition (%)
Dry matter	90.09
Moisture	9.91
Crude protein	16.22
Crude fibre	6.75
Ether extract	4.75
Nitrogen-free-extract	60.89
Ash	1.95
* Metabolizable energy (kcal/kg)	3117.88

* $ME = 35 \times CP\% + 81.8 \times EE\% + 35.5 \times NFE\% = \text{Kcal/kg/Dm}$ (Pauzenga, 1985).

4.4 Amino Acid Content of Toasted Bambara Nut Sievate

The amino acid profile of Bambara groundnut sievate is presented in table 4.4. The analysis shows that the bambara groundnut sievate contain 0.80% methionine, 0.50 tryptophan, 2.20 valine, levcine 3.20, isolevcine 2.10, cystine 0.60, histidine 2.50, arginine 3.10, lysine 2.20 and threonine 2.50.

Table 4.4: Amino Acid Content of Toasted Bambara Nut Sievate

Amino acid	Composition (%)
Methionine	0.80
Tryptophan	0.50
Valine	2.20
Levcine	3.20
Isolevcine	2.10
Cystine	0.60
Histidine	2.50
Arginine	3.10
Lysine	2.20
Threonine	2.50

4.5 Feed intake of Rabbits fed Graded Levels of Toasted Bambara Nut Sievate Meal

The result of the growth performance of rabbits fed graded level of bambara nut sievate is presented in table 4.5. Feed intake was significantly ($P<0.05$) higher with Rabbits on diet five, Rabbits on inclusion level of 40% bambara nut sievate meal had the highest feed intake of 67.11g/r/day. The lowest feed intake was recorded for the control group with 0% TBNSM inclusion level.

4.6 Body Weight Gain of rabbits fed TBNSM

Results of body weight is presented in table 4.5. Treatment 3 with 20% TBNSM inclusion level had significant ($P<0.05$) effect having a body weight gain of 12.11g/r/day while the lowest weight gain was recorded for treatment one with 0% inclusion level of TBNSM.

4.7 Feed Conversion Ratio of Rabbits fed TBNSM

The efficiency of feed utilization is shown in table 4.5. Feed utilization as measured by feed intake per unit of weight gain was significant ($P<0.05$) among treatment groups. Treatment two with inclusion level of 10% TBNSM gave the best utilization with feed conversion ratio of 5.08.

Table 4.5: Performance of Rabbit Fed Graded Levels of Toasted Bambara Nut Sievate Meal

Parameters	Graded levels of TBNSM (%)					SEM
	0	10	20	30	40	
Initial weight g/r	627.5 ^a	638.5 ^a	698 ^a	764.5 ^a	680 ^a	79.35 NS
Final weight g/r	1039.5 ^b	1063 ^a	1376.5 ^a	1397.5 ^a	312.5 ^a	77.91 *
Daily feed intake g/r/day	51.67 ^{ab}	55.90 ^{ab}	59.58 ^{ab}	65.87 ^a	67.11 ^a	4.36 **
Daily weight gain g/r/day	7.35 ^b	11.20 ^a	12.11 ^a	11.30 ^a	11.29 ^a	0.98 *
Feed conversion ratio	7.20 ^b	5.08 ^a	5.17 ^a	5.86 ^{ab}	6.03 ^{ab}	0.76 *
Mortality	0	0	0	0	0	

***abcd, means with the different superscripts on the same row differ significantly (P<0.001), * (P<0.05), ** (P<0.01),

NS = Not significant

SEM = Standard Error of the Means.

4.8 Nutrient Digestibility by Rabbits Fed Graded Levels of Toasted Bambara Nut Sievate Meal

The results of nutrient digestibility by rabbits fed the experimental diet is presented in table 4.6. The result indicated that the dry matter content was 51.82, 70.23, 71.95, 70.53 and 59.08 for treatments 1, 2, 3, 4 and 5 respectively. The results of 77.67, 78.07, 79.31, 79.67 and 82.37 was obtained for crude protein, crude fibre has the following values for digestibility, 77.58, 77.77, 82.81, 84.06 and 83.18 for treatments 1, 2, 3, 4 and 5. Ether extract has 82.14, 81.48, 81.13, 80.76 and 80.00 as nitrogen-free-extract got the following values 19.55, 20.60, 19.52, 19.74 and 18.42 for treatments 1, 2, 3, 4 and 5.

The dry matter (Dm), crude protein (CP), crude fibre (CF), Ether extract (EE) and nitrogen free-extract digestibility differ significantly ($P < 0.05$) among the treatments. Diet 3 with 20% level of inclusion had significantly ($P < 0.05$) high dry matter while diet 5 with 40% level inclusion has higher crude protein digestibility. Diets 4 and 1 had significantly ($P < 0.05$) higher values for crude fibre and Ether extract. However diet 2 recorded the highest value for nitrogen free extract.

Table 4.6: Nutrient Digestibility Rabbits Fed Graded Levels of Toasted Bambara Nut Sievate Meal

Nutrients	Replacement Levels of Bambara Nut Sievate for Maize Offal					SEM
	0	10	20	30	40	
Dry matter	51.82 ^d	70.23 ^b	71.95 ^a	70.52 ^{ab}	59.08 ^c	0.46 ^{***}
Crude protein	77.67 ^c	78.07 ^c	79.31 ^b	79.67 ^b	82.22 ^a	0.22 ^{***}
Crude fibre	77.58 ^c	77.77 ^c	82.81 ^b	84.06 ^a	83.18 ^b	0.21 ^{***}
Ether extract	82.34 ^a	81.48 ^b	81.13 ^{bc}	80.76 ^c	80.00 ^d	0.18 ^{***}
Nitrogen-free-extract	19.55 ^b	20.60 ^a	19.52 ^b	19.74 ^b	18.42 ^c	0.25 ^{***}

***abcd, means with the different superscripts on the same row differ significantly

(P<0.001), * (P<0.05), ** (P<0.01),

NS = Not significant

SEM = Standard Error of the Means.

4.9 Carcass Characteristics of Rabbits Fed Graded Levels of TBNSM

The carcass weight obtained in this study is presented in table 4.7. The values for average live weight, slaughtered weight, dressed weight, dressing percentage, rack/ribs and loin were significant ($P < 0.05$) amongst treatment groups. The values obtained for body length and stomach in (cm) were significant ($P < 0.05$) among treatments while characteristics such as thigh/hindlegs, shoulder/forelegs, head, skin, liver, kidney, lungs all measured in grammes were not significant ($P > 0.05$) among the treatment groups, similarly small intestine, large intestine and caecum measured in centimeters were not significant ($P > 0.05$).

Table 4.7: Carcass Characteristics of Rabbits Fed Graded Levels of TBNSM

Parameters (%)	Graded levels of TBNSM (%)					SEM
	0	10	20	30	40	
Av. Live weight (g)	1223.33 ^b	1400.00 ^{ab}	1375.00 ^{ab}	1350. ^b	1541.67 ^a	5426*
Av. Slzughter wt(g)	1140.00 ^b	1316.67 ^b	1308.33 ^b	1316.67 ^b	1508.33 ^a	54.90*
Av. Dressed wt(g)	716.67 ^b	833.33 ^b	825.00 ^b	808.33 ^b	975.00 ^a	39.48*
Dressing (%)	58.30 ^b	59.43 ^{ab}	60.00 ^{ab}	59.83 ^{ab}	63.23 ^a	1.18*
Rack/ribs(g)	66.67 ^b	91.67 ^{ab}	108.33 ^a	81.67 ^{ab}	100.00 ^{ab}	10.08*
Loin (g)	115.00 ^b	166.67 ^a	158.33 ^{ab}	191.67 ^a	183.33 ^a	15.20*
Thigh/hindlegs(g)	291.67	350.00	325.00	333.33	365.00	21.62NS
Shoulder/forelegs(g)	181.67	215.00	200.00	208.33	233.33	21.98NS
Head (g)	116.67	158.33	133.33	141.67	133.33	15.14NS
Skin (g)	103.33	115.00	108.33	115.00	138.33	11.85NS
Liver (g)	33.33	35.00	33.33	41.67	35.00	8.41NS
Kidney(g)	20.00	40.00	41.67	25.00	63.33	12.54NS
Lungs (g)	16.67	13.33	18.33	16.67	21.67	2.95NS
Body length (cm)	30.00 ^b	32.17 ^{ab}	31.17 ^{ab}	31.97 ^{an}	33.33 ^a	0.71 *
Small intestine (cm)	223.83	197.00	220.00	225.33	255.00	18.67NS
Large intestine (cm)	93.67	85.00	87.50	102.0	103.67	9.11NS
Caecum (cm)	34.83	41.00	36.33	34.17	37.00	2.15NS
Stomach (cm)	10.00 ^a	9.33 ^{ab}	9.17 ^{ab}	9.33 ^{ab}	8.67 ^b	0.32 *

***abcd, means with the different superscripts on the same row differ significantly (P<0.001), * (P<0.05), ** (P<0.01),

NS = Not significant

SEM = Standard Error of the Means.

4.10 Haematological and Biochemical Characteristics of Rabbit Fed Graded Levels of TBNSM

The haematological and biochemical characteristics of rabbits fed graded levels of TBNSM based diets are summarized in table 4.8. The PCV values were significant ($P < 0.05$) among treatment groups, treatment one with 0% TBNSM had the lowest PCV value of 40% while treatment 3 with 20% TBNSM had the highest PCV value of 56.00%.

The RBC values were also significant ($P < 0.05$) amongst treatment groups. Treatment one has ($3.08 \times 10^{12/L}$) which is the lowest and treatment 3 recorded the highest value of ($4.43 \times 10^{12/L}$). Hb, MCH, WBC, MCV and MCHC values showed no significant ($P > 0.05$) differences amongst the treatments. The serum biochemical estimations are presented in table 4.8. The values obtained for urea, creatinine, cholesterol, albumin, total protein and globulin were not significantly ($P > 0.05$) different amongst treatment groups.

Table 4.8: Haematological and Biochemical Characteristics of Rabbit Fed Graded Levels of TBNSM

Parameters (%)	Graded levels of TBNSM					SEM
	0	10	20	30	40	
Packed cell volume (%)	40.0b	41.33b	56.00a	47.33ab	52.67a	2.73*
MCH (Pg)10 ⁻¹²	43.13	43.43	41.83	43.16	43.70	0.54NS
Hb g/dl	13.30	13.77	15.97	17.07	17.53	14.57NS
RBC (x10 ¹² /L)	3.08c	3.17bc	4.43a	3.96ab	4.01ab	0.24*
WBC (x10 ⁹ /L)	13.10	8.47	10.20	9.10	9.53	2.60NS
MCV(10 ⁻⁵)	129.60	130.40	126.47	129.93	131.73	1.56 NS
MCHC(g/dl)	33.23	33.27	33.27	33.23	33.30	0.03 NS
Urea (g/dl)	5.93	4.03	6.10	4.97	4.60	1.25 NS
Creatinine (mg/dl)	166.90	150.90	139.77	139.20	135.50	12.49NS
Cholesterol (mg/dl)	3.47	3.80	4.33	2.57	2.47	1.22NS
Albumin (g/dl)	33.87	31.67	30.90	33.87	28.40	2.42NS
Protein (g/dl)	60.30	63.33	60.60	63.13	64.37	3.53NS
Globulin (g/dl)	26.50	31.67	29.80	30.13	32.63	2.11 NS

**abc mean value on the same row with different superscript differ significantly (P<0.05) NS – Non Significant, RBC – Red Blood Cells

WBC – White Blood Cell, MCV – Mean Corpuscular Volume

MCH – Mean Corpuscular Haemoglobin

MCHC – Mean Corpuscular Haemoglobin Concentration

PCV – Packed Cell Volume, Hb – Haemoglobin

TBNSM – Toasted Bambara Nut Sievate Meal

4.11 Economic Analysis of Rabbits Fed Graded Levels of TBNSM

Result for economic analysis of production of rabbits fed graded levels of TBNSM is presented in table 4.9. The result shows that diet 1 had the highest value of ₦ 70.69/kg, then the value of ₦ 62.26, ₦ 60.85, ₦ 52.93 and ₦ 49.76 for diets 2, 3, 4, and 5 respectively. Cost of total feed intake ranges from ₦ 391.15 to ₦ 408.58 and the feed cost/kg ₦/gain ranges from ₦ 617.93 to ₦ 991.69.

Table 4.9: Economic Analysis of Production of Rabbits Fed Graded Levels of TBNSM

Parameters	Graded levels of TBNSM				
	0	10	20	30	40
Total feed intake (g)	5784	6251	6660	7391	7517
Total feed intake (%)	5.78	6.25	6.66	7.39	7.52
Feed cost (kg/₦)	70.69	62.26	60.85	52.93	49.76
Cost of total feed intake (₦)	408.58	389.13	405.26	391.15	374.19
Total weight gain (g)	412.00	424.00	678.50	633.00	632.00
Feed cost/kg/₦ /gain	991.69	916.67	597.28	617.93	591.60
Cost saving (kg/₦)	-	75.02	394.41	373.76	400.09
Economic ranking		4	2	3	1

CHAPTER FIVE

5.0 Discussion

5.1 Effect of Toasted Bambara Nut Sievate on Feed Intake

The average daily feed intake as presented in table 4.5 shows significant ($P>0.05$) difference in the mean daily feed intake of rabbits fed the experimental diet. The values were 51.67, 55.90, 59.58, 65.87 and 67.11 for treatments (T₁, T₂, T₃, T₄ and T₅) respectively, which is similar to the range 53 – 60.55 reported by Adegbola and Okonkwo (2002) for rabbit fed diet containing maize and varying level of cassava meal.

The level of differences observed may be as a result of the increase in levels of the bambara nut sievate. Ajala (1990) observed higher values than what was obtained in this study. The values were 87.6, 76.4 and 74.4 respectively for rabbits fed diets containing 0.15 and 30% of industrial cotton waste. Dairo *et al* (2002) also reported an average daily feed intake of 80.53, 81.64, 78.16 and 72.55g when rumen ingesta was included in the diets of growing rabbits at 0, 10, 20 and 30% respectively.

One could conclude that feed intake by the rabbits used in this study was within the ranges reported in the literatures.

5.2 Effect of Toasted Bambara Nut Sievate on Weight Gain

The average daily weight gain (ADWG) ranges from 7.35g/rabbit/day to 12.11g/rabbit/day. Treatment 3 with an inclusion level of 20% bambara sievate gave the highest weight gain. The average weight gain in this study showed significance ($P>0.05$) differences across dietary treatments.

The mean daily weight gain of 7.35 - 11.3g/r/day, obtained in this study fell within the range of 10-20g/rabbit/day reported by Cheeke (1987) for rabbits reared in tropical countries. Other studies in semi arid environment gave a daily weight gain between 5.20 and 10g/rabbit/day (Igwebuike *et al.*, 1998; Alade *et al.*, 2001).

Aduku and Olukosi (1990) reported an average daily weight gain of 15-20g as a common range in the tropics. There may be variations from this range which may be due to depressive effect of high ambient temperature on feed intake and weight gain (Stephen, 1980) and this appears to be the situation for this study where temperatures as high as 39°C and 40°C on the average were experienced during the study period.

The temperature is by far beyond the 16°C – 19°C and 21°C – 25°C as recommended for Rabbits as reported by Broody (1984) and Fielding (1991).

5.3 Effect of Toasted Bambara Nut Sievate on Feed Conversion Ratio

The values obtained in this study are presented in table 4.5. The values for feed conversion efficiency was significantly ($P < 0.05$) lower for rabbit on diets T₂ and T₃ respectively. When compared to diets T₁. The result suggested that diets were better utilized in T₂ and T₃ respectively.

The range of 7.35 – 11.30 for feed conversion ratio recorded in this study was inferior to the range of 6.91 – 7.38 reported by Alade *et al.* (2002) when poultry waste was included in the diets of growing rabbits at levels of 0, 5, 10, 15 and 20% respectively. Alade *et al.* (2002) also recorded values of 7.16, 7.47, 8.49 and 11.85 when different levels of wheat bran was used in the diets of growing rabbits. The values of feed conversion ratio obtained in this study is a clear indication of the effect of high ambient temperature in the area at the time of the experiment.

The temperature recorded during the experiment were 35.87°C , 35.31°C, 37.21°C, 36.57°C, 37.5°C, 40.57°C, 39.5°C and 38.43°C for weeks 1, 2, 3, 4, 5, 6, 7, and 8 respectively.

The results showed that the most efficient ratio as far as the feed to gain ratio is concerned was that T₂ (10% TBNSM) followed T₃, T₄ and T₅ respectively.

The value obtained T₁ (0% TBNSM) suggested that this ration was least efficient compared to the other four.

5.4 Effect of Toasted Bambara Nut Sievate on Mortality

No mortality was recorded throughout the period of the experiment. This suggests that anti-nutritional factors such as cyanogens, flatulence factors, tannine and trypsin inhibitors as specified by Ensimerger *et al.* (1990) were far beyond effect causing value, hence the effect could not be felt on the performance characteristics of rabbits. This means that bambara nut sievate is a safe ingredient that can be used to replaced maize offal in rabbits diet.

5.5 Effect of Toasted Bambara Nut Sievate on Digestibility

The dry matter digestibility results obtained in this study indicates that diet 3 with 20% toasted bambara nut sievate inclusion was highest with 71.95% and the lowest being diet 1 with 51.82%, these values agreed with Lang (1981). Crude protein digestibility, though lower in diet 1, 2, 3, and 4 compared to diet 5 were generally high (77.67 to 82.22%) further confirming the assertion that protein in concentrate diets (Deblas *et al.*, 1981) and in forage (Cheeke, *et al.*, 1987) are efficiently utilized by rabbits. The crude fibre digestibility of 77.58, 77.77, 82.81, 84.06 and 83.18 agrees with the findings of Anugwa *et al.* (1982) for rabbits on concentrate diets. Lang (1981) also observed that differences between individual rabbits appear to be large especially in digesting fibre and legumes. The high digestibility of ether extract is in agreement with the observation of (Cheeke *et al.*, 1987; Onifade and Tewe, 1993). The digestibility of nitrogen-free-extract was 19.55, 20.60, 19.52, 19.74 and 18.42 for diets 1, 2, 3, 4, and 5 respectively.

5.6 Effect of Toasted Bambara Nut Sievate on Carcass Parameters

The effects of dietary treatments on carcass weights of rabbit is shown in Table 4.7. The results showed that the carcass traits were average live weight, dressed weight, slaughter weight, dressing percentage and loin all significant ($P < 0.05$) among treatments. Also the values obtained for body length and stomach were also significant ($P < 0.05$) among treatments. For others parameters which include thigh/hindlegs, shoulder/forelegs, head, skin, liver, kidney, lungs, small intestine, large intestine and caecum showed no significant ($P > 0.05$) difference among the treatment groups.

The results obtained in this study agreed with that of Agunbiade and Bello (1997). It is obvious that both maize offal and cassava peels based diets gave body lengths and slaughter weights, which showed a significant ($P < 0.05$) difference in their treatment means. Variation in body weight could be due to inherent factors and may not be due to dietary related issues. While variations in slaughter weight could be as a result of differences in live weight values.

The dressing percentage range obtained in this study (58.30 - 63.23%) were almost the same as that reported by Garcia *et al.* (1993) who slaughtered rabbits between 2.0 – 2.5kg live weight and got dressing percentage of 58.0 and 60%

respectively. But the values obtained were lower to the range reported by Ahmed and Olorede (2003) which were, 83.81 - 86.14 for rabbits fed graded levels of locust bean pulp.

Another factor affecting dressing percentage of rabbit is the mode of dressing or dressing method. Uko *et al.* (2001) obtained dressing percentage ranging from 67.70% to 68.4% in rabbit which the fur were removed by roasting and the head left intact, these figures agreed with that obtained in the study. It also compared favourably with the 50% in United States of America where skin, head and feet are usually removed. (Aduku and Olukos, 1990) a practice which agreed with the dressing method used in this study. The values obtained for head, skin and legs showed no significant difference among treatment. This result agreed with Igwebuiké *et al.* (1998) who recorded no significant difference between the treatment groups for head, skin and feet when different levels of sorghum waste was used in evaluating carcass characteristics of growing rabbits. Alade *et al.* (2002) also reported no significant difference for head, feet and skin of rabbits when different levels of dried poultry waste was used. Iyeghe – Erakpotobor *et al.* (2000) also recorded no significant difference between treatment groups for head and skin of rabbits when palm oil was supplemented at different levels. Igwebuiké *et al.* (2003) reported no significant difference between treatment groups for head, skin and feet of rabbits when different levels of soaked acacia albida pod were used. Joseph *et al.* (2000) also reported that there is no significant difference between different treatment groups for head and legs of growing rabbits while significant differences exist between treatment groups for loin when different levels of bambara ground nut was used in evaluating carcass characteristics of growing rabbits, this quite agreed with the result obtained from this study.

5.7 Effect of Toasted Bambara Nut Sievate on Haematological Indices

The results for haematological indices are as shown in Table 4.8. The PCV values had a significant difference ($P < 0.05$) amongst the various treatment and increased with increasing dietary levels of toasted bambara nut sievate meal, with treatment T₃ having the highest value (56.00) followed closely by T₅ with value (52.67), T₄ with (47.33), (41.33) and (40.00) T₂ and T₁ respectively. The RBC values also had significant differences ($P < 0.05$) amongst treatments. The values obtained for

RBC were (3.08, 3.17, 4.43, 3.96 and 4.01 x 10^{12/L}) for T₁, T₂, T₃, T₄ and T₅ respectively. The Pcv values obtained in this study were higher than that reported by Alade *et al.* (2001) for growing rabbits fed dry poultry waste which were 29.50, 36.50, 10.40 and 12.60g/l.

The values however fell within the ranges of 31 to 50 as reported by (Schalm *et al.*, 1975 and Anon, 1980). Hb values showed no significant differences amongst the treatments, but all values fell within the normal range reported by Maxwell *et al.* (1990). The result of this work on Hb also agreed with the report by Etchu and Egbunike (2003), with values of 11.54, 10.76, 11.22, 11.70, 11.86, 12.04 and 12.04 respectively. This suggests that toasted bambara nut sievate is nutritionally sufficient to meet the protein needs of growing rabbits. Hb concentration decreased in animals on low protein intake, parasite infection or liver damage (Lindsay, 1997). Furthermore, this also suggests that the blood of the rabbits had a higher oxygen carrying capacity. The values of RBC and WBC obtained in this study were within the normal range of 3.0 – 7.73 x 10^{12/L} and 3.0 – 12.5 x 10^{12/L} for RBC and WBC respectively (Schalm *et al.*, 1975 and Anon, 1980). Bush (1975) reported that any form of anaemia or sub-clinical viral infection can lead to low RBC and WBC respectively.

The results for MCH, MCV and MCHC obtained in this study show no significant difference (P<0.05) amongst treatments. The values obtained in this study are higher than that recorded by Anon (1980) for MCV, MCH and MCHC which is an indication of the higher level of protein utilization. Abnormal values would have indicated a negative effect. Deviation of erythrocytes indices values from the normal may be an indication of anaemia (Onifade and Tewe, 1993; Abu *et al.*, 1999).

5.8 Effect of Toasted Bambara Nut Sievate on Biochemical Indices

The values for biochemical estimations do not showed significant differences (P>0.05) for all parameters among treatments. The comparatively high values of total protein obtained contrast that of Etchu and Egbunike (2008) which showed that the serum total protein concentrations were not adversely affected by varying levels of processed bambara nut sievate in the diets since efficient utilization is reflected in high total serum protein (Chandral *et al.*, 1983).

Blood urea concentrations (mg/dl), even though similar ($P>0.05$) for all groups, were lower than the normal range (30.0 – 37.3). These values obtained were in order because high blood urea levels are associated with poor protein quality (Eggun, 1970).

Uric acid which is the primary catabolic product of protein, non protein nitrogen and purines is a good indicator of the quality of protein fed to the rabbits. According to Chandra *et al.* (1983), hyper-uricemia occurs in rabbits when there is starvations, massive tissue destruction and renal disease.

The cholesterol levels obtained in this study fell within the normal reference range of 20 to 83mg/dl (Anon, 1980). But the values in this study are relatively low due to the low levels of cholesterol in bambara nut sievete and the rabbits system. Since cholesterol levels are within the normal range, the problem of severe liver dysfunction, nephrosin, debility or malabsorption of fat observed in abnormal levels are ruled out (Bush, 1975).

The albumin and globulin values obtained in this study were not significant ($P>0.05$) amongst treatments but numerically were different and higher than those reported by Onifade and Tewe (1993) who reported the values of 5.81 to 6.75g/dl and 3.07 to 4.50g/dl. Since total protein, globulin and albumin are averagely responsive to total protein intake (Onifade and Tewe, 1993) the values obtained in the study indicates nutritional adequacy of the dietary protein. Schalm *et al.* (1975) reported that the concentration of serum protein at any given time is a function of the nutritional status, water balance and other factors affecting the state of health of the animal. The numerical values of globulin indicates the difference in strength or the ability of rabbits subsisting on the different dietary treatments to fight against disease (Robert *et al.*, 2000).

The range of serum creatinine values obtained in this study (1.39 – 166.90) are higher to that reported by Oloyede *et al* (2007) (89.50, 58.50, 44.0 and 48.75nmol/L) for soybean meal, raw bambara nut meal, roasted bambara nut meal and fermented bambara nut meal fed to broiler chickens. These values obtained by Oloyede *et al* (2007) was as a result of improper protein utilization. The serum creatinine values in this study were lower not significant ($P>0.05$) among treatments but values were higher than the normal range for rabbits (12.0 – 18.0), suggesting that there was

muscle waste in the rabbits and that the animals survived at the expense of body reserves. This inference could not be substantiated in this study as there was no evidence of loss of weight within each treatment group. It is however possible that the dietary proteins were not fully utilized by the animals within each treatment group probably because the processing methods did not facilitate total protein availability (Eggun, 1970; Ross *et al.*, 1979).

5.9 Economic Analysis of Rabbit Fed Graded Levels of Toasted Bambara Nut Sievate

The results of economic analysis are presented in table 4.9. The results showed that cost per kg feed reduced from ₦ 70.69/kg in T₁ (0% TBNSM) to ₦49.76/kg in T₅ (40% TBNSM). The cost per kilogram feed were ₦ 70.69, ₦ 62.26, ₦ 60.85, ₦ 52.93 and ₦ 49.76 for T₁ (control) T₂, T₃, T₄ and T₅ respectively.

The lowest cost per weight gain (₦ 591.60) was recorded in T₅ where maize offal fraction of the diet was replaced by 40% toasted bambara nut sievate meal. The highest cost per kg weight gain (₦ 991.69) was recorded in the control diet (T₁ 0% TBNSM). This is due to the cost of maize offal (₦ 24/kg) at the time of the study (Jan. 2011) compared to (₦5/kgdm) of bambara offal. As the levels of bambara offal (sievate) increased, the feed cost and cost per kg weight gain reduced as shown in the table 4.9.

The economic results obtained in the study agrees with Alade *et al* (2002) reported that the economic evaluation of feeding growing rabbits fed varying levels of dried poultry waste indicated that the feed cost per kilogram live gain reduced significantly ($P<0.05$) especially at 20% level.

The cost differential and relative cost advantage were better in treatment five (T₅ 40% TBNSM). This suggests that the best economic return were obtained in treatment 5. Therefore maize offal based diet containing up to 40% (TBNSM) could be fed to growing rabbits without compromising the growth, economic performance and health status, while the economic ranking was diet 5, 3, 4 and 2 respectively.

CHAPTER SIX

6.0 Summary, Conclusion and Recommendations

6.1 Summary

The experiment was conducted to assess the performance, carcass and internal organs characteristics, haematological, biochemical indices and digestibility of growing rabbits fed TBNSM as replacement for maize offal. The experiment lasted for 56 days with an adaptation period of one week. The results of the experiment indicates that feed intake, weight gain and feed conversion ratio were significantly ($P < 0.05$) different among the treatment groups with the following values 51.67, 55.90, 59.58, 65.87 and 67.11, 7.35, 11.20, 12.11, 11.30 and 11.29 and 7.20, 5.08, 5.17, 5.86 and 6.03 for feed intake, weight gain and feed conversion ratio respectively. PVC and RBC differ significantly ($P < 0.05$) among the treatment with these values 40.00, 41.33, 56.00, 47.33 and 52.67 and 3.08, 3.17, 4.43, 3.96 and 4.01 for PVC and RBC respectively. While MCH, Hb, WBC, MCV and MCHC did not differ significantly ($P > 0.05$) among treatments. All the biochemical parameters, creatinine, albumin, cholesterol, protein and globulin did not differ significantly ($P > 0.05$) among the treatment groups.

Nutrient digestibility showed that the toasted bambara nut sievate is highly digestible, crude protein, crude fibre, ether extract and dry matter all showed appreciable digestibility.

In terms of economic benefits of using toasted bambara nut sievate meal, the cost per kilogram diet decreased with increase in the level of TBNSM in the diet. Also feed cost per kilogram weight gain followed similar trends. Highest cost saving was recorded in treatment 5 (40% TBNSM).

6.2 Conclusion

In this study, the result indicated that up to 40% TBNSM can be used to replaced maize offal in the diet of growing rabbits without any adverse effect on growth performance, carcass, haematology and biochemical indices as well as digestibility. The results also indicated that bambara nut sievate is more economical than maize offal and is a good source of energy for growing rabbits.

6.3 Recommendations

Based on this result of the study, it is recommended that TBNSM be used at 40% inclusion levels in the diet of growing rabbits.

Further research should investigate the utilization of higher levels of TBNSM in the diets of growing rabbits

REFERENCES

- A. O. A. C (2000). Official Methods of Analysis, Association of Official Analytical Chemists, Washington D. C. USA. P. 957. 17th edition
- Abu, O. A.; Igwebuike, J. U; Bikoibell, D.; Mbaya, M. Y. and Umaru R. S. (1999) Growth Performance and Economy of Production of Rabbits Fed Urea Treated or Untreated Rice Husk-Based Diets. *Production. 20th Annual SAN Conference* 21-25 March 1999 Ilorin P. 140-143.
- Adegbola, T. A. and Okonkwo, J. C. (2002) Nutrient Intake Digestibility and Growth Rate of Rabbits Fed Varying Levels of Cassava Lea Meal. *Nigerian Journal of Animal Production*, 29; P 21-26.
- Aduku, A. O and Olukosi, J. O. (1990). Rabbit Management in the Tropics. Living Book Series, G. U., Publications. Abuja P 111.
- Agunbiade, J. A. and Bell, R. A. (1997) Cassava Peel in a Balanced Diet for Weaner Rabbits. *Proc. 22nd Conference of Nigerian Society of Animal Production* 23-27 March. Bauchi, Nigeria P. 25-36.
- Agunbiade, J. A., Adeyemi, O. A., Fasina, O. E. and Bagbe S. A. (2000). Fortification of Cassava Peel Meals in balanced diets for rabbits. *Nigerian Journal of Animal Production* 28(2): 167-173.
- Ahamefule F. O., Ejiofor C. A., Ibeawuchi J. A. (2000) A comparative study of the constitutes of cattle, sheep and goat milk in a hot humid environment. *Disc. and innov.* 15 (1/2): 64-68.
- Ahmed, T. S. and Olorede, B. R. (2003) Effect of feeding varying levels of African locust bean pulp (Dorowa) on the carcass yield and economy of broiler production. *Proceeding of 8th Annual Conference of Animal Science Association of Nigeria* Sept. 16-18, 2003, Minna Niger state, Nigeria P 4-6.
- Ajala, A. A. (1990). A note on rabbit feeding in the traditional farming system of Nigeria (Oyo state) and implication for extension activities. *Journal of Applied Rabbit, Research*, 12:280-282.
- Akinmutimi A. H. (2004) Evaluation of sword bean (*canavalia gladiara*) as an alternative feed resources for broiler chickens. Ph.D thesis department of non.ruminant animal production, Micheal Okpara, University of Agriculture, Umudike, Nigeria.
- Alade, N. K., Igwebuike J. U. and Lawan, A. (2002) Effect of varying proportions of wheat bran on the growth performance and carcass components of growing rabbits. *Journal of sustainable Agriculture Environment* 4(1): 1-7.
- Alade. N. K.; Kwaji, D. T. and Igwebuike, J. U. (2001) Growth performance and blood constituents of rabbits fed graded levels of poultry waste. *Annals of Borno* 17 (18): 152 -187.

Amaefule K. U. (2002) Evaluation of pigeon pea seeds (*cajanus cajan*) as protein source for pullets. Ph.D thesis, department of animal science, University of Nigeria, Nsukka.

Amaefule K. U. and Iroanya C. O. (2004) Replacement of soybean meal and maie offal with bambara groundnut offal in broiler diets. *Nigerian Agricultural Journal*. 35:133-142.

Amaefule, K. U. and Iroanya, C. O. (2004) Replacement of soyabean meal and maize offal with Bambara groundnut offal in broiler diets. *Nigerian Agricultural Journal* 35: 133-142.

Amaefule, K. U., Nwaokoro, C. C. and Iheukwumere, F. C. (2004) The effect of graded levels of raw pigeon pea seed (*cajanus cajan*) mean on the performance, nutrient retention and carcass characteristics of weaner rabbits *Nigerian Journal of Animal Production* 31:194-199.

Anon, (1980) Guide to the care and use of experimental animals. *Canadian council of animal care*, Ottawa, Ontario, Canada, 1:85-90.

Anugwa F. O. I., Okorie A. U. and Esomonu A. F. N. (1982) Feed utilization and growth of rabbits fed three levels of protein and energy. *Nigerian Journal of Nutritional Science* 3(2) 109-114

Anyanwu, A. C. Anyanwu, B. O. and Anyanwu, V. A. (1982) Agricultural science for school certificate 2nd edition P. 300-400.

Apata, D. F. and Ologhobo, A. D. (1997) Trypsin Inhibitor and other Anti-Nutritional Factors in Tropical Legume Seeds. *Tropical Science*. 37: 52- 59

Aremu, D. K. (1988). Rabbit production made easy 3rd edition P 1-15.

Balogun, A. M. and B. L. Fetuga (1986). Chemical composition of some under exploited Leguminous Crop and Seeds in Nigeria. *J. Agri. Fd. Chem.*, 34: 189-192.

Begemann, F. (1986b) Bambara groundnut. Pests and diseases. *International institute of tropical agriculture* (IITA), Gentic resources unit. Ibadan, Nigeria P 18.

Billington, R. V. (1970). The effect of planting dates on disease incidence on legumes and its effect on final yields. *Ukiriguru research notes* 44:5-7.

Biobuku, W. O. (1994). Effect of feeding raw and cooked delonixragia seed bean on the performance of rabbits *Journal Agricultural Technology* (JAT) 7:10-14.

Blasco, A.; Ouhayoun, J. and Masuero, G. (1993) Harmonization of criteria and terminology in rabbits meat research. *World rabbit meat science* 1(1): 3-10.

Broody, S. (1984) Bioenergetics and growth. Hoiner New York P. 113.

- Brough, S. H., S. N. Azam-Ali and A. J. Taylor (1993). The potential of bambara groundnut in vegetable milk production and basic protein functionality systems. *Food chemistry* 44:277-283.
- Bush, B. M. (1975) Veterinary laboratory manual. William Heineman medical books Ltd, London. P. 447.
- Chandra, M.; Singh, B., Soni, G. L. and Abuja, S. P. (1983). Real biochemical changes produced in broilers by high protein high calcium, urea containing and vitamin A deficient diets. *Avosm fid.* 28:1-6.
- Cheeke, P. R. (1983). The significance of fibre in rabbit nutrition *Journal Applied. Rabbit. Research.* 6:103-106.
- Cheeke P. R., Patton N. M., Lukefair S. O. and J. I. McNitt. (1987) Rabbit production. The interstate publishers and printers Inc. Danville, Illinois USA.
- Cheeke, P. R., (1987) Rabbits feeding and nutrition. Academic press inc., lando, Florida, USA P. 57.
- Church, I. (1991). Livestock feeds and feeding prentice Hall. P. 546.
- Colin, M. and Lebas, F. (1994). La Production du lapin dans le monde. Communication to 6^{es} *journees de la recherché cunicole en france*, 6 to 7.
- D' Mello, J. P. F. (1995). Antinutritional substances in legumes seeds in D'mello D. P. F. and Devendra C. (editors). *Tropical legumes in animal nutrition*, CAB international, walling ford, U.K.
- Dairo, F. A. S., Aina, O. and Asafa, A. R. (2002) The performance of growing rabbit fed ration containing rumen content in *proceedings of 7th Annual conference of animal science association of Nigeria*. Abeoukuta P. 131.
- Davidson, W. J. and Spreadbury, D. (1975). Nutrition of new Zealand white rabbit. *Proceeding of Nutritional Society* 34:75-83
- De Blas J. C.; Perez E.; Fraga M. J.; Rodriquez J. M. and J. F. Galvez (1981) Effect of diet on feed intake and growth of rabbits from weaning to slaughter at different ages and eight *Journal of Animal Science* 52: 1225-1232.
- Demenna, G. J., (2010) Determiation of vitamins, Amino acid, and preservatives in Bervages by Isocratic Hplc. *International journal of food science*. 1-800-562-5566.
- Doku, E. V. and S. K. Karikari (1991) Operational selection in wild bambara groundnut. *Ghana. Journal of Science* 11(1):47-56.
- Duncan, D. E. (1955). Multiple range and multiple f-tests. *Biometrics*. 11:1-42.

Eggun, B. O. (1970). Blood wea. Measurement as a technique for assessing protein quality *Arit. J. Nutr.* 24:985-988.

Ekenyem, B. U. and Onyeagoro, C. P. (2006). Replacement value of bambara nut voandzeia subterranea sievate for soya bean meal Glycin max on the performance of finisher broiler chicken. *International Journal of poultry Science* 5(4):381-384.

Ekenyem, B. U., S. I. Omeje and F. N. Madubuike (1999) An Estimation of Feed Intake, Feed Efficiency and Water Intake of Broiler and Breeder Genotypes of Exotic Chicken *Journal of Agricultural Technology Education* 4: 11-14.

Ensinminger, M. E., J. E. Oldfield and W. W. Heinemann, (1990). Feeds and nutrition. The Ensinminger publishing company. California. USA.

Eschiet, N. O., Omole, T. A. and Demosun, A. A. (1979). The effect of feeding cassava root meal on the performance of fryer rabbit. *Journal of Agriculture* 2:2-40.

Esonu, B. O., F. C. Iheukwumere, T. C. Iwuji, N. Akanu and O. H. Nwugo, (2003) Evaluation of Microdesmis Puberula Leaf Meal as Feed Ingredient in Broiler Starter Diets. *Nigerian Journal of Animal Production* 30: 3-8.

Esonu, B. O., O. O. Emenalom, Abi Udechibie, U. Herbert C. F. Ekpor, I. C. Okelie and F. C. Iheukwumere, (2001) Performance and Blood Chemistry of Weaner Pigs Fed Raw Mucuna (Velvet Bean). *Tropical Animal Production Investment* 4: 49-54.

Etchu, K. A.; and Egbunike, G. N. (2003) Haematological and biochemical changes in broilers fed processed sweet potato-based diets in the humid tropics during the rainy season. *Tropical Animal Production Investment* 6:45-54.

F. A. O. (1982). Food and agricultural organization of the United Nations. Rome, The state of food and Agriculture P 42. F.A.O Rome. Italy.

Fielding D. (1991) Rabbits London and Basingstone. The macmillan press. Ltd. P 100.

Fielding, D. (1991). Rabbits the tropical agriculturalist series. C. T. A. Publishers. 106p.

Garcia G., Galvez, J. F. and De-blas J. C. (1993) Effect of substitution of sugar beet pulp for barley in the diets for finishing rabbits on growth performance and on energy and nitrogen efficiency. *Journal of Animal science* 71: 1825-1830.

Goli, A. E., F. Begemann and N. Q. Ng (1991). Germplasm diversity in bambara groundnut and prospects for crop improvement. *Crop genetic resource of Africa* Vol. 2. P 195-202.

Igwebuike, J. U. (2001). Utilization of acacia pods (acacia albida) for rabbit feeding PhD thesis submitted to university of Agriculture Makurdi. Nigeria.

- Igwebuike, J. U., Anugwa, F. O. I., Ikurior, S. A. and Ehiobu, N. G. (2003). Effect of feeding graded, levels of soaked Acacia Albida pods on the performance of growing rabbits. *Indian journal of Animal science*. 73(7):802-806.
- Igwebuike, J. U; Abbas I. and Mshelia N. (1998) Effect of feeding graded levels of sorghum waste on the nutrient and mineral utilization of growing Rabbits. *Research Journal of Science* 4(1 and 2); P 46-56.
- Iyayi, E. A. (2001). Cassava leaves supplement for feeding weaner swine. *Tropical Animal Production Investment* 4:141-150
- Iyeghe-Erakpotobor, G. T.; Ekpenyong, T. E. and Balogun, R. O. (2000). Effect of palm oil supplementation on carcass yield and fatty acid composition of growing rabbits *Nigerian Journal of animal Production* 27 (1): 29-34.
- Jenkins, J. R. (1999). Nutrition and gastrointestinal physiology. The veterinary clinics of north Amercia. *Exotic Animal practice* (Rabbit) W. B. Saunders Co. Philadelphia, PA.
- Jenny, L. (1982). Nutrient requirement of commercial rabbit. Part 1 nutrition abstract and review series. P. 2016-2673.
- Joseph, J. K.; Awosanya, B.; Adeoye P. C. and Okekunle, M. R. (2000) Influence of graded levels of toasted bambara ground nut meal on rabbit carcass characteristics. *Nigerian journal of animal production* 27 (1): 86-89.
- Karikari, S. K. (1971). Economic importance of bambara groundnut. *World crops* 23(4):195-196.
- Lang, J. (1981) The nutrition of commercial rabbits part 1: Physiology, digestibility and nutrient requirements. *Nutritional Abstract Review*. (series B). 51(4): 197-225.
- Lebas, F. (1992). Alimentation Pratique des lapins en engraissement (2^e partie et perspective cuni-sci., 5:1-28.
- Lebas, F. and Colin, M. (1992). World rabbit production and research: situation in 1992. *5th world rabbit congress*, vol. A, p. 29-54.
- Liener, I. E. (1980). Significance for human of biological active factors in soyabeans and other food legumes. *Jacoec*, 56:121-129.
- Lindsay, D. B. (1977). The effect of feeding patterns and sampling on blood parameters. Occa. Public. No 1, *Britain. Animal Production*; ed by D. Lister, P. 9-120.
- Linnemann, A. R. (1987). Bambara groundnut (*voandzeia subterranea*): a review. *Abstr. on tropical Agriculture* 12(7) 30-34.

- Linnemann, A. R. (1988). Cultivation of bambara groundnut in northern Nigeria. *Trop crops. Comm.* 15:1-14.
- Linnemann, A. R. (1990). Cultivation of bambara groundnut (*voandzeia subterranea*) in western province. Zambia. Report of a field study. Tropical Crops commun. No 16. Wageningen agricultural university.
- Maxwell, M. H.; Robertson, W.; Spence, S. and Machorquodale, C. C. (1990). Comparison of haematological parameters in restricted and ad libitum fed domestic fowls. *Britain Poultry Science* 31: 407-413.
- Mukurumbia, L. M. (1985). Effects of the rate of fertilizer nitrogen and previous grain legume crop on maize yields. *Zimbabwe agricultural Journal* 82(6):177-179.
- N. R. C. (1977). National research council. Nutrient requirement of rabbit. Washington D. C. publication No. 1194.
- N.R.C (1984). National research council. Washington D. C. Nutrient requirement of rabbit 2nd revised edition P. 34-40.
- Ng, N. Q., A. A. Osunmakinwa, F. Begemann and A. E. Goli (1985). Germplasm Maintenance/preservation, characterization and documentation. GRU Annual Report, international institute of tropical agriculture (IITA), Genetic Resources unit, Ibadan, Nigeria. 11p.
- Obizoba, I. C. (1983). Nutritive value of cowpea-bambara groundnut rice mixtures in adult rats. *Nutritional Rep. inst.* 27: 709-712.
- Odobote, I. K. and Akinokun, J. C. (1991). Reproductive and body weight performance of New Zealand white rabbits in the humid tropics of Nigeria. *Nigerian Journal of Animal Production* 18:61-65.
- Ogundipe, S. O. (2002). Ration formulation and least cost ration. A paper presented at the small ruminant training workshop held at NAPRI ABU Zaria. 13th – 18th Jan. 2002.
- Okah, U. (2004). Effect of dietary replacement of maize with maize processing-by-products on the performance of broiler starter. *9th annual conference of animal science association of Nigeria*. Proceedings P. 2-4.
- Okorie, J. U. (1977). A guide to rabbit production in Nigeria published by macmillan education limited P 190-220.
- Okoye, F. C. (1998). Substitution of sundried cassava peel meal for maize in broiler finisher diets *Journal of Agricultural Technology* 6(1): 10-15.
- Oliveira, J. S. (1976). Grain legumes of Mozambique. *Tropical Grain and legume bulletin*. 3:13-15.

Ologhobo, A. D. (1992) . The nutritive value of some tropical (west African) legumes for poultry: *journal of applied Animal research* 2:193-194.

Oloyede, O. B.; Odotuga, A. A.; Minari, J. B.; and Amballi, A. A. (2007). Assessment of some serum metabolites and enzymes of Broiler-chickens fed raw and processed Bambara groundnut. *International journal of poultry science* 6(9): 647-650.

Oluyemi, J. A., B. L. Fetuga and H. N. I. Endeley (1976). The metabolizable energy value of some feed ingredients for young chicks. *Poultry Science* 55:611-618.

Onifade A. A. and Tewe O. O. (1993) Alternative tropical energy feed resources in rabbit diets: growth performance, diet digestibility and blood composition. *World rabbit science* 1:17-24.

Onwudike O. C. and Eguakun A. (1992) Effect of heat treatment on the composition, trypsin inhibitory activity, metabolizable energy level and mineral bioavailability of bambara groundnut meal with poultry. *In proceedings XIX world's poultry congress*, Amsterdam, the Netherlands 20-24 September, 1992. 508-513.

Onwudike O. C. and Eguakun A. (1994) Nutritional evaluation of raw and heat-treated bambara groundnut meals for starter broilers birds. *Journal of agricultural technology*, 2:38-46.

Onwudike, O. C. and Eguakun, A. (1994) Nutritional Evaluation of Raw and Heat-Treated Bambara Groundnut Meals for Starter Broilers Birds. *Journal of Agricultural Technology* 2:38-46.

Onyimonyi A. E. and Onukwufor J. O. (2003) Effects of toasted bambara groundnut (*voandzeia subterranea*) waste (TBW) on performance of growing pullets. *Proceedings of the 28th annual conference of the Nigerian society for animal production* 28:237-239.

Onyimonyi, A. E. and Okeke, G. C. (2002). Performance of weaner pigs fed varying dietary levels of bambara nut sievate. In proc. 7th ann. Conf. Anim. Sci. assoc. of Nig. (ASAN) Sept. 16-19 2004. University of Agriculture, Abeokuta, Nigeria. P. 85-87.

Opera, C. C. (1996). Studies on the use of Alchornea Cordifolia leaf meal as fed ingredients in poultry diets. M.Sc thesis, Federal University of Technology, Owerri, Nigeria.

Otar, J. U; Patricia A. and Gabriel, M. B. (1990). Substitution value of maize offal in diet of laying hens. *Nigerian Journal of animal Production Research* 17: 56-60.

Owusu-Domfeh, K., Christensen, D. A. and Owen, B. D. (1970). Nutritive value of some Ghanaian feed stuffs. *Canadian Journal of Animal Science* 50:1-14.

Oyawoye E. O., Ogunkunle M. (1998): Physiological and biochemical effects of raw jack beans on broilers. *Proceedings of annual conference of Nigeria society of animal production* 23:141-142

- Pauzenga, U. (1985) Feeding parent stock. *Journal of zoological technology international* 22-24.
- Poulter, N. H. (1981). Properties of some protein fractions from bambara groundnut (*voandzeia subterranea*) *Journal of science of food an agriculture*. 32:44-50.
- Proto, V. (1980). Alimentazione del coniglio da carne coniglicoltura, 17(7):17-32.
- Roberts, K. M.; Daryl, K. G.; Peter, A.M and Victor, W. R. (2000). Mayer's Biochemistry. 25th edition, MC Grawhill, New York 25:763-765.
- Ross, J. G.; Christies, G., Haliday, W. G. and Jones, R. M. (1979). Haematological and blood chemistry comparism values for clinical pathology in poultry. *Vet. Record* 102:29-31.
- Schalm, J. W.; Jain, N. C. and Carrol, E. J.; (1975) Veterinary haematology 3rd ed, lea and frebiger, Philadelphia, P. 15-81.
- Sirios, M. (1995) Mosbys fundamentals of veterinary techniques. Venterinary clinical laboratory procedures mosys year book ince.
- Smith, A. J. (2001). Poultry Revised edition. The tropical Agriculturalist C.T.A. Macmillan P. 241.
- Somasegaran, P., R. C. Abaidao and F. Kumaga (1999). Host-Bradyrhizobium relationships and nitrogen fixation in the bambara groundnut (*voandzeia subterranea*) (L.) thou. *Tropical Agriculture* 67:137-142.
- Spreadbury, D. (1978). A study of protein and Amino acids requirement of the growing new Zealand white rabbit with emphasis on lysine and sulphur containing amino acid. *Britian Journal of Nutrition*.
- Steel, N. H. (1980). Principles and procedures of statistics. McGraw Hillbook. Co. New York, USA.
- Stephen E. (1980) The influence of environmental temperatures on rabbit meat of different breeds . *Proc. World rabbit congress* 2nd 1: P. 399-409.
- Taraba Diary (2003). Ministry of information Jalingo, Taraba State, Nigeria.
- Temple, V. J. and Aliyu, R. (1994). Proximate composition of the cream coloured decorticated seeds of Bambara ground nut (*voandzeia subterranean*(L.) Thouras) *Bioscience research communication* 6: 51-54.
- Uko, O. Ayaja, A. M.; and Tanko H. B. (2001). Cereal by products as alternative energy sources in diets for rabbits growth performance, nutrient digestibility and carcass yield. *Tropical animal Investment*. 4: P. 67 – 76.

APPENDIX I: COST OF FEED INGREDIENTS

Items	Quantity (kg)	Cost (₦)	Unit
price (₦)			
Bonemeal	12.5	450	36
Palm kernel meal	15	2200	146.67
Maize offal	250	6000	24000
Salt	2.5	500	200
Premix	2.5	3000	1200
G/nut cake	34	6000	176.47
Fish meal	11.50	7500	652.17
Maize	71	3500	49.30
Bambara nut sievate	100	500	5.00

Cost was based on the prevailing prices at the time of study (January, 2011).

**Appendix II: ANOVA tables for performance, carcass characteristics, haematological
and biochemical indices.**

Appendix 1: ANOVA for fed intake

SV	DF	SS	MS	F	P
Trt	4	856.75	214.18	2.34	4.36
Replicate	4	411.82	102.96	1.07	
Error	16	1533.29	95.83		
Total	24	92893.08			

Appendix 2: ANOVA for Daily Weight

SV	DF	SS	MS	F	P
Trt	4	70.63	17.66	4.75	1.11
Replicate	4	17.34	4.33	1.17	
Error	16	59.55	3.72		
Total	24	2985.42			

Appendix 3: ANOVA for FCR

SV	DF	SS	MS	F	P
Trt	4	14.60	3.65	2.09	0.76
Replicate	4	13.33	3.33	1.92	
Error	16	27.82	1.74		
Total	24	917.75			

Appendix 4: ANOVA for Av. Live Weight

SV	DF	SS	MS	F	P
Trt	4	155956.67	38989.17	4.41	54.26
Replicate	2	26770.00	13385.00	1.52	
Error	8	70663.33	8832.92		
Total	14	28736650.00			

Appendix 5: ANOVA for Av. Slaughter Weight

SV	DF	SS	MS	F	P
Trt	4	204023.33	51005.83	5.64	54.90
Replicate	2	28170.00	14085.00	1.56	
Error	8	72346.67	9043.33		
Total	14	26361400.00			

Appendix 6: ANOVA for Av. Dressed Weight

SV	DF	SS	MS	F	P
Trt	4	103083.33	25770.83	5.51	39.48
Replicate	2	12583.33	6291.67	1.35	
Error	8	37416.67	4677.8	-	
Total	14	10528125.00			

Appendix 7: ANOVA for Dressing Percentage (%)

SV	DF	SS	MS	F	P
Trt	4	40.69	10.17	2.43	2.18
Replicate	2	2.27	1.13	0.27	
Error	8	33.47	4.18		
Total	14	54364.82			

Appendix 8: ANOVA for rack/ribs

SV	DF	SS	MS	F	P
Trt	4	3156.67	789.17	2.58	10.08
Replicate	2	123.33	61.67	0.20	
Error	8	2443.33	305.42		
Total	14	126325.00			

Appendix 9: ANOVA for Loin

SV	DF	SS	MS	F	P
Trt	4	10723.33	2680.83	3.87	15.20
Replicate	2	1470.00	735.00	1.06	
Error	8	5546.67	693.33		
Total	14	416275.00			

Appendix 10: ANOVA for Thigh/hind legs

SV	DF	SS	MS	F	P
Trt	4	9256.67	2314.17	1.65	21.62
Replicate	2	2470.00	1235.00	0.87	
Error	8	11213.33	1401.67		
Total	14	1686275.00			

Appendix 11: ANOVA for Head

SV	DF	SS	MS	F	P
Trt	4	2750.00	687.50	1.00	15.14
Replicate	2	333.33	166.67	0.24	
Error	8	5500.00	687.50		
Total	14	288750.00			

Appendix 12: ANOVA for skin

SV	DF	SS	MS	F	P
Trt	4	2160	540.00	1.28	11.85
Replicate	2	280.00	140.00	0.33	
Error	8	3370.00	421.25		
Total	14	5810.00			

Appendix 13: ANOVA for Heart

SV	DF	SS	MS	F	P
Trt	4	0.00	0.00	0.00	0.00
Replicate	2	0.00	0.00	0.00	
Error	8	0.00	0.00	0.00	
Total	14	150.00			

Appendix 14: ANOVA for Liver

SV	DF	SS	MS	F	P
Trt	4	143.33	35.83	0.67	8.41
Replicate	2	253.33	126.67	0.59	
Error	8	1696.67	212.08		
Total	14	21175.00			

Appendix 15: ANOVA for Kidney

SV	DF	SS	MS	F	P
Trt	4	3456.67	864.17	1.83	12.54
Replicate	2	210.00	105.00	0.22	
Error	8	3773.33	471.67		
Total	14	29100.00			

Appendix 16: ANOVA for Lungs

SV	DF	SS	MS	F	P
Trt	4	110.0	27.50	1.05	2.95
Replicate	2	123.33	61.67	2.35	
Error	8	210.00	26.25		
Total	14	4950.00			

Appendix 17: ANOVA for Body Length

SV	DF	SS	MS	F	P
Trt	4	18.38	4.59	3.02	0.71
Replicate	2	0.92	0.46	0.30	
Error	8	12.19	1.52		
Total	14	31.49			

Appendix 18: ANOVA for Small Intestine

SV	DF	SS	MS	F	P
Trt	4	5122.60	1280.65	1.22	18.67
Replicate	2	683.03	341.52	0.33	
Error	8	8367.30	1045.91		
Total	14	768381.75			

Appendix 19: ANOVA for Large Intestine

SV	DF	SS	MS	F	P
Trt	4	840.40	210.10	0.84	9.11
Replicate	2	629.63	314.82	1.26	
Error	8	1992.70	249.09		
Total	14	137038.75			

Appendix 20: ANOVA for caecum

SV	DF	SS	MS	F	P
Trt	4	85.83	21.46	1.54	2.15
Replicate	2	56.23	28.12	2.02	
Error	8	111.27	13.91		
Total	14	20420.00			

Appendix 21: ANOVA for Stomach

SV	DF	SS	MS	F	P
Trt	4	2.73	0.68	2.22	0.32
Replicate	2	2.70	1.36	4.38	
Error	8	2.47	0.31		
Total	14	1305.25			

Appendix 22: ANOVA table for shoulder/forelegs

SV	DF	SS	MS	F	P
Trt	4	4343.33	1085.83	0.75	21.98
Replicate	2	603.33	301.67	0.21	
Error	8	11596.67	1449.58		
Total	14	663425.00			

Appendix 23: ANOVA for PCV

SV	DF	SS	MS	F	P
Trt	4	579.73	144.93	6.52	2.72
Replicate	2	36.13	18.07	0.81	
Error	8	177.87	22.23		
Total	14	34590.00			

Appendix 24: ANOVA for MCH

SV	DF	SS	MS	F	P
Trt	4	6.21	1.55	1.74	0.54
Replicate	2	6.57	3.28	3.68	
Error	8	7.14	0.89		
Total	14	27823.76			

Appendix 25: ANOVA for HB

SV	DF	SS	MS	F	P
Trt	4	3248.38	812.35	1.28	14.57
Replicate	2	1274.54	637.27	1.00	
Error	8	5093.65	636.71		
Total	14	17365.09			

Appendix 26: ANOVA for RBC

SV	DF	SS	MS	F	P
Trt	4	4.05	1.01	5.52	0.24
Replicate	2	0.001	0.001	0.003	
Error	8	1.47	0.18		
Total	14	214.21			

Appendix 27: ANOVA for WBC

SV	DF	SS	MS	F	P
Trt	4	38.99	9.75	0.48	2.60
Replicate	2	16.16	8.08	0.39	
Error	8	162.39	20.30		
Total	14	1741.64			

Appendix 28: ANOVA for MCV

SV	DF	SS	MS	F	P
Trt	4	39.59	9.89	1.36	1.56
Replicate	2	56.27	28.13	3.85	
Error	8	58.42	7.30		
Total	14	251682.12			

Appendix 29: ANOVA for MCHC

SV	DF	SS	MS	F	P
Trt	4	0.009	0.002	0.82	0.03
Replicate	2	0.004	0.002	0.71	
Error	8	0.023	0.003		
Total	14	16593.45			

Appendix 30: ANOVA for Urea

SV	DF	SS	MS	F	P
Trt	4	9.29	2.32	0.49	1.25
Replicate	2	1.77	0.88	0.19	
Error	8	37.59	4.69		
Total	14	442.89			

Appendix 31: ANOVA for Creatinine

SV	DF	SS	MS	F	P
Trt	4	1965.41	491.35	1.05	12.49
Replicate	2	515.48	257.74	0.55	
Error	8	3747.16	468.39		
Total	14	327956.74			

Appendix 32: ANOVA for Cholesterol

SV	DF	SS	MS	F	P
Trt	4	7.72	1.93	0.43	1.22
Replicate	2	2.58	1.29	0.29	
Error	8	35.95	4.49		
Total	14	212.25			

Appendix 33: ANOVA for Albumin

SV	DF	SS	MS	F	P
Trt	4	53.48	13.37	0.76	2..42
Replicate	2	10.89	5.44		
Error	8	140.71	17.59		
Total	14	15151.89			

Appendix 34: ANOVA for Protein

SV	DF	SS	MS	F	P
Trt	4	38.74	9.68	0.26	3.53
Replicate	2	6.79	3.39	0.91	
Error	8	299.68	37.46		
Total	14	58651.80			

Appendix 35: ANOVA for Globulin

SV	DF	SS	MS	F	P
Trt	4	65.74	16.43	1.23	2.11
Replicate	2	19.08	9.54	0.71	
Error	8	107.06	13.38		
Total	14	13824.20			