GROWTH PERFORMANCE, NUTRIENT DIGESTIBILITY AND CARCASS CHARACTERISTICS OF RABBITS FED VARYING LEVELS OF GROUNDNUT HAULMS SUPPLEMENTED WITH CONCENTRATE

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

With a population of over 200 million people, Nigeria`s daily protein consumption is below the recommended level of 35g animal protein per person per day (FAO, 2006). This may be attributed to the declining animal protein production due to high cost of livestock production especially the cost of feeds which usually accounts for up to 70 % of the total cost of production (Ijaiya *et al.,* 2002). Nigerians consume less than one quarter of the animal protein required for normal functioning of the body (Adegbola, 1991). High levels of animal proteins may be met by production of fast growing animals such as rabbits, poultry and pigs. The gap between demand and supply of meat in the country can be met by increasing the production of rabbits (Shahrbabak *et al*., 2009).

Rabbits have been recognized to play a very vital role in the supply of animal protein to Nigerians (Egbo *et al*., 2001). Nutritionally, rabbit meat has a higher protein (20-21%), low calories (1749kcal kg^{-1}) and low fat content (10-11%) when compared with meat from most livestock species (USDA, 1985). Nevertheless, improved quality, dressing percentage and the proportion of valuable body parts of growing rabbits could be improved upon through alternative feed sources such as groundnut haulms which are not in competition with man.

Rabbits tend to have better conversion efficiency of forage protein to animal protein when compared to other livestock (Cheeke *et.al*., 1994). Apart from the seeds, legume forages also contain protein in their vegetative parts. These forages such as lablab, soybean, groundnut haulms and Stylosanthes can be fed to rabbits (Lebas.

1980). Leguminous forages spend less time in the ceacum when compared to grasses because they are easily masticated and broken down (Cheeke *et al.,* 1986) during digestion and through coprophagy. The haulms of groundnut is highly valued as fodder for feeding cattle, sheep, goats, rabbits, horses and many other livestock animals. Rabbits have the ability to utilize forages, however, feeding forages alone does not supply all the needed nutrients in sufficient quantities, for optimum productivity in terms of growth (Adegbola *et al.,* 1996) or reproduction. It is important therefore, that forages fed should be supplemented with a well formulated concentrate for optimal performance in rabbits. With current trends advocating for commercial production and supply of rabbits, it is important to look into supplementing forage meals with complete diets.

Given the advantages of legume forages such as groundnut haulms especially for dry season feeding of livestock, it is important to investigate the performance of growing rabbits in relation to varying inclusion levels of the forages and concentrate. This study was therefore, carried out to determine growth performance, nutrient digestibility and carcass characteristics of rabbits fed varying proportions of concentrate and groundnut haulms in the diet of rabbits.

1.2 Statement of Research problem

One of the major problems of rabbit production is the high cost of feed. Commercial rabbit feed is expensive and beyond the reach of the average farmer. The problem has been worsened due to the increasing competition between humans and livestock for grain and oil seed ingredients used in the production of feedstuffs. As a result, Gueye and Branckaert (2002) recommended that locally available feed resources should be identified in order to formulate diets that are as balanced as possible, hence

the need to explore the use of non-conventional feed sources (like groundnut haulms) that might have the capacity to give good performance (in terms of growth, digestibility and carcass quality) as conventional feeds, perhaps and at a cheaper cost.

1.3 Justification of the Study

Rabbits have been recognized to play a very vital role in the supply of animal protein to Nigerians (Egbo *et al*., 2001). Nutritionally, rabbit meat has a higher protein (20-21 %), low calories (1749Kcal kg^{-1}) and low fat content (10-11 %) when compared with meat from most livestock species (USDA, 1985), hence the choice of using rabbits for this research work.

The increasing demand for animal protein indicates the urgent need to intensify livestock production as solution. Rabbits have been identified to possess the potential of becoming an important source of animal protein with its ability to utilize forage efficiently. Profitability and sustainability in livestock enterprise have necessitated alternative cheap feedstuff which can adequately replace the more expensive and highly competitive ones. Gunasekaran *et al.* (2013) evaluated the growth characteristics of rabbits and confirmed that it was economical to rear rabbits on mixed diet of concentrate and forage.

1.4 Aim and Objectives of the Study

The general aim of this research is to assess the growth performance, nutrient digestibility and carcass characteristics of rabbits fed varying levels of groundnut haulms with concentrates.

The objectives of this study are to;

1. Determine the proximate composition of groundnut haulm
2. Evaluate the growth performance and nutrient digestibility of rabbits fed diets containing varying levels of groundnut haulms and concentrate.
3. Evaluate the carcass characteristics of rabbits fed diets containing varying levels of groundnut haulms and concentrate.
4. Determine the sensory properties of boiled and fried meat of growing rabbits fed diets containing varying levels of groundnut haulms and concentrate.
5. Assess the cost benefits of producing weaner rabbits fed varying levels of groundnut haulms supplemented with concentrate.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Brief Description of Rabbit

The domestic rabbit (*Oryctolagus cunniculus*) descended from the wild rabbit found in the Mediterranean countries and was introduced into England in the late eleventh or early twelfth century. It was first introduced to Nigeria during the early 1960's by the United States Department of Agriculture (USDA, 1985). Over the years the number of people involved in rabbit production has increased tremendously. The rabbit is an herbivorous, non-ruminant animal which has the capacity to efficiently utilize forages and industrial by-products as feed source (Cheeke *et al*., 1986). Rabbits have a characteristic long ear, whiskers and rather soft skin. The front legs are shorter than the hind legs. Rabbit squat on the hocks and walk on them. The tail is short and usually found in a curled up position. Rabbits live in groups, and the best known species, the European rabbit, lives in underground burrows, or rabbit holes. Rabbits have the ability to utilize forage or agricultural by-products, they are also good potential meat producing animals in the tropics due to their characteristic small body size, short gestation interval with rapid growth rate. The vegetable waste, are well utilized as feed resources for rabbits, and the manure from the animals could be used as an organic fertilizer for crops (Mikled, 2005). The consumers of today pay great attention to the health aspects of food, such as low fat content and organic origin. Meat from rabbits has a low cholesterol level, high protein/energy ratio and is relatively rich in essential fatty acids (Iraqi. 2003).

2.2 Potentialities of Rabbitry in Nigeria

Rabbits have immense potentials and good attributes which include high growth rate, high efficiency in converting forage to meat, short gestation period high and prolificacy, relatively low cost of production, high nutritional meat quality which includes low fat, sodium and cholesterol levels. It also has high protein level about 20.8 % and consumption is free from cultural religious biases (Biobaku and Oguntona, 1997). In an efficient production system rabbits can turn 20% of the proteins they eat into edible meat. Comparative figures for other species 22-23% for broiler chickens. 16-18 % for pigs and 8-12 % for beef (Lebas *et al.*, 1990) as cited by Liman (2012).

Moving along villages, it is obvious that other animal production sectors such as poultry, cattle, sheep and goat production are reared on a large scale commercial farm while rabbits are yet to be rear on a large scale in Nigeria. Moreki (2007) reported a low protein intake of 3.0 – 6.4g per head per day which is far lower than what was prescribed by World Health Organization (WHO). Rabbit production's reality will go a long way in animal protein shortage in Nigeria because of its numerous or countless attributes and potentials which include high prolificacy, feed conversion efficiency, growth rate, short gestation period, relatively low cost of production, good meat nutritional qualities such as low sodium, cholesterol and fat content. Its meat contains as high as 20.8 % crude protein with no religious biases. This poses an assurance that very soon, rabbitry expansion will become a reality in Nigeria in other to reduce animal protein shortage and the issue of malnutrition also.

2.3 Carcass Characteristics

Carcass quality of rabbits is defined by the proportion of the cut parts as loin, hind and fore parts (Larzul and Gondret 2005). Carcass quality has to satisfy economic objectives, such as sell able meat yield and attractiveness to consumer (Dalle Zotte, 2002). Dressing percentage is a very important economic variable in the rabbit market as well and as the animal grows, the carcass becomes an increasing proportion of its live weight.

Akinwolere and Tsado (2014) carried out research work on performance, nutrient digestibility and carcass characteristics of broiler chicken fed replacement levels of rumen filtrate fermented shea nut (Halicize) meal for groundnut meal and reported that fermentation led to slight increase in dry matter content, crude fibre and NFE. In the aspects of performance, total feed intake and average daily feed intake showed no significant difference ($P>0.05$). The authors also reported that as the crude fibre increases the longer the length of intestine of broiler chickens.

2.3.1 Carcass of rabbit fed concentrate and forage

Aries *et al.* (2003) reported that the greatest disadvantages of forages used as feeds is the low dry matter (DM) content, resulting in low dry matter intake (DMI). The DM content can be improved by drying the forage before feeding. Adeyemi *et al.* (2014) studied the effect of concentrate to forage (*Tridax procumbens*) ratio on the carcass characteristics of growing rabbit. The forage was included in the diets by 0, 25, 50 and 75 %. The final weight, weight gain and feed conversion ratio were significantly better for rabbits fed 50 % (*Tridax procumbens*) forage in comparison to the other experimental groups. Results also showed that rabbits fed 50 % forage had the highest live weight, dressed weight and dressing percentage. Therefore, the

authors recommended that for optimum performance, rabbits should be fed 50 % of concentrate and 50 % of forage.

Rabbits can convert locally available plant products into animal protein for human consumption. Rabbits are very selective in their feeding behavior and in the wild will nibble and select specific plant parts. They generally select leaves rather than stems, young plant materials rather old and green rather than dry materials, resulting in a diet that is higher in protein and digestible energy and lower in fiber than the available total plant material. Safwat *et al*. (2014) and Ayssiwede *et al*. (2010) noted that chemical composition of forages may vary according to various factors such as climatic condition under which forage plants were grown, plant age as well as both soil type and fertility.

Olorunsanya *et al.* (2010) noticed no significant difference in the carcass of rabbit put in five treatments groups marked A, B, C, D and E. The treatment groups comprised of the following, Concentrate, Elephant grass enhanced with 30g of concentrate, Tridax enhanced with 30g concentrate, Mixture of Tridax and Pueraria (60:40) with 30g of concentrate and blend of Elephant grass and *Pueraria* (60:40) with 30g concentrate respectively. The slaughter weight of rabbit in treatment D was like that of diet A and E. This value was similar to the value portrayed by Akinusi *at al.* (2007). Weight of the liver, lung, heart bile shows no significant ($p>0.05$) distinction over the group. Additionally, the kidney weight of rabbit in diet A wasn't significantly ($p>0.05$) different from those in other diets. The non-significant ($p>0.05$) difference seen in the liver weight, lung weight, heart weight and bile weight demonstrate that the physiological and anatomical element of those organs were not influenced by the different diets, this further shows that these roughages

fed might not be hostile to the nutritive elements or poisonous at the levels that could alter the ordinary physiological and anatomical element of these organs in weaner rabbits. According to Soaban (2019), rabbits fed mixture of forage and concentrate recorded higher values than those fed on exclusive forage or concentrate.

2.4 Nutrition

Proper feeding will influence the rabbit's growth, fertility and health. Rabbits are pseudo-ruminant animals because they have a unique nutritional system when compared to other monogastric animals such as poultry, pigs and dogs. Rabbit have high potentials of utilizing feeds that are high in crude fiber. Their feeds also contain other feed ingredients such as crude protein, ether extract, mineral (ash), vitamins and carbohydrates (Henry *et al,* 2013). They can digest cellulose anaerobically with the help of microorganisms present in their enlarged caecum similar to the action that takes place in the rumen of ruminants. Cellulose digestion occurs in the hind gut, the large intestine and colon are modified so that absorption of the nutrients generated can occur (De Blas and Wiseman. 2003). Meanwhile, the hind gut basically absorbs moisture in other animals. For this reason, they are also referred to as hindgut fermenters. Rabbits and horses practice coprophagy (eating faeces) because the faeces formed from food passing through the gut the first time is highly rich in protein and vitamins B-complex (Babayemi *et al.,* 2006).

2.5 Nutrient Requirement of Rabbits

The rabbit is a monogastric herbivore with simple stomach that can survive on forage only however for better growth, there's need for their forage to be supplemented with concentrates that can be fed in meal or balanced pelleted rabbit's feed that contains (3 - 35g) dry matter per kg of live weight per day. Rabbits require

the following nutrients; carbohydrates, fibre, protein, fat, vitamins minerals and water.

2.5.1 Carbohydrates

Carbohydrate mainly provides energy for the rabbits and can be gotten from grains such as maize which is included in the concentrate of the rabbit's diet. Minute quantity from fresh forage and hay fed to the rabbit also provide carbohydrate (Olorunsanya *et al.*, 2007). Also the volatile fatty acids such as acetate, butyrate and propionate that are produced by bacteria present in the caecum are absorbed into the blood stream and as well used as source of energy.

The energy requirement for various productive function (growth, gestation and lactation) has not been given much attention, like most animals, rabbits voluntarily adjust their feed intake to meet their energy needs. According to Frederick (2010), daily energy intake can be regulated if dietary digestible energy concentration is above 2250 kcal/kg, although energy is not a nutrient, it is a property of fats, carbohydrates and proteins when they are oxidized during metabolism. The energy requirement by rabbits for organic synthesising is usually supplied by carbohydrates and to a lesser extent by fats. Where there is excess of protein, when delaminated it helps to supply energy (Frederick, 2010). Several factors influence the energy requirement of rabbits (Lamidi and Akilapa, 2013.These include environment (temperature, humidity, and air-movement) and productive function (age, body size, growth, lactation, maintenance and sex). As temperature decrease, the rabbit requires more energy to maintain normal body temperature (NRC. 1995) and to compensate for this increased energy, therefore the energy content of the ration must be increased or intake level of feed must be increased.

Maertens *et al.* (2003) in different experiments recommended energy levels of between 350-430 Kcal/g digestible energy per day for various stages of rabbit growth, while Aduku and Olukosi (1990) and Adeyemi and Abubakar (2011) recommended between 2390 to 2800 kcal digestible energy per kg of feed. Hermida (2006) reported that rabbit require a diet of 2200 kcal/kg or 2.2 kcal/g. Average maintenance energy requirement determined in growing rabbits is about 100 kcal DE/kg (Maertens, 2003) .The author went further to report that in breeding rabbits, a general recommendation is that the feed should contain 2600-2700 kcal/kg metabolizable energy, DM or 65-66 % TDN, or 2.0-3.0 MJ ME/kg DM. Kellams and Church (2006) reported that digestible energy levels of typical rabbit diets are quite low, between the range of 2400-2800 kcal/kg weight diet. They further indicated that higher energy levels result in reduced energy intake and impaired performance.

2.5.2 Protein

Increasing the dietary protein concentrate, increases the proportion of lean carcass and increasing energy concentrate increases the proportion of carcass lipid (Raharjo *et al.,* 1986) for rapid growth, rabbits are dependent upon adequate quantities of dietary essential amino acid.

Aduku and Olukosi (1990) indicated that rabbits can adapt to poor protein situation though their production level will not be optimal. Within the tropical environment, particularly in Nigeria, dietary protein supplementation ranging from 16-22 % have been observed to ensure adequate levels of weight gain, maintenance and high production levels (Omole *et al*., 2007; Fasanya and Ijaiya, 2002).

Rabbit makes its own particular proteins from the proteins and amino acids it o obtains from its food (Kellems and Church 2006). The ten essential amino acids which must be provided in the diets if the rabbit is to survive and grow are; lysine, methionine, arginine, phenylalanine, histidine, valine, threonine, tryptophan, leucine and isoleucine (Fielding. 1991).

Fielding (1991) reported that for rabbits, the recommended crude protein level in the dry matter of the ration is over 18% for newly weaned rabbits; 16-18 % for rabbits from 12-24 weeks; 15-17 % for breeding does and 12-14 % for all other stock. The protein requirements of 12-17 %, lysine 0.66 % and methionine 0.60 % can easily be met by combining common animal protein sources (Aduku and Olukosi 1990).

Protein intake by most of domestic animals is highly dependent on the quantity available to them and the dietary energy level. Though the utilized ingredients are products of protein hydrolysis i.e. amino acids (Kennedy and Hernnerberge, 1974, Lebas (1975). This implies that feed stuff that can readily and efficiently have their protein hydrolyzed will be quite beneficial and rewarding in the provision of amino acid needs of rabbits. Martins and DeGroote (1994) reported the levels of digestibility of protein from some plants and leguminous crops such as soya beans, groundnut, full-fat soya, oats, barley and other grains and that these crops are capable of providing the required amino acids for rabbits.

2.5.3 Fat

Fat helps in the maintenance of energy in animals. About 3 % of fat is recommended in rabbits diets, dietary fat is well utilized by rabbits to improve diets palatability and increases energy level without causing carbohydrate overload of the hindgut (Pond *et al.*, 1995). Fat requirement for rabbits as suggested by Berge et *al*., (1984)

and Ekpeyong, (1985) are within the range of 2-5 % of feed. Aduku and Olukosi (1990) however reported that rabbits can tolerate fat levels of up to 5 % without any type of adverse effects on growth. Fats provide energy as well as supplying essential fatty acids, namely linoleic acid and arachidonic acid. Fat also provide palatability, satiety and reduces dustiness in feeds.

2.5.4 Minerals vitamin

Minerals are required in minute quantities in animal diets (Roberts *et al.,* 2013). Rabbits require mineral elements which are needed in relatively large quantities e.g. calcium, potassium, phosphorus, magnesium and sodium, or in minute quantities (micro elements) e.g. iron, molybdenum, zinc, fluorine and silicon. Pond *et al.* (1995) stated that the major mineral elements of concern in rabbit diet formulation are calcium and phosphorous (C and P), and that the other minerals are usually provided in adequate amount by the ingredients used plus the addition of trace mineralized salt. Studies on the calcium and phosphorous requirements of growing rabbits have shown that they need these minerals much less than lactating does. The amounts excreted through the milk are significant. However, excesses of calcium (>40g/kg) or phosphorous (>9g/kg) induce significant alteration of fertility and prolificacy or higher proportions of still births. Total dietary phosphorous intake ranging from 0.45% to 0.76% did not affect any of the does' reproductive performances (Lebas *et al*., 1990). The Ca: P ratio does not seem to be critical for rabbits (Lebas *et al.,* 1998) and is usually 2:1. However, rabbits can tolerate much higher ratios.

In the same vein, deficiencies of a number of vitamins such as fat soluble vitamins (A, D, E and K), nicotinic acid, choline and pyridoxine have shown to produce

clinical signs in rabbits (Lebas, 1980). Riboflavin, pantothenic acid, Biotin and vitamin C appear to be synthesized in the body via caecotrophy and so do not have to be supplied in feed. The vitamin A requirement of rabbits has not been adequately determined and a level of 10,000 IU/kg of diet is adequate while levels in excess of 40,000 IU/kg of diet may adversely affect production (Pond *et al.,* 1995).

2.5.5 Crude fibre

In spite of the fact that crude fiber does not serve as an efficient energy source for rabbits, there is evidence that dietary fiber may have beneficial effect. It is considered a nutrient to maintain gut motility. Aduku and Olukosi (1990) reported that about 12-15 % dietary fiber can minimize enteritis. Research reports from Gidenne and Jehl (2000) examined the effect of low fiber diets in rabbits, and observed that a sharp decrease in fiber level from 19 % to 9 % in the diet doubled the risk of digestive trouble. The population of cellulolytic bacteria decreased in the caecum, and the microbial ecology system in the caecum became unbalanced, which may cause death from diarrhea. The optimum level of crude fiber for growing rabbits is 13-14% (Lebas *et al.*, 1997).

2.5.6 Water

The classification of water as nutrient is quite controversial, though recent reports indicate that water is essential for all domestic animals. Water is the major component of the rabbit body, making up 70 % of the lean body mass Cheeke (1987) and Maertens (2003) reported that rabbits have higher water intake when compared to other domestic animals. This is likely to be so when the size and body weight of the animal are taken in to consideration. Restricted drinking water or limited drinking time leads to reduced feed intake that is directly proportional to the amount

of water being consumed (Szendro *et al.*,1988). They further reported that water and feed consumption varies with changes in temperature and humidity. As the average temperature rises above 20^0 C day and night, feed intake tends to drop, while water consumption increases. At high temperature (30^0 C and above), feed and water intake decline, affecting the performance of growing and lactating animals (Fernez-Carmona *et al.*, 1996*).*

2.6 Growth Response of Rabbits

Abdulmalik (1997) observed that growth rate of rabbits vary with factors such as sex, breeds, nutrition, litter size, parity and genetic makeup of individual. Raharjo *et al.* (1987) and Soaban (2019) recommended that tropical forages should be supplemented with concentrate in the diet of rabbits since feed intake, digestibility and nitrogen balance are higher for rabbits fed mixture of forage and concentrate diet than for those fed forage alone. Poor performance has also been attributed to depression in feed intake as a result of ambient temperatures in tropical regions..

According to Cheeke and Patton (1983), forage is very vital for rabbit growth, rabbits being capable of digesting leaf protein effectively. Bamgbose *et al*. (2003) reported that rabbits can perform well with mixed regime of forages and concentrates without any adverse effect on digestibility. lyeghe-Erakpotobor *et al*. (2002) observed significant effect of diets on intake of rabbits offered a combination of concentrate, grass and other forages. Rabbits fed fibrous diets compensate for low nutrient density of such diets through higher voluntary feed intake, Santoma *et al*. (1999).

2.7 Feed intake, Weight Gain and Feed Conversion Ratio

In a research study carried-out by Olorunsanya *et al*. (2010) on growth performance and carcass analysis-of broiler chickens fed graded levels of toasted *Albizia lebbeck* seed meal (TASM). The birds were fed a commercial starter ration for the first seven (7) days before given the experimental diets. The result showed that birds on the control diet had the highest feed intake which differed significantly ($P < 0.05$) from others except those fed 5 % TASM. Feed intake of birds fed 10, 15 and 20 % TASM diets were significantly ($P < 0.05$) lower than those on 0 and 5 % dietary levels. This indicate that any slight increase in TASM dietary level in broiler chicken diets above 5 % may not support growth and thus reduce weight gain. This may be due to decrease feed intake and inability of the birds to utilize the diets as a result of poor digestion and absorption. The result support Lowry, (1989) reports that the presence of anti - nutritional factors in this plant do limit feed intake. The dietary levels of TASM had a significant ($P < 0.05$) effect on feed conversion ratio of broiler chicken where birds fed 0 and 5 % had very close feed conversion ratio which differed significantly ($P < 0.05$) from those birds on 10 % TASM and above. The superior feed conversion ratio with lower values exhibited by 0 5 % dietary levels may therefore prove that birds on these dietary levels optimally utilize the feed consumed

2.8 Organoleptic Properties of Rabbit Meat

Organoleptic is defined as the bodily organ or sense used to perceive the combination of tastes (perceived by the mouth) and aroma (perceived by the nose).

Organoleptic as sensory evaluation is therefore a science that measures, analyses and interprets the reactions of the sense of sight, smell, touch, taste, texture of the products.

Practical interest in sensory evaluation is often focused on a number of issues; How to connect consumers hedonic information to weakness of products.

A - How to choose different testing methods with maximum power.

B - How to monitor panellist and evaluate panel training.

C - How to understand cultural and other sources of differences in the use of rating scales.

D - How to manage the vast amount of sensory and consumer data typically generated.

Sensory measurement in food science can roughly be divided according to its goals. As cited by Maryam (2014) consumer preference and acceptance testing (i.e. measuring how much human like, prefer, or accept a product with a view to predicting sales).

Akinnusi *et al*. (2007) observed significant difference ($P < 0.05$) only in the dressing percentage of the meat, when comparing the effect of different animal protein concentrates with forage on the carcass quality of rabbits. Carcass quality of rabbits is characterized by colour, tenderness, juiciness, flavour and marbling quality, which are direct effect of the animal protein concentrate of the diet and overall quality of fermented feed in general. Research carried out by Malik *et al*. (2011) on nutritional and organoleptic assessment of the meat of giant African l snail *(Archachatina magnata)* compare to the meat of other livestock species, (beef, rabbit and chicken) showed that meat of rabbit, chicken and beef were highly

accepted for their appearance and colour, juiciness and taste when boiled, fried and barbecued; whereas snail meat had a significantly lower acceptance ($P < 0.05$) among the respondents.

Apata *et al*. (2005) studied the taste panel socio -economic characteristics and organoleptic properties of rabbits meat cooked by five different methods and reported that the cooking methods did not have significant effect ($p > 0.05$) on the eating quality of rabbit meat. However, tenderness and juiciness were highest in roasted meat while flavour and overall acceptability were highest in fried meat.

The nine-point hedonic scale used by Vasanthakumar *et al*. (1999) in their study on effect of graded dietary levels of neem seed kernel cake on carcass characteristics of weaned rabbits. They reported that sensory attributes of pressure cooked meat with and without salt, were similar across treatment. They also reported that neem bitterness did not have any bitter taste or odour on the meat.

2.8.1 Parameters used in sensory evaluation

- Colour
- Tenderness
- Juiciness
- Flavour
- Overall acceptability.

A. Colour: This is an important quality in many foods. For any food to be acceptability by an individual, the colour or appearance must attract the retina of the eyes.

B. Tenderness: By feeling the texture of the meat, we are more sensitive to the physical state of the meat we eat as well as its flavour e.g. a gritty or hard, soft texture can be felt.

C. Taste sensation: This deals with the hidden aspects of quality such as nutritive value and wholesomeness. Consumers are becoming aware of the nutritive value of food and food packs are beginning to contain information concerning some of their component e. g the protein content of processed meat products. Taste is also concerned with the non- volatile components which are sweetness, saltiness, sourness and bitterness. These taste sensations are therefore responsible for chemical stimulation.

D. Flavour: This deals with flavour perceived in the nose either pleasant during or before consumption.

E. Overall acceptability: These are adopted in determining the degree of consumer acceptance for a product. The hedonic tests as cited by Maryam (2014) are designed to measure the degree of likeness for a product. The term "Hedonic" means having to do with pleasure. It is used where a panellist expresses his degree of likeness or dislike for a sample. The mid-point of a hedonic scale is neither like nor dislike.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

The research was carried out in the Rabbitry Multiplication Unit of the Ministry of Livestock and Fisheries Minna, Niger State. Minna lies between Latitude 9^0 30'N and Longitude $6^0$33E of the equator, the annual rainfall is between 1100 mm-1600 mm and a mean temperature of between 21 C 36.5 C`(Usman, 2011).

3.2 Source of Experimental Animals and Feed Ingredients

The experimental animals were sourced from the Rabbitry Multiplication Unit of the Niger State Ministry of Livestock Fisheries, Minna. Groundnut haulms were sourced from animal feed vendors, opposite Power Holding Company of Nigeria (PHCN) Office Minna. Concentrate fed were sourced from Sammy Agro ventures, behind U.K. Bello Arts Theatre, Minna.

3.3 Experimental Design

A completely randomized design (CRD) was used for the experiment. Fifty four (54) weaner rabbits aged 6-7 weeks with an average initial weights of 735.81g were randomly allotted to six (6) treatments comprising three (3) replicates per treatment with three rabbits per replicate.

Treatment one (T_1) which is the control, contained 100 % concentrate and 0 % groundnut haulms forage. Treatments two (T_2), three (T_3), four (T_4),five (T_5) and six (T_6) contained 80 % concentrate and 20% groundnut haulms forage, 60 % concentrate and 40 % groundnut haulms forage, 40 % concentrate and 60 %

groundnut haulms forage, 20 % concentrate and 80 % groundnut haulms forage, 0 % concentrate and 100 % groundnut haulms forage respectively.

3.4 Management of Experimental Rabbits

An open sided house was used for this study. Thus, rabbits were confined in constructed wire cages of 80 x 75 x 50 cm dimension in width, depth and height per replicate with net fittings. Prior to the beginning of the experiment, the house and cages were thoroughly washed with disinfectant (Formaldehyde) to destroy the prevalent microorganisms. Feeders and drinkers were placed in each cage for easy access by the animals. The rabbits were dewormed using albendazole in the dose of 20 mg/kg and repeated after 14 days, broad spectrum antibiotic and vitality were given in drinking water to protect them against any bacterial infection and to reduce stress Adeyam and Akanji (2012). The rabbits were acclimatized to the new environment for one week. The study lasted for twelve (12) weeks during which the rabbits were served with concentrate diets and groundnut haulms offered to animals in each replicate and one hundred grams of feed was served to each rabbit in a day with half (½) served between 7-8am daily and the remaining half (½) was served between 3-4pm daily. Water was also provided *ad libitum*. Left over feeds were recorded to determine the daily feed intake.

3.5 Data Collection

The following parameters were generated from daily and weekly recording in each of the feeding trials. The rabbits were weighed at the start of the experiment using weighing scale (Camry Emperors, 20kg× 50g) and subsequently on a weekly basis. Feed intake, weight gain, digestibility and feed conversion ratio were taken

3.5.1 Feed intake

On daily basis, 2700g of concentrate 2700g of forage (groundnut haulms) were weighed and given to each treatment of experimental rabbits. Likewise, the left over feed were weighed before a fresh ration was administered at the end of the study.

$$Feed\ intake\ (g/R) = \frac{quantity\ of\ feed\ served - quantity\ of\ \text{Feed refused}}{number\ of\ rabbits}$$

3.5.2 Daily weight gain

The rabbits were weighed with a weighing scale at the commencement of the experiment and at weekly intervals thereafter. The weight gain of each rabbit was determined using the formula.

$$Daily\ weight\ gain\ (g/R) = \frac{Final\ body\ weight - \text{initial body weight}}{Period\ (days)}$$

3.5.3 Feed conversion ratio

Feed conversion ratio (FCR) was calculated from feed consumed and weight gained for each replicate group by dividing the weekly feed consumption value by the respective weight gains of the replicate group for that week. This was determined using the following expression:

$$\text{F.C.R} = \frac{\text{feed intake (g)}}{\text{body weight gain (g)/week}}$$

Source: Esonu *et al*. (2010).

3.5.4 Digestibility trial

A 7-day digestibility trial consisting of the determination of feed intake and faeces voided on daily basis was conducted in the twelfth week of the experiment. A total of thirty six (36) rabbits were used. Two (2) rabbits were selected from each replicate. They were house individually in modified metabolic cages for a 2-day

adjustment period and after which droppings were collected for five (5) days. The animals were offered feed *ad-libitum* and total droppings collected were kept separately for each trial during the five (5) days period. Collected droppings from each replicate each day were weighed, preserved with boric acid, wrapped in aluminium foil paper and taken immediately to the laboratory for analysis. Dry matter, crude protein, crude fibre, ether extract, nitrogen free extracts and total ash were determined for both feed and faecal collections using the method of AOAC, (2006).

$$\text{Nutrient digestibility} = \frac{\text{Nutrient in feed consumed} - \text{nutrient voided in faeces}}{\text{Nutrient in feed consumed}} \times 100$$

Source: Gresakov (2016).

3.6 Carcass Evaluation

At the end of the experimental period, eighteen (18) rabbits were used for carcass evaluation. One rabbit from each replicate was randomly selected, weighed and starved overnight to clear the gut. The rabbits were slaughtered by cutting the jugular vein with a sharp knife. The tail close to the base was first removed and then the head, feet and pelt. During evisceration, the internal organs and other gut contents were removed and weighed individually. Then the dressed carcasses were weighed and expressed as percentage of the live weight. The organ weights were also expressed as percentage of the dressed weight as reported by Aduku and Olukosi (1990) thus

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

3.7 Sensory Evaluation

Meat samples were taken from thigh and fore limbs of eighteen (18) rabbits. They were collected after removing the flesh from the bone manually, cut into an average of 40g and labeled for identification. 5g of salt was added to the meat before being subjected to boiling and frying. The meat was steamed in water at a temperature of 75°C for 30 minutes in a pot using a gas cooker as described by Fasae *et al.* (2010). Twenty trained panelists were used in the assessment. The scoring was based on parameters stated on the scoring sheets that is color, flavor, texture, juiciness and tenderness. Bottled water was served to the panelists to rinse their mouth after tasting each sample to reduce carryover of taste from the previous sample. The panelists scored each sample on a nine- point hedonic scale as used by Vasanthakumar *et al.* (1999).

3. 8 Proximate Analysis

Sample of the experimental groundnut haulms (GNH) and concentrate were taken to Animal production laboratory at Federal University of Technology, Minna, for proximate analysis to determine dry matter, crude protein, crude fibre, ether extracts, and ash and nitrogen free extracts using the method of AOAC (2006) analytical procedure.

3.9 Feed Cost Benefits

The procedure of Abel et al (2015) was used to analyse the cost benefits as follows;

i. Concentrate intake (g). This is the percentage feed intake of concentrate (grower mash) from total feed intake.

ii. GNH intake (g). This is the percentage feed intake of groundnut haulms (GNH) from total feed intake.

iii. Conc. + GNH intake (g). Addition of concentrate intake with groundnut haulms (GNH) intake.

iv. Cost of feed (N). This is the cost of feed/bag from the number of kg/bag.

v. Cost of feed intake/rabbit). This is the total feed intake multiply by the cost of feed.

vi. Cost of feed/kg body weight gain. Multiply feed cost by feed conversion ratio.

3.10 Statistical Analysis

The statistical package for social science (SPSS, 2016) was used for analysing all the data collected during the study using one-way ANOVA. The sources of variation were the treatments. Means were compared where there's significant difference via Duncan multiple test.

CHAPTER FOUR

4.0 RESULTS

4.1 Proximate Composition of Groundnut Haulms and Concentrate (based diets) Fed to Rabbits

Table 4.1 shows the proximate composition of groundnut haulms and concentrate fed to rabbits. The moisture contents of GNH (12.43 %) and concentrate (10.60 %) that of crude protein content of groundnut haulms (21.00 %) and concentrate (20.00 %) were similar, the crude fibre content of groundnut haulms (49.33 %) was almost five times compared to the concentrate (10.0 %). A marked difference was also noted in both the fat and nitrogen free extracts of concentrate in comparison to those of groundnut haulms (0.63 % vs 16 % and 9.61 % vs 34.12 %).

4.2 Growth Performance of Rabbits Fed Varying Levels of Groundnut Haulms and Concentrate Based Diet

The results of growth performance of rabbits fed varying levels of groundnut haulms and concentrate based diets are presented in Table 4.3, There was no significant difference ($P>0.05$) in the initial body weight of rabbits used in the experiment. The final total body weight of rabbits in T3 (1831.34g), was significantly higher ($P<0.05$) than those rabbits in T5 (1718.77g) and T6 (1727.06g) but was comparable with T1 (1760.41g) and T4 (1773.26g). The rabbit in T1 (1033.30g), T2 (1000.01g), T3 (1100.12g) and T4 (1031.04g) have significant ($P<0.05$) higher body weight gain than the rabbits in T5 (986.33g) and T6 (991.51g).

The daily weight gain was significantly higher in T3 (13.40g) than those in T1 (12.30g) and T4 (12.27g) and were comparable to the rest in treatments group. The rabbits differed significantly ($P<0.05$) in daily feed intake across various treatments with the highest daily feed intake recorded for T4 (76.89g) and T3 (75.33g) while the lowest daily feed intake was recorded for rabbit in T6 (50.43g). The total feed intake showed significant difference ($P<0.05$) with the highest observed in rabbits in T2 (6263.43g), while lowest feed intake was observed in rabbits in T5 (4903.93g).

Feed conversion ratios were significantly ($P<0.05$) higher in T2 (6.26) and T1 (5.53), while the lowest feed conversion ratio were recorded for rabbits in T3 (4.83) and T5 (4.97). Rabbits in T4 (5.28) and T6 (5.24) did not differ significantly ($P>0.05$) in feed conversion ratio but were significantly ($P<0.05$) comparable to the feed conversion ratio of rabbits in any other group.

Table 4.1: Proximate composition of groundnut haulms and concentrate

Parameters	Groundnut haulms (%)	Concentrate (%
Moisture	12.43	10.60
Crude protein	21.00	20.00
Crude fibre	49.33	10.00
Ash	7.00	9.28
Fat	0.63	. 16.00 *
Nitrogen free extract	9.61	34.12

Table 4.2: Growth performance of weaner rabbits feds varying levels of groundnut haulms and concentrate based diets

Parameters (g)	T1	T2	T3	T4	T5	T6	SEM	P-value
Initial body weight	727.11	728.22	731.22	732.22	732.44	735.81	13.93	0.71
Final body weight	1760.41^{ab}	1740.06^{b}	1831.34^{a}	1763.26^{ab}	1718.77^{b}	1727.23^{b}	48.26	0.01
Total body weight gain	1033.30^{a}	1000.01^{a}	1100.12^{a}	1031.04^{a}	986.33^{b}	991.51^{b}	32.59	0.02
Daily body weight gain	12.30^{b}	11.90^{ab}	13.40^{a}	12.27^{b}	11.80^{ab}	11.74^{ab}	10.02	0.01
Total feed intake	5754.69^{ab}	6263.43^{a}	5320.12^{b}	5450.93^{b}	4903.93^{c}	5197.71^{b}	24.43	0.00
Daily feed intake	55.94^{c}	60.14^{b}	76.33^{a}	76.89^{a}	58.72^{b}	50.43^{d}	12.34	0.02
Feed conversion ratio	5.56^{a}	6.26^{a}	4.84^{b}	5.29^{ab}	4.97^{b}	5.24^{ab}	0.84	0.03

abc = means in the same row carrying different superscripts are significantly ($p<0.05$) difference.
T1=100 % concentrate and 0 % groundnut haulms (control)
T2=80 % concentrate and 20 % groundnut haulms
T3=60 % concentrate and 40 % groundnut haulms
T4=40 % concentrate and 60 % groundnut haulms
T5=20 % concentrate and 80 % groundnut haulms
T6=0 % concentrate and 100 % groundnut haulms
SEM=Standard error of means.
P-value=Probability value.

4.3 Nutrient Digestibility Coefficient of Rabbits Fed Varying Levels of Concentrate and Groundnut Haulms

The results of nutrient digestibility coefficient of rabbits fed varying levels of concentrate and groundnut haulms are presented in Table 4.3. The table shows significant ($p<0.05$) differences in digestibility's of all the parameters. However, the values of both dry matter and crude protein digestibility of rabbit in T1(91.44%,78.71%), T2(90.23%,76.23%) T3(90.14%,75.94%) and T4(89.56%,76.66%) were higher than those in T5(84.45%,66.95%) and T6 (8266%,54.47%) respectively, while digestibility of rabbit of crude fibre T3(85.16%), T4(85.66% T5(88.79%) and T6(89.19%) were significantly higher ($P<0.05$) than those in T1(69.02%) and T2(77.39%). The T1 (74.73%) in ash are higher than other treatments group with T6 (40.17%) been the least. The values of fat and NFE show that rabbit fed T1 (92.06%, 76.12%) ration respectively had better digestibility of these nutrients over other rabbits in other groups.

4.4 Carcass Characteristics of Rabbits Fed Varying Levels of Groundnut Haulms and Concentrate Based Diets

The results of carcass characteristics of rabbits fed varying levels of groundnut haulms and concentrate based diets are presented in Table 4.4. There were significant differences ($P<0, 05$) observed in most parameters. The value of live weights for rabbits fed diets T1 (1110.00), T2 (1148.00), T3 (1062.70) and T4 (1176.70) differ significantly ($P<0.05$) from those rabbits in diets T6 (782.67) but were observed to be statistically the same with those in diets T5 (910.33). The carcass weights of rabbits in diets T1 (968.33) and T4 (906.00) were found to be

significantly higher (P<0.05) in values over those in T2 (875.67), T3 (799.00), T5 (698.67) and T6 (624.67). In the dressed weights and dressing percentage, rabbits in T1 (891.33, 80.82) respectively differ significantly from those in the other treatments. Similarly the neck values of rabbits in T1 (3.45) differed significantly from those in T6 (2.51) but statistically the same with those in other treatment groups. The finding in this trial showed significant (P<0.05) weight differences in the foreleg of rabbits in the various treatment groups with rabbits in diets T3 (12.20) been the highest.

Table 4.5. **Organs of Rabbit Fed Varying Levels of Groundnut Haulms and Concentrate Based Diets**

The offal's shows no significant difference (P<0.05) across various dietary treatments (P<0.05). However, rabbits in T1 showed higher values in liver (2.85), kidney (1.15) and spleen (0.30), although there are no significant difference (P>0.05).

4.6 Sensory Characteristics of Rabbit Meat Fed Varying Level of Groundnut Haulms and Concentrate Bases Diets

The results of sensory characteristics of rabbits meat fed varying levels of groundnut haulms and concentrate based diets are presented in Table 4.5. The result showed that there was no significant difference (P>0.05) in the colour and juiciness, however the table shows that flavour, tenderness and overall acceptability each differed significantly (P<0.05) across the dietary groups.

Table 4.3: Nutrient digestibility of rabbits fed varying levels of groundnut haulms and concentrate based diets

Parameter (%)	T1	T2	T3	T4	T5	T6	SEM	P-Values
Dry matter	91.44^{a}	90.23^{a}	90.14^{a}	89.56^{a}	84.45^{b}	82.66^{b}	2.45	0.02
Crude protein	78.71^{a}	76.23^{a}	75.94^{a}	76.66^{a}	66.95^{b}	54.47^{c}	2.14	0.00
Crude fiber	69.02^{c}	77.39^{b}	85.16^{a}	85.66^{a}	88.79^{a}	89.19^{a}	1.87	0.01
Ash	74.73^{a}	72.60^{ab}	68.51^{cd}	63.03^{d}	45.32^{e}	40.17^{e}	3.29	0.02
Fat	92.06^{a}	91.47^{a}	84.00^{b}	82.89^{b}	49.15^{c}	43.38^{c}	4.87	0.01
NFE	76.12^{a}	69.23^{b}	68.51^{b}	49.15^{c}	57.79^{c}	57.76^{c}	1.88	0.02

abc means on the row having different superscripts differ significantly ($p<0.05$):
SEM = standard error of mean; NFE = Nitrogen free extract.
T1 = 100% concentrate and 0% groundnut haulms (control),
T2 = 80% concentrate and 20% groundnut haulms,
T3 = 60% concentrate and 40% groundnut haulms,
T4 = 40% concentrate and 60% groundnut haulms
T5 = 20% concentrate and 80% groundnut haulms,
T6 = 0% concentrate and 100% groundnut haulms.
P – Value =Probability value.

Table 4.4: Carcass Characteristics of rabbits fed varying levels of groundnut haulms and concentrate based diets.

Parameter (g)	T1	T2	T3	T4	T5	T6	SEM	P - Value
Live weight (g)	1110.00^{a}	1148.00^{a}	1062.70^{a}	1176.70^{a}	931.6^{ad}	782.67^{b}	15.84	0.03
Slaughter weight (g)	1090.00^{a}	1121.30^{a}	1025.70^{a}	1113.70^{a}	910.33^{ab}	763.33^{b}	32.67	0.00
Carcass weight (g)	968.33^{a}	875.67^{ab}	799.00^{abc}	906.00^{a}	698.67^{bc}	624.67^{c}	42.17	0.02
Dressed weight (%)	891.33^{a}	703.33^{bc}	582.00^{cd}	748.67^{b}	535.00^{d}	464.00^{d}	38.31	0.01
Dressing %	80.82^{a}	61.42^{b}	55.71^{b}	64.14^{b}	57.60^{b}	59.36^{b}	2.55	0.02
Neck (%)	3.45^{a}	3.12^{ab}	2.76^{ab}	2.30^{ab}	2.45^{ab}	2.51^{b}	0.74	0.03
Tail (%)	0.45	0.59	0.52	0.49	0.48	0.83	0.21	1.08
Head (%)	9.69	10.23	10.26	9.86	10.10	11.70	2.21	0.10
Fore Leg (%)	9.33^{b}	11.22^{ab}	12.20^{a}	11.70^{ab}	9.68^{ab}	10.30^{ab}	0.62	0.02
Hind Leg (%)	12.91	17.33	15.97	15.16	14.25	14.12	1.47	1.03
Cevico thoracic region (%)	8.17	11.20	8.94	12.98	9.43	8.99	4.10	1.03
Lumber sacral region (%)	13.67	12.8	13.24	11.11	11.96	10.73	1.82	0.00

SEM=Standard Error Mean
P-value=Probability value,
TI=100 % concentrate and 0 % groundnut haulms (control),
T2=80 % concentrate and 20 % groundnut haulms,
T3=60 % concentrate and 40 % groundnut haulms,
T4=40 % concentrate and 60 % groundnut haulms,
T5=20 % concentrate and 80 % groundnut haulms
T6=0% concentrate and 100 % groundnut haulms

Table 4.5**:** Organs of rabbit fed varying levels of groundnut haulms and concentrate based diets

Parameter (g)	T1	T2	T3	T4	T5	T6	SEM	P - Value
Heart (%)	0.36	0.35	0.39	0.29	0.40	0.39	0.21	0.09
Liver (%)	2.85	2.11	2.15	1.91	2.73	2.48	0.10	0.12
Kidney (%)	1.15	0.62	0.62	0.66	0.64	0.62	0.21	0.09
Lungs (%)	0.61	0.46	0.41	0.57	1.26	0.74	0.57	0.13
Intestine (%)	21.11	21.07	20.54	20.42	22.63	25.17	0.62	1.03
Spleen (%)	0.30	0.27	0.29	0.23	0.22	0.26	0.31	0.67
Fur (%)	11.67	9.63	11.27	11.70	11.00	10.20	0.62	1.01

abc= means in the same row carrying different superscripts are significantly ($p<0.05$) difference.
SEM=Standard error mean
P- value = Probability value
TI=100 % concentrate and 0 % groundnut haulms (control)
T2=80 % concentrate and 2 0 % groundnut haulms
T3=60 % concentrate and 40 % groundnut haulms
T4=40 % concentrate and 60 % groundnut haulms
T5=20 % concentrate and 80 % groundnut haulms
T6=0 % concentrate and 100 % groundnut haulms
Percentage (%) = expressed as proportion of carcass weight

Table 4.6**:** Sensory characteristics of rabbit meat fed varying levels of groundnut haulms and concentrate based diets

Parameter (g)	T1	T2	T3	T4	T5	T6	SEM	P – Value
Colour	8.33	7.67	7.67	8.00	7.67	7.33	0.47	0.82
Juiciness	8.67	8.67	8.00	7.67	7.67	7.67	0.66	0.71
Flavour	8.33^{a}	7.33^{ab}	7.33^{ab}	7.00^{b}	7.67^{ab}	7.33^{ab}	0.67	0.02
Tenderness	6.67^{a}	7.00^{ab}	6.00^{b}	6.67^{b}	6.00^{b}	6.33^{b}	0.47	0.02
Overall Acceptability	8.67^{a}	8.33^{ab}	7.67^{bc}	7.33^{bc}	7.33^{bc}	7.00^{c}	0.62	0.02

abc=means in the same row carrying different superscripts are significantly ($p<0.05$) difference.
SEM=Standard Error Mean
P-value = Probability value
T1=100 % concentrate and 0 % groundnut haulms (control)
T2=80 % concentrate and 20 % groundnut haulms
T3=60 % concentrate and 40 % groundnut haulms
T4=40 % concentrate and 60 % groundnut haulms
T5=20 % concentrate and 80 % groundnut haulms
T6=0 % concentrate and 100 % groundnut haulms

4.7 Cost Benefits of Rabbits Production Fed Diet Containing Varying Levels of Concentrate and Groundnut Haulms.

The cost benefits of the experiment is presented in Table 4. 7. It shows that the cost of feed varied significantly ($P<0.05$) among the treatment groups. Cost of feed of rabbits was decreasing as groundnut haulms increased over concentrate. It was observed that T1 (100% concentrate) had the highest cost of feed per kg body weight gain of ₦778.40, while T6 (100% groundnut haulms) had the lowest cost of feed per kg body weight gain of ₦209.60.

4.7 Cost benefits of producing rabbit fed diet containing varying levels of concentrate and groundnut haulms

Parameter (kg)	T1	T2	T3	T4	T5	T6	SEM	P-Value
Concentrate intake (g)	5754.69^{a}	5010.74^{ab}	3192.07^{b}	2180.37^{c}	1089.54^{d}	0	34.04	0.04
GNH intake (g)	0	1256.67^{d}	2128.05^{c}	3270.56^{b}	4158.17^{ab}	4903.93^{a}	61.43	0.03
Conc + GNH intake (g)	5754.69^{ab}	6263.43^{a}	5320.12^{b}	5450.93^{b}	5247.71^{b}	4903.93^{c}	70.02	0.03
Cost of feed/kg(N)	140^{a}	120^{ab}	100^{b}	80^{c}	60^{d}	40^{e}	4.04	0.02
Cost of feed Intake/rabbit	805.66^{a}	751.61^{ab}	532.01^{ab}	436.07^{c}	311.86b^{c}	196.16^{d}	41.04	0.02
Cost of feed/kg body weight gain	778.4^{a}	751.2^{a}	483^{b}	422.4^{b}	298.2^{c}	209.6^{c}	32.41	0.01

abc=means in the same row carrying different superscript are significantly ($p<0.05$) difference.
SEM=Standard Error Mean
P-value=Probability value
GNH-Groundnut haulms
Conc- Concentrate.
T1=100 % concentrate and 0 % groundnut haulms (control)
T2=80 % concentrate and 20 % groundnut haulms
T3=60 % concentrate and 40 % groundnut haulms
T4=40 % concentrate and 60 % groundnut haulms
T5=20 % concentrate and 80 % groundnut haulms
T6=0 % concentrate and 100 % groundnut haulms

CHAPTER FIVE

5.0 DISCUSSION

The crude protein values (20.00 %, 21.00 %) recorded for concentrate and groundnut haulms respectively in this experiment was within the range reported by Fielding (1991), who reported that weaner rabbits require over 18 % crude protein, The crude fibre in this experiment (10.00 %) for concentrate was within the same range as that reported by Johnson and Delany (2009), while crude fibre in the experiment (49.33%) for groundnut haulms was higher than the range reported by Johnson and Delany (2009), who recommended crude fibre levels of between 10-16 % for the growth and lactation of rabbits. The value of fat content for concentrate (16.00 %) in this work, was higher than the recommended values of 2-5 and 3-5.5 for rabbits as reported by Ograin (2011) and was lower in groundnut haulms (0.63) obtained in this work. The value of Nitrogen free extract of concentrate obtained in this experiment (9.61%) was in the same range as (9.57%) reported by Uwalaka *et al.* (2013) and was lower than the value obtained for concentrate (34.12) in this experiment.

In daily body weight gain ,the significant ($P<0,05$) differences observed among the treatment groups favour the rabbit fed 60 % concentrate and 40 % groundnut haulms in final body weight and body weight gain. This agrees with the work of Soaban (2019) who observed that rabbits fed mixture of forage and concentrate recorded higher values than those fed forage or concentrate only. And also agrees with the work of Adeyemi *et al*. (2014) who recommended that for optimum performance, rabbits should be fed 50 % of concentrate and 50 % of forage.

There is significant difference ($P<0.05$) in nutrient digestibility recorded in all the parameters examined, and this also agrees with Soaban, (2019) who reported that rabbit shows higher digestibility values in all the parameters.

The non-significant differences (P>0.05) observed on part of carcass cut and organs proportion of live weight could means that the percentage inclusion of concentrate and groundnut haulms in the mixture has no negative effects. This is in line with the work of Bamgbose *et al.* (2003) who also observed non-significant difference on rabbit fed concentrate and forage. All the organs of the rabbits fed varying levels of concentrate and groundnut haulms diet shows no significant (P<0.05) differences, this could be that the percentage mixture of the diets has no effect on the physiological and anatomical elements of their organs and this agrees with the work diets of Apata, (2019) who also observed no significant difference (P<0.05) in liver, kidney and lung.

The result of organoleptic showed that rabbits on control diet T1 (100 % concentrate) was better accepted compared with T6 which was 100 % groundnut haulms, this might be due to the fact that, overall acceptability were significantly higher. While the significant difference (P< 0.05) in flavour, tenderness and overall acceptability, this is in line with Akinnusi *et al*. (2007) who on a similar study considered meat tenderness and juiciness as the most important palatability attributes of meat and that it is a critical eating quality which determine whether consumers are repeat buyers.

The cost of feed observed in this study tends to decrease as the groundnut haulms increased over concentrate. i.e. ₦140, ₦120, ₦100, ₦80, ₦60, ₦40. This agrees with the cost obtained by Akinmutimi (2006) in which the cost of feed decreased with increasing levels of inclusion (₦35.16, ₦30.10, ₦25.04, ₦20.45 and ₦14.19). The reason may be that, groundnut haulms are readily cheaper and affordable in this part of the country as compared to concentrate (grower mash) used in the experiment.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

1. The crude protein levels of concentrate (20.00 %) and groundnut haulms (21.00 %) are comparable, but crude fibre of groundnut haulms (49.33 %) are almost five times than the concentrate (10.00 %).

2 .Up to 60 % concentrate with 40 % groundnut haulms can be included in the diet of rabbits for optimal feed intake, body weight gain, live weight, slaughter weight, good appearance, flavour and overall acceptability of the meat

3. Increasing the levels of concentrate in diets of rabbits improves the digestibility, while groundnut haulms could be effectively utilized and tolerated by weaner rabbits up to 100 % inclusion levels with concentrate addition without any deleterious effect on the growth performance of rabbits.

4 Sensory characteristics such as colour, flavour and juiciness are similar between the treatment diets. Additionally, acceptability of rabbit meat fed only concentrate and those fed concentrate along with up to 80 % groundnut haulms are similar.

6.2 RECOMMENDATIONS

Farmers can feed 60 % concentrate with 40 % groundnut haulms to weaner rabbits for better feed conversion ratio, body weight gain and feed intake.

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