PERFORMANCE OF WEANER RABBITS FED MAIZE HUSK BASED DIETS WITH AND WITHOUT ENZYME SUPPLEMENTATION

BY

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A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL, AHMADU BELLO UNIVERSITY, ZARIA IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN ANIMAL SCIENCE

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DECLARATION

I hereby declare that this thesis titled "Performance of weaner rabbits fed maize husk diets with and without enzyme supplementation" was written by me as a record of my research work and was supervised by Prof A. A Sekoni and Prof T. S. B. Tegbe. The information derived from literature was duly acknowledged in the text and in the list of references provided. No part of this thesis has been previously presented for another Degree or Diploma at any University.

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KURTONG Domshak Alfred **Date**

CERTIFICATION

This thesis titled "Performance of weaner rabbits fed maize husk diets with and without enzyme supplementation" by Kurtong, Domshak Alfred meets the regulation governing the award of the Degree of Master of Science of Ahmadu Bello University, Zaria and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This project is dedicated to God Almighty who gave me grace and strength to complete this study successfully and to my dear parents Mr. and Mrs. Alfred .V. Kurtong who were the engine that propelled me to this platform of success.

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ABSTRACT

Two experiments were conducted to evaluate the performance of weaner rabbits fed maize husk based diets with or without enzyme supplementation. In the first experiment, thirty six weaner rabbits were used for the study. Maize husk replaced rice offal at 0, 4, 8, 12, 16 and 20% inclusion levels for treatments one to six respectively. Each treatment consisted of six rabbits and each rabbit served as a replicate in a completely randomized design. In the second experiment, each treatment consisted of six rabbits and each rabbit served as a replicate in a completely randomized design. The experimental diets consisted of 20% maize husk supplemented with enzyme at 0.00, 0.02, 0.03 and 0.04% for treatments one to four respectively. Maize husk had significant ($P<0.05$) effect on final body weight, average daily weight gain, feed conversion ratio and feed cost per kg gain. Packed cell volume (PCV) and haemoglobin level (Hb) were not significantly affected ($P>0.05$) by dietary maize husk. However, total protein (TP) was significantly affected. Crude protein, crude fibre, ether extract and nitrogen free extract significantly decreased ($P<0.05$) with increasing levels of maize husk. Thigh, skin, dressing percentage, slaughter weight and dressed weight significantly ($P<0.05$) declined with increasing levels of maize husk. In all parameters studied, the best results was obtained for rabbits fed 4% maize husk while the poorest result was obtained for rabbits fed 20% maize husk. In the second experiment, twenty four weaner rabbits were used. Rabbits fed diets supplemented with 0.02% enzyme gave the best results in average daily weight gain, feed conversion ratio, and feed cost per kilogram weight gain, nutrient digestibility and carcass evaluation. This performance declined as the levels of enzyme supplementation increased. It was therefore concluded that weaner rabbits can tolerate up to 4% maize husk in their diets. This inclusion level could be increased up to 20% if enzyme is supplemented at 0.02% level.

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CHAPTER ONE

1.0 INTRODUCTION

Inadequate animal protein in the diets of people in developing countries has called for the integration of some micro livestock in the farming system as sources of animal protein. Productivity of these livestock will depend to a large extent on their ability to utilize feeds that have no value in human diets. Increased rabbit production is one way of meeting the animal protein requirements of the Nigerian populace (Iyeghe-Erakpotobor *et al.,* 2002). Increased production of breeders can be ensured through proper nutrition and feeding of weaner rabbits. Supply of meat always remains a major constraint in animal production due to the ever increasing cost of conventional feedstuffs occasioned by the competition between man and livestock (Amaefule *et al*., 2004). The key to abundant animal production is the availability of cheap and balanced feed. Feed dictates how many animals you can grow and how fast they can mature for the market (Aduku, 1992).

Weaner rabbits require 2400-2600 kcal ME/kg of feed 15% crude protein and 9-17% crude fibre (Aduku, 2005). The fibre requirement is higher than that of monogastric animals, because rabbits have a large caecum with microbial organisms which aid in the breakdown of the high fibre. Rabbits possess various attributes that are advantageous in comparism to other livestock, Taylor *et al.,* (1989) noted that rabbit meat is of excellent protein quality, low in total as well as saturated fat, cholesterol and sodium. Therefore, rabbit production is considered a good source of meat in the developing countries where there is an abundance of agro-industrial by-product feedstuffs.

The insufficient supply of feedstuffs at economic prices has continued to limit the production and thus, availability of animal protein in the diets of humans in the developing countries of the world. This situation has compelled animal nutritionists to intensity research into alternative feed sources to reduce cost of animal proteins (Raharjo *et al*., 1988). Rabbits have a number of characteristics that are advantageous to small holder subsistence integrated farming system. The traits include small body size, short generation interval, rapid growth rate, genetic diversity and high performance potential which make rabbits suitable as meat producing micro livestock in developing countries (Arijeniwa *et al*., 2000). For livestock production in Nigeria to be profitable one has to search for ways to reduce the cost of feed used in production through the use of non-conventional feedstuffs.

Maize husk is an example of non-conventional feedstuffs. It is the leafy fibrous sheath covering the corn ear which farmers remove and large quantities are left on the farm after harvest to be grazed by small and large ruminants. Maize husk is usually subjected to trampling, soiling and termite damage, with less than 50% being consumed by livestock (Munthali *et al*., 2000). Maize crop residues compared with other cereal residues produce the largest proportion of the total crop residues hence they serve as a major source of ruminant feed in Africa and Nigeria in particular (Tang *et al.,* 2006). Non-conventional feedstuffs are however bulky, low in digestible nutrients and high in fibre thereby posing a limitation to their use. These limitations can be overcome through enzyme supplementation of the fibrous feed materials which in turn aids digestion, improve nutrient uptake, prevent nutritional deficiencies and improve growth performance of the animals.

Mc Donald *et al*. (1995) reported that the digestibility and intake of highly lignified cereal crop residues may be improved by physical and biological treatment/processing. Several studies have been carried out on the use of exogenous enzymes in rabbit diets to improve nutrient utilization (Falcao-e- Cunha *et al*., 2007), reduce mortality (Garcia *et al*., 2005) and also improve feed conversion ratio (Eiben *et al*., 2004). In addition, enzyme supplementation increased serum glucose concentration and decreased cholesterol concentration. Colombatto *et al*. (2003) reported that enzyme supplementation in rabbit diet improved the impact of supplemented enzymes on ceacal fermentation thus, the enhancement in feed utilization. Gutierrez *et al*. (2002) also observed that enzyme supplementation in rabbit diet resulted in better digestibility of nutrients and improved feed conversion ratio. The aim of the study was to evaluate the performance of weaner rabbits fed graded levels of maize husk based diets with or without enzyme supplementation.

1.1 Justification of study

Literature abounds on the use of maize crop residue in rabbit nutrition, some of which includes: the use of maize offal Vantsawa *et al*., (2007), maize Stover Jokthan *et al*., (2009) and maize bran Onakpa *et al*., (2011). However, not much study has been done on the use of maize husk in rabbit diet. Consequently, the study was carried out to evaluate the performance of weaner rabbits fed maize husk based diets with and without enzyme supplementation.

1.2 Objectives of the study

1. To evaluate the performance characteristics, nutrient retention, carcass characteristics and hematological parameters of weaner rabbits fed diets in which maize husk replaced rice offal.
2. To evaluate the performance characteristics, nutrient retention, carcass characteristics and hematological parameters of weaner rabbits fed maize husk based diets supplemented with graded levels of enzyme.

1.3 Hypotheses

H_O1: Diets in which maize husk replaced rice offal has no effect on performance characteristics, nutrient retention, carcass characteristics and hematological parameters of weaner rabbits.

H_A1: Diets in which maize husk replaced rice offal has effect on performance characteristics, nutrient retention, carcass characteristics and hematological parameters of weaner rabbits.

H_O2: Enzyme supplementation on maize husk based diets has no effect on performance characteristics, nutrient retention, carcass characteristics and hematological parameters of weaner rabbits.

H_A2: Enzyme supplementation on maize husk based diets has effect on performance characteristics, nutrient retention, carcass characteristics and hematological parameters of weaner rabbits.

CHAPTER TWO

LITERATURE REVIEW

2.1 Origin and distribution of rabbits

The domestic rabbit, *Oryctolagus cuniculus* is a descendent of wild rabbits of southern Europe and North Africa (Brewer and Cruise, 1994). The rabbit is thought to have been discovered by Phoenicians when they reached the shores of Spain about 1000 BC. During this time the Romans spread the rabbit throughout the Roman Empire as a game animal. The Romans, like Spaniards of that time ate foetuses or newly born rabbits, which they called laurices. In their natural environment, rabbits are gregarious and prolific. They are completely herbivorous (eat only plants) and most actively forage in the twilight or in the dark.

Rabbits have been recognized to have a very important role to play in the supply of animal protein to humans, especially in tropical and subtropical areas (Carabano *et al.,* 2000). Moreover, rabbits occupy a midway between ruminants and monogastric animals and can effectively utilize cellulose rich feed with ration containing less than 20% grain (Fraga, 1998). Rabbits have short breeding cycle, high prolificacy and better feed conversion efficiency which logically place them just below poultry (Hasanat *et al.*, 2006). It was reported by Merino (1992) that world's production of rabbit meat was estimated to be 1.5 million tons per annum. This would mean *per caput* annual consumption of 280g per person per year. In Africa, the leading rabbit producing countries are Morocco and Nigeria and both countries were reported to produce about 20,000 to 99,000 tons of meat per year (Merino, 1992).

2.2 Nutrient requirements of the rabbit

2.2.1 Energy

The energy requirements for various functions (growth, gestation and lactation) have received little attention. Assuming that rabbits, like most animals voluntarily adjust their feed intake to meet their energy needs, the lack of precise data on energy requirements is perhaps of less concern in rabbit diet formulation than the lack of data on requirements of most other nutrients. Lebas (1975) studied the performance of growing rabbits fed diets of different energy content and reported that 9.5 kcal of digestible energy (DE) was required per gram of body weight gain, regardless of energy content of the diet. The data suggested that a level of 2,500kcal of DE per kg of diet will satisfy the energy needs for rapid growth (Lebas, 1975).

Rabbits can efficiently digest starch, the major carbohydrate in cereal grains. High-starch diets were reported to be incompletely digested by rabbit due to rapid transit time in the gastro intestinal tract GIT (McNitt *et al.*, 1996). Similarly, Stevens and Hume (1995) asserted that incomplete chemical digestion of starch fed to weaner rabbits resulted in rapid microbial fermentation. This is because excess starch in the gut resulted in an extremely rapid growth of microbes. If toxin-producing microbes primarily (*Clostridium spiroformes*) are present in the GIT, high levels of a starchy diet may result to enteritis or possibly death (McNitt *et al.*, 1996; Jenkins, 1999). Grains processed too finely can lead to rapid bacterial fermentation of the starch and cause enterotoxaemia, thus, a coarse grind is recommended.

2.2.2 Lipids

Lipids (fats or oil) are biological components soluble in organic solvents (Fernandez and Fraga, 1996). They can be classified as fatty acids, triglycerides, phospholipids, glycolipids, sterols, fat-soluble vitamins etc. Lipids fulfill many essential functions in the body such as providing basic materials for cellular membranes and lipoproteins, as precursor for biological components and source of vitamins A, D, E and K (Maertens, 1998). Rabbits require essential fatty acids such as linoleic and linolenic acids as building blocks for other unsaturated fatty acids (Fernandez and Fraga, 1996).

Signs of deficiency in essential fatty acids in rabbits include reduced growth, loss of hair, and changes in the male reproductive system which involves degenerative changes in the seminiferous tubules, impaired sperm development, and decreased accessory gland weights (Villamide, 1996).Cheeke (1974) observed a preference of rabbits on a diet with 5% corn oil over one with no added fat, there was a distinct preference for a diet with 10% added corn oil over one with 20% oil added. Arrington *et al.*, (1974) also observed better performance with fat levels of 11 and 14% than with 2.4 and 3.6%. It appears that there is no special problem associated with feeding of fat to rabbits. The level used in feeds is thus dictated by the prevailing economic relationship between fat sources and grains.

2.2.3 Protein

Many attempts have been made to determine the exact protein requirement of rabbits. Reports obtained so far have shown a dietary requirement for ten amino acids (NRC, 1995). Aduku and Olukosi (1990b) stated that the quantity and the quality of these amino acids were not critical in rabbits as in other animals such as poultry because rabbits practice coprophagy and can adapt to low or poor protein situations. De Blas and Mateo (1998) however reported that the amino acid supply through caecotrophy has for a long time been considered adequate to support essential amino acid requirements in rabbits fed conventional diets. In lactating does, the contribution of caecotrophy has been found to make up 0.17 % of the supply of sulphur amino acid, 0.18 % of lysine and 0.21 % of threonine (Nicodemus *et al*., 1999).

The most limiting essential amino acids in rabbit diets are methionine (and/or cystine) and lysine, immediately followed by threonine. A minimum of 5.4 g of total sulphur-containing amino acid /kg (4.0g digestible amino acid/ kg) was required to obtain adequate productivity in growing and non-reproducing rabbits. A higher level (6.3 g total amino acid/ kg and 4.9 g digestible sulphur-containing amino acid/ kg) was recommended for reproducing females to increase milk production, reduce the interval between parturitions and improve efficiency of feed utilization (Taboada *et al*., 1996). Recommended levels of lysine for lactation, maximum reproductive performance, maximum milk production and litter growth were 6.8, 7.6-8.0 and 6.0-6.4g total lysine/kg diets respectively (Taboada *et al*., 1994).

Various units are available for expressing protein requirements (De Blas and Mateos, 1998; Fraga, 1998; Carabano *et al*., 2000 and Garcia *et al*., 2005). Crude protein (CP) and apparent dietary protein (ADP) are the most commonly used units, for which both requirements and raw material composition are largely available (Villamide *et al*., 1998; Maertens *et al*., 2002). Rabbits have specific amino acid requirements and apparent faecal and true ileal digestible amino acids would be more reliable units. However, if increasing information is available on the amino acid concentrations of the most common raw materials it would give better information on feed inclusion levels and utilization (Carabano *et al*., 2008a). In practice, due to the chemostatic regulation of appetite in rabbits, nitrogen requirements are expressed in relation to dietary energy (DE) by the dietary protein (DP) which it directly correlated to body nitrogen retention and excretion.

2.2.4 Protein requirement for growth

In growing rabbits, dietary protein (DP) was estimated to be 2.9 g DP/ day/ kg LW0.75 (Partridge *et al*., 1989; Fernandez and Fraga, 1996; Motta Ferreira *et al*., 1996; Fraga, 1998). Lower DP has been found in a new strain of laboratory rabbits (2.11–2.14 DP/ day/ kg

LW$^{0.75}$), which was attributed to a lower basic metabolic rate (Lv *et al*., 2009). In non-reproducing adult rabbits, since specific information is lacking, the same figures as for growing rabbits may be used for DP, this vary with growth rate.

The efficiency of utilization of dietary protein intake for growth was estimated to be 0.56 (Partridge *et al*., 1989; Fernandez and Fraga, 1996; Motta Ferreira *et al*., 1996; Fraga, 1998). Overall dietary protein retention decreases linearly from 0.40 to 0.10 with increasing live weight, due to the increase in dietary protein used for maintenance (Xiccato and Cinetto, 1988; Maertens *et al*., 1997; Trocino *et al*., 2000, 2001). Lebas (1980) and NRC (1995) have recommended 12-13% crude protein for maintenance, 15-16 % for growth, 15-18 % for gestation and 17-18 % for lactation.

2.2.5 Protein and amino acids requirement

The importance of protein quality in rabbit nutrition is well recognized. For rapid growth, rabbits are dependent upon adequate quantities of dietary essential amino acids (NAP, 1977). Bacterial protein synthesis in the caecum has been demonstrated, but this protein, obtained by means of coprophagy, apparently does not make a large contribution to the essential amino acid needs of the young rabbit (NAP, 1977). The first amino acid shown to be a dietary essential was arginine (McWard *et al.*, 1967). The essential nature of arginine, methionine and lysine has been demonstrated by Fisher *et al.*, (1970) and Cheeke (1971). However, Adamson and Fisher (1973) have reported that the arginine requirement was over estimated in the initial studies.

Based on the above studies, there were general agreement for the following: arginine, 0.6%, lysine, 0.55%, and sulphur amino acids (methionine plus cysteine), 0.6% of the diet on as-fed basis. These levels will support a rapid growth rate of 35-40 g/day (NRC, 1995).In contrast to other simple-stomached animals, such as swine and poultry, the rabbit is able to utilize efficiently the protein in forage plants. Bacterial protein synthesized in the caecum has not been shown to contribute significantly to the growing rabbit's protein needs, though it may help to maintain nitrogen equilibrium in mature animals fed poor quality proteins. Kennedy *et al*., (1970) demonstrated that amino acids can be absorbed rapidly from the rabbit caecum. Crude protein levels of 16, 12, 15, and 17% were recommended for growth, maintenance, pregnancy, and lactation, respectively. These values assume the use of protein of good quality to meet the essential amino acid requirements (NRC, 1995).

2.2.6 Mineral elements requirement

Calcium and phosphorus are major constituents of bone, in addition calcium has metabolic roles in blood clotting, controlling excitability of nerve and muscle tissues and in the maintenance of acid base equilibrium while phosphorus is a component of such vital cellular constituents as ATP, DNA, RNA, and phospholipids. The absorption of calcium is influenced by its level in the diet and the dietary levels of phosphorus and vitamin D (Jenkins, 1999). Dietary requirements for calcium and phosphorus for rabbits have been estimated. Mathieu and Smith (1961) estimated the phosphorus requirement for growth to be 0.22% of the diet. In an intensive study of calcium requirements, Chapin and Smith (1967a) reported maximum growth with a dietary phosphorus level of 0.37%, when 0.22% calcium was in the diet, while 0.3 to 0.40% calcium was needed for maximum bone calcification.

Rabbits are tolerant to high dietary calcium levels. Chapin and Smith (1967b) found that diets containing as much as 4.3% calcium and a calcium: phosphorus ratio of 2:1 did not depress growth and resulted in normal bone ash. A higher phosphorus level beyond this was unpalatable causing feed rejection (Chapin and Smith, 1967c). In most mammals, less than 2% of dietary calcium is excreted in the urine, but in rabbits it is higher and can range from 45-75 %. Rabbits have an unusual calcium metabolism, absorbing calcium without vitamin D facilitation and activation of calcium-binding proteins in the gut resulting in excess calcium being excreted in the urine (McNitt *et al.,* 1996; Jenkins, 1999).

2.2.7 Water requirement

Water is essential as a constituent of all part of the body and without it, food cannot be digested. The maintenance of effective elimination of harmful products via the urine is dependent upon sufficient water, as it is also important in the maintenance of almost all other physiological processes. Gillespie, (1992) observed that rabbits need good supply of cool clean water at all times for the maintenance of health and rabbits usually consume 2-3 times more water than dry matter. Sanford, (1979) stated that water intake in rabbits was variable, it was higher in the young rabbits than in the old, thus a shortage of water in early life has more serious effect and even a restricted amount of water may seriously retard growth, although their water requirement can sometimes be satisfied by highly succulent rations (which is not generally desirable). He went further to recommend that it was preferable to supply fresh drinking water. Water consumption was affected by both hot and cool weather as well as salt content of the feed (Stephen, 1980). He further stated that under hot conditions feed intake reduces while water intake increases. Similarly, feed intake increases in cool conditions and water intake reduces. The decrease in water intake during cold conditions could reduce milk supply for suckling does and predispose the rabbits to digestive disorder.

2.3 Feeding behavior of the growing rabbit

From weaning (classically between 4 and 5 weeks), the daily feed intake of the domestic rabbit (fed a complete pelleted feed) increases in relation to metabolic live weight and stabilizes at about 5 months of age. It was observed that at 4 weeks a young rabbit eats 0.25% of the amount an adult rabbits eats, but its live weight is only 0.14% of that of the adult. When Belenguer *et al*. (2008) took reference from a 4 kg New Zealand white rabbit that was fed 140-150 g dry matter (DM) /day at 8 and 16 weeks they reported relative proportion in live weights were 0.62 and 1.10% respectively..

Weaning from (4–5 weeks) to 8 weeks of age gave the highest weight gain and feed conversion was optimal (Belenguer *et al.*, 2008). Like with other mammals, the rabbit regulates its feed intake according to energy requirements. Chemostatic mechanisms were involved, by means of the nervous system and blood levels of compounds used in energy metabolism (Gidenne and Lebas, 1987). In non-ruminants, however, blood glucose level plays a key role in food intake regulation, while in ruminants the plasma levels of volatile fatty acids have a major role. Since the rabbit is a non-ruminant herbivore, the main blood component regulating feed intake is not clear, but it is probably glucose (Lebas, 1973).

2.4 Challenges in the use of non-conventional feedstuffs for rabbit

Although non-conventional feedstuffs help to reduce dependence on conventional feed resources such as maize, however they are associated with many problems which limit their effective utilization when fed to rabbits (Medugu *et al.*, 2012). These include presence of anti-nutritional factors, seasonality of production, location and collection in relation to area of use, cost of processing and estimation of feeding value (Adebowale, 1983). Most non-conventional feedstuffs are high in fibre. Fibre levels of over 20% may cause caecal impaction and limit energy intake (Champe and Maurice, 1983). Also the presence of anti-nutritional factors has been found to have negative effects on absorption and utilization of minerals (Waghorn *et al.*, 1994). Abeke *et al.* (2003) reported that some anti-nutritional factors inhibit enzymes directly thereby forming complexes with nutrients thus, rendering them indigestible to proteolytic enzymes. Anti-nutrients such as tannins were responsible for an astringent taste of feed that induces lower intake due to reduced palatability (Butler *et al.*, 1986). Similarly, toxic factors such as cyanide in cassava and mimosine in *Leucaena* *leucocephala* were often present which could cause growth depression and mortality (Cheeke and Shull, 1985).

2.5 Strategies to improve the quality of non-conventional feedstuffs for incorporation in rabbit diet

2.5.1 Crop breeding

Genetic manipulation of many non-conventional feedstuffs can enrich the nutritive quality of the by-products derived from them thereby enhancing their usage in rabbit diets (Velmurugu, 1990). For example plant seed proteins can be modified to express proteins with a more desirable amino-acid composition. This was particularly important for animal feeds, where seeds engineered to produce a higher concentration of sulfur-containing amino acids could improve feed utilization (Heyer *et al.*, 1999). Plants may also be modified to produce proteins that aid in mineral nutrition, such as hemoglobin to improve iron uptake and other specific proteins to improve calcium uptake (Topfer *et al.*, 1995).

2.5.2 Feed processing

Feed processing is important when diets containing anti-nutrients are fed to monogastric animals (Akande *et al*., 2010). Feed processing can help to reduce the levels of anti-nutrients in plant feed sources to innocuous levels that can be tolerated by animals particularly in monogastric nutrition (Fasuyi and Aletor, 2005). Feed processing also provides for proper mixture of feedstuffs with supplements, increases nutrient digestibility, palatability and passage rates of ingesta. Processing methods such as cooking, soaking, fermenting, toasting, autoclaving etc could be employed to enhance the palatability of feedstuffs in rabbit diets.

2.5.3 Feed Additives

Diet formulation with non-conventional feedstuffs can affect nutrient digestibility and utilization by non-ruminants (Velmurugu, 1990). Hence the use of feed additives such as exogenous enzymes, fats or oil, synthetic amino acids, vitamin mineral premixes, growth promoters and also organic acids can help to enhance the nutritional quality of the feedstuffs (Rosen, 2006). Reports by Boling *et al.* (1998) and Radcliffe *et al.* (1998) have shown tremendous potentials on the use of organic acids to improve feed utilization by non-ruminant animals. Pinheiro and Gidenne (1999) reported that antibiotics modify the gut flora, suppress bacterial catabolism and reduce bacterial fermentation. Thus, leading to improved nutrient utilization and growth performance in rabbits. Maertens (1998) also reported that the use of probiotics in rabbit production is beneficial as it helps to encourage competitive growth against microorganisms, improve digestion, and also strengthen the rabbit’s immune defense.

2.6 Importance and uses of maize husk in animal feed

Maize husks left-over are either burnt or grazed by ruminants. These residues have been incorporated into ruminant diets to eliminate wastage and to improve uptake and utilization (Jokthan *et al.,* 2009). Maize husk may be relatively poor in nutritive value compared to some other locally available residues or roughages however it is composed of cellulose, hemicelluloses and lignin that encourages its utilization as energy source in ruminant diet.

2.7 Maize husk in rabbit nutrition

The ability of rabbits to utilize cheap and non -conventional feedstuffs is an important advantage over other monogastric animals. Rabbits can sufficiently degrade substantial amounts of fibre, making dietary fibre the main constituent of rabbit feed. Rabbits can digest 65-78% fibre consumed (Harris, 1969), their digestive tract is set up to digest cellulose in the form of tough, woody stem and fibrous vegetation due to the long digestive tracts that slowly break down cellulose and process it. This inherent quality of the rabbit makes maize husk inclusion in their diet a potential non-conventional feedstuff.

2.8 Role of fibre in rabbit nutrition

Available data showed that fibre is necessary in rabbit diets for normal functioning of the digestive tract. Rabbits require a level of crude fibre in excess of 9% for normal growth and to reduce the incidence of enteritis and diarrhea. In the study of Cheeke and Amberg (1972) it was observed that fibre levels exceeding 17% reduced energy intake. Low fibre levels predispose the animal to diarrhoea (Champe and Maurice, 1983). A crude fibre level of between 10-17% was found to support weight gain. A growth level of the 41.3g/day/animal was found to be adequate for crude fibre level of 14.8% as reported by Champe and Maurice (1983). It had been reported that rabbits were able to digest fibre relatively well, due to the presence of the caecum (Laplace, 1978). The author further stated that fibre and non-fibre components in the hind-gut were separated with the rapid excretion of the fibre in the hard faeces. The non-fibre components were digested efficiently because they were re-ingested as caecotropes and thus subjected to more than one passage through the digestive tract. It had been reported that with hind gut fermentation a high intake of high fibre diet can be achieved with nutrient requirement met by the high digestibility of non-fibre component (Laplace, 1978). Amongst factors that affect digestibility of feedstuffs, the most important factor is the amount of fibre it contains (Standford, 1979). Furthermore as the proportion of this constituent rises, the total digestibility and the individual digestibility of the various constituent of the feed fall. The reason advanced was that the fibre tends to protect the more digestible constituents from the digestive juices.

Rabbits eat hair from their body when fed low fibre diet in attempt to satisfy craves for fibre (Aduku and Olukosi, 1990b). Increase in dietary fibre help to reduce hair ball problem which reduces feed consumption. Feeding hay or other coarse roughages, also help to “sweep” hair from the stomach hence preventing hair ball disease which can block the opening of the stomach and ultimately lead to death due to starvation (Sandford, 1979).

2.9 Role of fibre in maintaining rabbit gut health

In critical role in maintaining gut health, stimulating gut motility (insoluble fibre only), reducing fur chewing, and preventing enteritis (McNitt *et al*., 1996; Brooks, 1997). It was reported by Cheeke (1994) that rabbits require a minimum dietary fibre level of 10 to 17% to maintain gut health. Diets with less than 10 to 17% fibre resulted in gut hypo motility, reduced caecotrophy, prolonged retention time in the hindgut and often enteritis as reported by Jenkins (1999). Thus, high-quality fibre was essential for gut health in rabbits (McNitt *et al*., 1996; Stein and Walshaw, 1996).

In rabbits, insoluble fibre have been widely recognized as the most important fibre fraction used to express fibre requirements and it accounts for about 65-90% of the total dietary fibre (TDF). Current recommendations stated that diets for rabbits should contain at rabbits, dietary fibre has a least 30% Neutral Detergent Fibre (NDF) and 16% Acid Detergent Fibre (ADF) (De Blas and Mateos, 2010). Lignin and to a lesser extent, cellulose remain largely undigested because their polyphenolic structure was not hydrolyzed by the bacteria in the rabbit caecum (Lebas, 1980). Lignin play a dominant role in the transit time in the gut, and increasing levels were associated with a significant reduction of the digesta retention time (Gidenne, 2003). Similarly, Gidenne *et al.* (2005) reported that hemicellulose and pectins were considered as digestible fiber because their digestibilities were 30 and 70%, respectively.

The retention time of hemicellulose and pectins in the caeco-colic segment was relatively short (8-12hr), thereafter these rapidly fermentable cell-wall polysaccharides play a key role in the rabbit digestive processes. Hall *et al.* (1997) asserted that uronic acid (a main constituent of the pectins) had been shown to modulate the fermentative activity and pH in the caecum . Hence a sufficient dietary content of these digestible fibers were necessary, in addition to the indigestible fraction, to optimize digestive health (Gidenne, 2010). In view of preventing digestive troubles, fibre requirements cannot be only based on insoluble fibre but also on soluble fibre.

2.10 Role of fibre in preventing digestive disorders in growing rabbit

The beneficial role of fibre in preventing digestive diseases was mostly based on the control of intestinal microflora through its effect on transit of ingesta and the availability of substrate for bacterial growth (Carabaño *et al.,* 2008a).Álvarez *et al*. (2007) asserted that a range of 10-17% dietary fibre reduced mortality, improved performance, reduced incidences of diarrhoea and also improved intestinal mucosal structure. De Blas *et al*. (1999) reported that insoluble fibre was necessary to decrease mean retention time of digesta in the gut, dilute dietary and ileal starch content. Similarly, García *et al*. (2000) reported that insoluble fibre helped to dilute protein content and also reduce total microbial growth. Consequently, the type of dietary fibre could be important in promoting the growth of beneficial microflora. Dietary inclusion of soluble fibre favoured the growth of intestinal villi and the activity of enterocytes while the inclusion of lignified fibre produced structural atrophy, lower activity of intestinal cells and proliferation of beneficial microflora. According to Marounek *et al.* (1995) the caecal microflora of weaner rabbits were limited compared to that of adults. Hence, caecal microbes in weaner rabbits were specialized in fermentation of soluble fibrous carbohydrates such as fructans, galactans, β-glucans and pectic substances.

The need for fibre was pertinent during the post-weaning period, low fibre intake without variations of fibre nature or origin resulted in lower growth rate two weeks after weaning (Gidenne and Jehl, 1999; Pinheiro and Gidenne, 1999).The rabbit thus attempts to increase its voluntary feed intake to satisfy energy needs and reduce feed conversion. When the dietary fibre level is very high (>25% ADF), the animal cannot increase its intake sufficiently to meet its energy needs, thus leading to reduced growth rate, but without digestive problems. Therefore, to reduce digestive troubles in the growing rabbit and also to preserve its growth performance, adequate quantity of fibre must be supplied (Álvarez *et al*., 2007).

2.11 Fibre digestion and degradation by rabbits

Traditionally, fermentation of dietary fibre had been considered to be a post-ileal activity of the endogenous microflora. However, there was evidence that some components of structural carbohydrates were degraded prior to entering the caecum of rabbits (Carabano *et al*., 2001). This had also been observed in other non-ruminant species such as pigs and poultry (Carabano *et al*., 2001). The extent of pre-caecal fibre digestion in rabbits varied from 0.07 to 0.19% for crude fibre (CF) (Yu *et al*., 1987), from 0.05 to 0.43% for NDF (Gidenne and Ruckebusch, 1989; Merino and Carabano, 1992) and from 0 to 0.37% for non-starch polysaccharide (Gidenne, 1992; Carabano *et al*., 2001).

It must be pointed out that the values obtained using (NDF) and CF with respect to those obtained with non-starch polysaccharide (NSP) might have been over estimated due to solubilization and filtration of cell wall components that would be considered digested (Bach, 2001). When NSPs were analyzed, arabinose and uranic acids which were typical monomers of pectin substances were found to be largely digested before the ileum (Carabano, 2001). On the other hand Bach (2001) reported that glucose and xylose which were monomers in most fibre sources had relatively low ileal digestibility. This implies that about 0.4% of total digestible fibre (including water-soluble NSP) was degradable before the caecum (Bach, 2001).

2.12 Role of Enzyme in Fibre Digestion and Utilization

Enzymes are proteins which are able to catalyze specific chemical reactions with a minimum energy waste (Chesson and Steward, 2002). Almost all processes in biological cells need enzymes at specific sites. Endogenous enzymes are naturally produced by the animal or by microbes present in the digestive tract. However specific activities necessary to break down some compounds in feed are not found or are at low levels in the digestive tract. Hence, exogenous enzymes are added to the diet to breakdown these compounds. Most animal feeds contain plant materials such as cereals and vegetable proteins that are not fully digestible by the animal's digestive system. Consequently digestion and utilization can be enhanced by addition of exogenous enzymes. Fasiullah *et al.* (2010) reported that exogenous microbial enzymes enhanced digestion of (NSP) breaking down cellulose, hemi-cellulose, pectins and lignified complexes thus leading to improved feed utilization and growth performance. Reports by Eiben *et al*. (2004), Garcia *et al.*(2005), Falcao-e-Cunha *et al.*(2007) and Bawa *et al.*(2009) showed that enzyme supplementation in rabbit diet significantly improved performance and nutrient digestibility.

Rabbits require enzymes to breakdown fats, cleanse the colon, maintain proper cholesterol levels and attain peak energy levels. Tawfeek (1996) reported that the use of enzymes in rabbit rations helped to improve the performance of rabbits by enhancing efficient nutrient utilization. It was also reported by Eiben *et al.* (2004) that exogenous fibrolytic enzymes can promote ceacal fermentation and modify volatile fatty acid concentration in rabbits thereby maintaining good health status. El-Latif *et al.* (2008) asserted that in order to obtain maximum benefits from exogenous enzymes, it was necessary to ensure that the enzymes were chosen on the basis of feed composition. Enzyme cocktails containing more than one enzyme will often improve the response compared to pure, single enzymes, assuming that cost considerations were not ignored.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Experimental site

The experiment was conducted at the Animal Farm of the Department of Animal Science, Ahmadu Bello University (ABU) Samaru, Zaria. The Departmental farm is located on longitude 11^0 $9^{'}$ $45^{''}$ N and latitude 7^0 $38^{'}$ $8^{''}$ E at an altitude of 610m above sea level (Ovimaps, 2012).

3.2 Source and processing of the maize husk

The chemical composition of maize husk used in the experiment is presented in Table 3.1. Maize husks were collected from boiled maize sellers within Samaru community area. The boiled maize husk was collected and sun dried to reduce the moisture content to 10%. The dried maize husk was chopped to smaller sizes using a cutlass after which it was taken to the food and nutrition Laboratory of the Department of Animal Science, Faculty of Agriculture, A.B.U., Zaria where it was milled for incorporation into the experimental diets at inclusion levels of 0, 4, 8, 12, 16 and 20% for treatments one to six respectively.

3.3 Proximate analyses

Feed samples for each of the six treatments were collected and taken for proximate analyses to determine the nutrient composition. The analysis of the maize husk and feed samples were carried out according to procedures described by A.O.A.C (1995). The dry matter (DM) content of the samples was determined based on the weight loss by oven drying at a temperature of 100^0C for 24 hours. The nitrogen content was determined by macro Kjeldhal method and protein content calculated as nitrogen multiplied by 6.25(Nx6.25). The ash content was determined as the residues remaining after incinerating the samples at 500^0C for

18hours in a muffled furnace. Similarly, crude fibre (CF) and ether extract (EE) were also determined according to procedures described by A.O.A.C (1995).

Table 3.1: Percentage Chemical Composition of Maize Husk

Nutrient	Percentage
Dry matter	95.25
Crude protein	2.61
Crude fibre	36.53
Nitrogen free extract	69.25
Ether extract	0.97
Ash	7.10

Source: Biochemistry laboratory, Department of Animal Science, A.B.U. Zaria.

3.4 Experiment 1:

Effects of graded levels of maize husk on the performance and carcass characteristics of weaner rabbits.

3.4.1 Proximate Composition of Maize Husk

The proximate compositions of maize husk is presented in Table 1

3.4.2 Experimental diets:

Six experimental diets were formulated to meet the nutritional requirements of rabbits. The diets contained 17% crude protein and 2512-2596kcal ME/kg diet for treatments one to six. Maize husk was included at graded levels of 0, 4, 8, 12, 16and 20% for treatments one to six respectively as shown on Table 3.2

3.4.3 Management of experimental animals and data collection

A total of 36 weaner rabbits that were five weeks of age with average initial weight of 503.12 grams were used for the study. Each treatment consisted of six rabbits and each rabbit was a replicate. The rabbits were randomly assigned in a completely randomized design. They were housed individually in wire cages of 40 x 60 x 60cm dimensions. They were provided feed *ad libitum* and had free access to water. The cages had wire screen base, which allowed faeces and urine to pass into a collection grid. The rabbits were allowed one week adjustment period before the feeding trial commenced. The rabbits were administered with ivomectin at 0.2mls per rabbit as a prophylactic measure against endo and ecto-parasites. The drinkers were washed daily before water was supplied. The rabbits were weighed weekly. The performance of rabbits was monitored in terms of feed intake, weight gain and feed to gain ratio. Mortality was recorded as it occurred throughout the trial period of 56 days (8 weeks).

Table 3.2: Composition of Weaner Rabbit Diets Containing Graded Levels of Maize Husk

	Treatments					
Ingredients (%)	**1**	**2**	**3**	**4**	**5**	**6**
Maize	42.38	42.7	41.73	41.4	41.06	40.75
Soybean cake	22.87	23.18	23.52	23.85	24.17	24.50
Palm kernel cake	11.00	11.00	11.00	11.00	11.00	11.00
Rice offal	20.00	16.00	12.00	8.00	4.00	0.00
Maize husk	0.00	4.00	8.00	12.00	16.00	20.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Premix**	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.10	0.10
Total	**100**	**100**	**100**	**100**	**100**	**100**
Calculated analysis						
ME(kcal/kg diet)	2512	2549	2586	2558	2559	2596
Crude protein (%)	17.00	17.00	17.00	17.00	17.00	17.00
Crude fibre (%)	10.95	10.65	11.12	11.40	11.61	11.91
Calcium (%)	0.89	0.87	0.86	0.86	0.87	0.86
Phosphorus (%)	0.62	0.61	0.61	0.60	0.61	0.61
Methionine (%)	0.73	0.72	0.71	0.70	0.70	0.70
Lysine (%)	1.12	1.11	1.10	1.11	1.12	1.12
Cost/kg diet(₦)	72.41	72.46	71.46	70.96	70.44	69.95

**Bio-premix supplied per kg of diet: Vitamin A, 12500I.U; Vit. D_3, 2500 I.U;Vit E, 50mg; Vit K_3, 2.5mg; Vit B_3.0mg; VitB_6 6.0mg; Niacin, 40.0mg; Calcium pantothenate 10.0mg; Biotin 0.8mg; VitB $_{12}$ 0.25mg; Folic acid 1.0mg; Choline chloride 300mg; Manganese 100mg; Iron 100mg; Zinc,50mg;Iodine 1.55I.U; Selenium 0.1mg.

3.4.4 Carcass evaluation

At the end of the 8 week feeding trial, carcass and blood evaluation were carried out. Three (3) rabbits representing the average weight of their treatments were selected for carcass evaluation. The rabbits were fasted for 24 hours prior to slaughter. They were bled by severing the jugular vein with the aid of a sharp knife after which their fur was removed by skinning. Removal of the internal organs and emptying of the gut followed which were then individually weighed. Dressing percentage was expressed as percentage of live weight. The skinned carcasses were cut up into retail cuts of loin, rack and ribs which were also weighed. The weights of the retail cuts and the internal organs were expressed as a percentage of the live weight at the point of slaughter for each rabbit.

3.4.5 Haematological evaluation

Blood samples (2mls) were collected from rabbit used for carcass evaluation for haematological studies. After the jugular vein was severed a sample bottle containing ethylene diammine tetraacetic acid (EDTA) was placed at the tip of the knife to collect blood samples. The samples were stored in a refrigerator prior to laboratory analyses. The blood samples were analyzed for total protein (TP), haemoglobin level (Hb), red blood cell count (RBC), white blood cell count (WBC) and pack cell volume (PCV). The analyses were carried out at the Clinical Pathology Laboratory, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria.

3.4.6 Digestibility study

Three rabbits from each treatment were individually housed in separate cages for faecal and urine collection. The trial lasted for a period of 7 days. A polythene sheet was placed under each cage to allow for individual faecal and urine collections. A small opening was made on the polythene sheet to allow urine drip into a bowl placed beneath the cage. During faecal collection, fur and feed were removed from the faeces on the polythene sheet daily before fresh feed of known quantity was given each morning. Daily feed intake per pen was calculated during this period. Urine samples were collected and transferred into 25mls bottles containing 5mls of tetraoxosulphate (VI) acid to prevent oxidation and later kept in a refrigerator. Faecal samples from each rabbit were then bulked, weighed and oven-dried at 70ºC for 72 hours. The urine samples collected were analyzed for their proximate compositions.

3.5 Data analysis

Data obtained from the experiment were subjected to analysis of variance (ANOVA) as described by Steel and Torrie (1980). Test of significance differences between means among the dietary treatments were separated using Duncan multiple range test (Duncan, 1955).

The data obtained was analysed using the following model:

$Y_{ij} = \mu + Oi + e_{ij}$

Where:

Y_{ij} = Individual observation

μ = overall mean

O_i= effect of the i^{th}levels of maize husk

e_{ij} = random error

3.6 Experiment 2:

3.6.1 Effect of Enzyme Supplementation of 20% Maize Husk Based Diets on the Performance of Weaner Rabbits

The diets consisted of 20% maize husk representing the diet with the least performance in the first experiment. The experimental diets contained graded levels of enzyme (maxigrain) at 0.0, 0.2, 0.3and 0.4% and composition is presented in Table 3.3

Table 3.3: Composition of Maize Husk Based Diets Containing Levels of Enzyme Supplementation

	Treatments			
	1	**2**	**3**	**4**
Ingredients	0.00%	0.02%	0.03%	0.04%
Maize	40.75	40.75	40.75	40.75
Soyabean cake	24.50	24.50	24.50	24.50
Palm kernel cake	11.00	11.00	11.00	11.00
Maize husk	20.0	20.0	20.0	20.0
Bone meal	3.00	3.00	3.00	3.00
Salt	0.30	0.30	0.30	0.30
Premix**	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10
Total	100	100	100	100
Calculated Analysis				
Metablizable energy kcal/kg	2596	2596	2596	2596
Crude protein (%)	17.00	17.00	17.00	17.00
Crude fibre (%)	10.61	10.61	10.61	10.61
Calcium (%)	0.86	0.86	0.86	0.86
Phosphorus (%)	0.61	0.61	0.61	0.61
Methionine (%)	0.70	0.70	0.70	0.70
Lysine (%)	1.12	1.12	1.12	1.12
Cost/kg diet (₦)	69.95	70.05	70.10	70.15

**Bio-premix supplied per kg of diet: Vitamin A, 12500I.U; Vit. D_3, 2500 I.U;Vit E,50mg; Vit K_3, 2.5mg; Vit B_3.0mg; VitB_6 6.0mg; Niacin, 40.0mg; Calcium pantothenate, 10.0mg; Biotin, 0.8mg; VitB $_{12}$ 0.25mg; Folic acid, 1.0mg; Choline chloride, 300mg; Manganese 100mg: Iron, 50mg; Zinc 45;2mg; Iodine 1.55I.U; Selenium 0.1mg.

3.6.2 Management of experimental animals and data collection

A total of 24 weaner rabbits were used for the study. Six rabbits were allotted to each treatment in a completely randomized design. Each rabbit represents a replicate within the treatment. Rabbits were housed individually as described in Experiment 1. The exogenous enzyme (Maxigrain®) used was purchased from a local feed mill in Samaru, Zaria. The enzyme was included at 0.00, 0.02, 0.03 and 0.04% levels in treatments 1, 2, 3 and 4 respectively. Performances of rabbits were monitored as described in Experiment 1.

3.6.3 Carcass evaluation

At the end of the experiment (56 days), carcass and blood evaluation were carried out for each treatment as described in Experiment 1.

3.6.4 Haematological evaluation, Digestibility study and Data Analysis were carried out as described in Experiment 1.

CHAPTER FOUR

RESULTS

4.1 Performance of Weaner Rabbits Fed Graded Levels of Maize Husk as Replacement for Rice Offal

Performance of weaner rabbits fed graded levels of maize husk as replacement for rice offal is presented in Table 4.1. There was no significant difference (P>0.05) observed in average daily weight gain for rabbits fed 0.0 and 4.0% maize husk. Rabbits fed 8.0, 12.0 and 16.0% maize husk showed similar (P>0.05) results in average daily weight gain. No significant difference (P>0.05) was observed in average daily feed intake across all dietary treatments. Feed conversion ratio (FCR) was significantly (P<0.05) affected by dietary levels of maize husk. Rabbits on the control diet and 4.0% maize husk had similar results in FCR and were significantly (P<0.05) better than all other treatments. FCR did not differ significantly (P>0.05) for rabbits fed 8.0, 12.0 and 16.0% dietary maize husk. The poorest result in FCR was observed for rabbits fed 20.0% dietary maize husk.

It was observed that rabbits fed 0.0 and 4.0% maize husk showed no significant (P>0.05) difference between each other and performed better than rabbits fed diets with graded levels of maize husk at 8.0, 12.0, 16.0 and 20.0% which performed the least in feed cost per kilogram weight gain. Mortality was observed for rabbits fed 12.0 and 16.0% maize husk while no mortality was observed in all other treatments.

Table 4.1: Performance of Weaner Rabbits Fed Graded Levels of Maize Husk as Replacement for Rice Offal

Parameters	Maize Husk (%)						SEM
	0.00	4.00	8.00	12.00	16.00	20.00	
Initial wt (g)	590.67	592.62	600.00	594.68	589.33	591.69	25.27
Final wt (g)	1300.00[a]	1280.00[a]	1200.00[b]	1154.00[b]	1140.00[b]	1086.00[c]	37.29
ADWG (g)	12.66[a]	12.29[a]	10.71[b]	9.98[b]	9.84[b]	8.82[c]	0.55
ADFI (g)	58.84[a]	53.00[ab]	54.88[ab]	53.57[ab]	51.88[b]	50.62[b]	4.00
FCR	4.65[a]	4.31[a]	5.12[b]	5.36[b]	5.27[b]	5.74[c]	0.21
Feed cost/kg gain	323.41[a]	301.92[a]	358.91[b]	380.34[bc]	371.22[b]	390.51[bc]	10.02
Total Cost (₦)	424.42[a]	402.91[a]	457.90[b]	481.33[bc]	472.21[b]	491.52[bc]	10.03
Mortality (%)	0.00	0.00	0.00	1.50	1.70	0.00	0.03

ADWG= Average daily weight gain, ADFI= Average daily feed intake, FCR= Feed conversion ratio, g/d= gram per day, SEM =Standard error of mean, a,b,c= Means with different superscript on the same row differ significantly (P<0.05)

4.2 Carcass Characteristics of Weaner Rabbits Fed Graded Levels of Maize Husk as Replacement for Rice Offal

Carcass characteristics of weaner rabbits fed graded levels of maize husk as replacement for rice offal is shown in Table 4.2.The live weight, slaughter and dressed weights, dressing percentage, thigh and skin measurements were significantly affected ($P<0.05$) by dietary maize husk. The live weights, dressed weight, dressing percentage and skin percentages were similar for rabbits on the 0.0, 4.0, 8.0 and 12.0% maize husk. At 16.0 and 20.0% maize husk, these parameters gave the poorest results. The best result in thigh measurement was observed for rabbits on the control diet while rabbits fed 4.0, 8.0 and 12.0% maize husk showed similar results ($P>0.05$). The poorest result was observed for rabbits fed 16.0 and 20.0% maize husk. The weights and lengths of internal organs expressed as percentages of the live weight were not significantly affected ($P>0.05$) by dietary levels of maize husk.

Table 4.2: Carcass Characteristics of Weaner Rabbits Fed Graded Levels of Maize Husk as Replacement for Rice Offal

	Maize Husk (%)						
Parameters	**0.00**	**4.00**	**8.00**	**12.00**	**16.00**	**20.00**	**SEM**
Live wt (g)	1325[a]	1275[a]	1300[a]	1200[ab]	1175[b]	1050[c]	34.97
Slau.Wt (g)	1200[a]	1200[a]	1250[a]	1075[b]	1075[b]	1000[c]	34.21
Dress.Wt (g)	625.00[a]	600.00[a]	562.50[ab]	562.50[ab]	460.00[b]	412.00[c]	24.13
Dressing (%)	47.16[a]	47.05[a]	43.27[a]	46.88[a]	39.14[b]	39.13[b]	2.50
Head (%)	9.50	8.90	8.53	8.85	9.60	9.70	4.15
Thigh (%)	23.50[a]	21.50[b]	21.95[b]	21.10[b]	16.40[c]	18.67[c]	1.50
Rack/Rib (%)	32.00	25.49	25.00	26.04	28.72	29.70	5.00
Skin (%)	9.78[a]	9.64[a]	9.86[a]	9.78[a]	8.00[b]	7.36[c]	0.81
Liver (%)	2.47	2.46	2.44	2.41	2.74	2.54	0.67
Lungs (%)	0.85	0.71	1.09	0.88	0.98	0.96	1.37
Heart (%)	0.21	0.20	0.22	0.24	0.33	0.32	0.77
Small int (cm)	335.00	346.20	346.50	344.50	326.50	323.00	10.84
Large int (cm)	45.50	44.50	45.00	45.50	42.50	44.50	5.26
Kidney (%)	1.05	0.82	0.73	0.85	0.85	0.80	0.20
Stomach (%)	1.38	1.55	1.48	1.43	1.42	1.65	0.75
Gall blad. (%)	0.03	0.03	0.05	0.03	0.04	0.04	0.01

Wt= weight, int= intestine, slau. Wt= slaughter weight, dress. Wt= dressed weight, Gall blad= Gall bladder

g= gram, SEM =Standard error of mean, a,b,c=Means with different superscripts on the same row differ significantly ($P<0.05$)

4.3 Haematological Parameters of Weaner Rabbits Fed Graded Levels of Maize Husk as Replacement for Rice Offal

Results of haematological evaluations of weaner rabbits fed diets in which maize husk replaced rice offal is presented in Table 4.3. Rabbits fed 4.0 and 8.0% maize husk based diets had similar values (P>0.05) for total protein (TP) and were significantly better (P<0.05) than other levels. Rabbits on the control diet and those fed 12.0% maize husk had similar values for TP and were significantly (P<0.05) higher than values obtained for rabbits fed 16.0 and 20.0% maize husk diets. No significant differences were observed (P>0.05) in haemoglobin level (Hb), white blood cell (WBC) and packed cell volume (PCV) across all dietary levels of maize husk studied.

Table 4.3: Haematological Parameters of Weaner Rabbits Fed Graded Levels of Maize Husk as Replacement for Rice Offal

	Maize husk (%)						
Parameters	**0.0**	**4.0**	**8.0**	**12.0**	**16.0**	**20.0**	**SEM**
TP (g/dl)	5.57^{b}	6.30^{a}	6.32^{a}	5.81^{b}	5.11^{c}	5.23^{c}	0.20
Hb (g/dl)	9.40	9.50	9.30	9.65	9.45	9.60	0.16
WBC(x 10^{9}/L)	9.75	9.47	8.96	9.00	9.25	8.98	0.77
PCV (%)	40.50	42.50	41.00	41.10	40.93	42.50	0.98

PCV= packed cell volume, Hb= Haemoglobin level, WBC= white blood cell, TP= total protein, SEM=Standard error of mean, a,b,c=Means with different superscripts on the same row differ significantly ($P<0.05$)

4.4 Digestibility of Nutrients by Weaner Rabbits Fed Diets in which Maize Husk Replaced Rice Offal

Nutrient digestibility of weaner rabbits fed graded levels of maize husk based diets is presented in Table 4.4. All parameters studied were significantly (P<0.05) affected by dietary levels of maize husk. Rabbits fed the control diet and 4.0% maize husk showed the best results for dry matter digestibility. Dry matter digestibility significantly declined (P<0.05) with increasing levels of maize husk thus, rabbits fed 20.0% maize husk showed the poorest result. Crude protein digestibility decreased significantly (P<0.05) as the levels of maize husk replacing rice offal increased in diets of rabbits. Crude protein digestibility on the control diet was significantly better (P<0.05) compared to other treatments. Crude protein digestibility on 4.0, 8.0, 12.0 and 16% maize husk diets were similar and better than digestibility on the 20% maize husk.

Crude fibre digestibility was significantly affected (P<0.05) by dietary levels of maize husk. Rabbits fed the control diet and 4.0% maize husk had the best result in crude fibre digestibility. Similarly, no significant differences (P>0.05) were observed for rabbits fed 8.0, 12.0 and 16.0% dietary maize husk. The least value in crude fibre digestibility was observed for rabbits fed 20.0% maize husk diet .Ether extract digestibility was also significantly affected (P<0.05) by dietary maize husk. It was observed that rabbits fed 0.0, 4.0, 8.0, 12.0 and 16.0% dietary maize husk had similar values (P>0.05). Rabbits fed 20.0% maize husk showed the poorest result in ether extract. Rabbits fed 0.0, 4.0 and 8.0% dietary maize husk showed similar values (P>0.05) in ash digestibility which was significantly better (P<0.05) than values obtained for rabbits fed 12.0, 16.0 and 20.0% maize husk.

The best result in nitrogen free extract (NFE) digestibility was obtained for rabbits on the control diet. No significant differences (P>0.05) were observed in digestibility for rabbits fed 4.0, 8.0, 12.0 and 16% dietary maize husk. The least result in digestibility was obtained for rabbits fed 20.0% dietary maize husk.

Table 4.4: Digestibility of Nutrients by Weaner Rabbits Fed Diets in which Maize Husk Replaced Rice Offal

	Maize Husk (%)						
Parameters	**0.00**	**4.00**	**8.00**	**12.00**	**16.00**	**20.00**	**SEM**
Dry matter	70.12^{a}	68.50^{a}	65.42^{b}	65.08^{b}	64.91^{b}	63.11^{c}	0.92
Crude protein	80.89^{a}	73.93^{b}	71.44^{b}	71.56^{b}	72.34^{b}	69.81^{c}	0.53
Crude fibre	79.15^{a}	78.68^{a}	75.95^{b}	75.30^{b}	74.98^{b}	68.30^{c}	0.87
Ether extract	76.02^{a}	74.48^{a}	72.44^{a}	72.30^{a}	73.93^{a}	70.97^{b}	2.03
Ash	77.18^{a}	76.81^{a}	73.81^{a}	62.81^{b}	60.10^{b}	60.10^{b}	1.85
NFE	68.44^{a}	65.53^{b}	64.99^{b}	63.80^{bc}	62.91^{bc}	60.60^{c}	0.72

NFE= Nitrogen free extract, SEM =Standard error of mean, a,b,c=Means with different superscripts on the same row differ significantly (P<0.05)

4.5 Performance of Weaner rabbits Fed 20% Maize Husk Based Diets Supplemented with Enzyme

Performance of weaner rabbits fed 20.0% maize husk based diets supplemented with graded levels of enzyme is shown in Table 4.5. The treatment with the least performance in the first experiment (20.0%) maize husk was supplemented with graded levels of enzymes and used for the second experiment. A significant difference (P<0.05) was observed in average daily weight gain across all dietary treatments. Rabbits fed diets supplemented with 0.02% exogenous enzyme had the highest average daily weight gain of 14.28g/d which was followed by 11.83g/d for rabbits supplemented with 0.03% enzyme. The poorest result in average daily weight gain was observed for rabbits fed 0.00 and 0.04% enzyme supplementation. Average daily feed intake did not differ significantly (P>0.05) across dietary levels of enzyme supplementation.

Feed conversion ratio (FCR) was significantly affected (P<0.05) by the graded levels of enzyme supplementation. All treatments fed diets supplemented with enzyme showed significantly (P<0.05) better results in FCR compared to the control which had no enzyme supplementation. It was observed that rabbits fed diets supplemented with 0.02% enzyme showed the best result (P<0.05) in FCR (4.96). This was followed by 6.11 obtained for rabbits fed diets supplemented with 0.03% enzyme level. Rabbits fed diets supplemented with 0.04% enzyme had a significantly better value (P<0.05) in FCR (7.89) compared rabbits fed the control which gave the poorest result 9.45.

Feed cost per kilogram weight gain was significantly (P<0.05) affected by the graded levels of enzyme supplementation. Rabbits fed diets supplemented with 0.02% enzyme showed the lowest cost (P<0.05) in feed cost per kilogram weight gain (₦347.44). This was followed by ₦428.31 obtained for rabbits fed diets supplemented with 0.03% enzyme level. Rabbits fed diets supplemented with 0.04% enzyme had a significantly lower value (P<0.05) in feed cost per kilogram weight gain of ₦553.48 compared to rabbits fed the control treatment which gave the highest cost of ₦661.02. Mortality occurred only in rabbits fed diets supplemented with 0.04% enzyme.

Table 4.5: Performance of Weaner rabbits Fed 20% Maize Husk Based Diets Supplemented with Enzyme

	Enzyme Levels (%)				
Parameters	**0.00**	**0.02**	**0.03**	**0.04**	**SEM**
Initial weight (g)	548.44	524.27	506.25	529.17	35.10
Final weight (g)	1012.50^{c}	1324.50^{a}	1168.80^{b}	1056.60^{c}	50.07
Daily weight gain (g/d)	8.29^{c}	14.28^{a}	11.83^{b}	9.58^{c}	1.20
Daily Feed intake (g/d)	78.35	70.85	72.32	75.60	3.75
Feed conversion ratio	9.45^{d}	4.96^{a}	6.11^{b}	7.89^{c}	0.08
Feed cost/kg gain (₦)	661.02	347.44	428.31	553.48	35.11
Total Cost (₦)	600.03	574.44	576.31	587.48	15.11
Mortality (%)	0.00	0.00	0.00	1.11	0.01

g/d= gram per day, SEM=Standard error of mean, a,b,c=Means with different superscripts on the same row differ significantly ($P<0.05$)

4.6 Carcass Characteristics of Weaner Rabbits Fed 20% Maize Husk Based Diets Supplemented with Enzyme

Carcass characteristics of weaner rabbits fed 20.0% maize husk based diets supplemented with graded levels of enzymes is presented in Table 4.6. All cut parts and internal organs measured were expressed as percentages of the live weight. The live, slaughter and dressed weights, dressing and thigh percentages were significantly affected (P<0.05) by the levels of enzyme supplementation. The best result in dressing percentage of 55.86 was observed for rabbits fed diets supplemented with 0.02% enzyme while the value 51.67% was obtained for rabbits fed 0.03% enzyme which was significantly inferior to 0.02%. The poorest result in dressing percentage was observed for rabbits fed diets supplemented with 0.00 and 0.04% enzyme supplementation..All other parameters such as fore and hind limbs, thigh, skin, rack and rib, were not significantly affected (P>0.05) by enzyme supplementation. Weight and length of internal organs such as liver, lungs, heart, small intestine, large intestine, kidney, stomach and gall bladder were not significantly affected (P>0.05) by enzyme supplementation.

Table 4.6: Carcass Characteristics of Weaner Rabbits Fed 20% Maize Husk Based Diets Supplemented with Enzyme

	Enzyme Levels (%)				
Parameters	**0.00**	**0.02**	**0.03**	**0.04**	**SEM**
Live wt (g)	1200^{b}	1416^{a}	1316^{ab}	1150^{c}	22.50
Slau.wt (g)	1150^{c}	1356^{a}	1266^{b}	1090^{d}	21.30
Dress.wt (g)	598.00^{b}	791.00^{a}	680.00^{ab}	560.00^{b}	52.38
Dressing (%)	49.83^{c}	55.86^{a}	51.67^{b}	48.69^{c}	0.90
Head (%)	9.28^{a}	9.87^{a}	9.46^{a}	8.71^{ab}	0.49
Forelimb (%)	0.67	0.68	0.70	0.72	0.31
Hind limb (%)	2.00	2.14	1.93	1.83	1.02
Thigh (%)	17.10	19.00	18.40	16.12	1.04
Rack & Rib (%)	30.47	27.14	29.43	29.80	15.03
Skin (%)	8.83	9.34	9.00	8.61	2.13
Liver (%)	3.02	3.17	3.05	3.43	5.95
Lungs (%)	0.85	0.65	0.68	0.66	0.53
Heart (%)	0.23	0.27	0.26	0.24	0.47
Small int. (cm)	232.33	246.00	241.31	240.03	12.02
Large int. (cm)	125.00	145.33	131.33	129.00	10.13
Kidney (%)	0.90	0.99	0.99	0.89	0.08
Stomach (%)	1.45	2.00	1.67	1.49	0.48
Gall bladder (%)	0.08	0.12	0.09	0.08	0.22

Wt= weight, int= intestine, slau. Wt= slaughter weight, dress. Wt= dressed weight, Gallblad= Gall bladder
g= gram, SEM=Standard error of mean, a,b,c=Means with different superscript on the same row differ significantly ($P<0.05$)

4.7 Haematological Parameters of Weaner Rabbits Fed 20% Maize Husk Based Diets Supplemented with Enzyme

Haematological parameters of weaner rabbits fed 20.0% maize husk based diets supplemented with graded levels of enzyme is shown in Table 4.7.No significant difference ($P>0.05$) was observed for, Hb WBC and PCV levels of enzyme supplementation. However, total protein (TP) was significantly affected ($P<0.05$) by enzyme supplementation.. Rabbits fed diets 0.02 and 0.03% enzyme showed the highest result in TP of 7.03 and 6.84g/dl respectively. This was followed by 6.62g/dl obtained for rabbits fed the control diet while rabbits fed diets supplemented with 0.04% enzyme gave the least result in TP.

Table 4.7: Haematological Parameters of Weaner Rabbits Fed 20% Maize Husk Based Diets Supplemented with Enzyme

	Enzyme Levels (%)				
Parameters	**0.00**	**0.02**	**0.03**	**0.04**	**SEM**
TP (g/dl)	6.62^{b}	7.03^{a}	6.84^{a}	6.40^{c}	0.10
Hb (g/dl)	10.06	11.30	10.53	10.20	2.48
WBC ($x10^{9}$/L)	7.13	7.23	7.33	7.83	1.34
PCV (%)	42.33	46.32	43.06	43.31	2.10

PCV= packed cell volume, Hb= Haemoglobin level, WBC= white blood count, TP= total protein, SEM=Standard error of mean, a,b,c=Means with different superscripts on the same row differ significantly ($P<0.05$)

4.8: Nutrient Digestibility of Weaner Rabbits Fed 20% Maize Husk Based Diets Supplemented with Enzyme

Nutrient digestibility of weaner rabbits fed 20.0% maize husk based diets supplemented with graded levels enzyme is presented on Table 4.8. Dry matter digestibility was significantly affected (P<0.05) by dietary levels of enzyme supplementation. Rabbits fed diets in which 0.02% and 0.03% enzyme were supplemented had the best results in dry matter digestibility. This was followed by rabbits fed diets in which 0.04% enzyme was supplemented. The worst result in dry matter digestibility was obtained for rabbits on the control diet. Rabbits fed 0.02% level of enzyme showed the best result (P<0.05) in crude protein digestibility of 79.88% and was closely followed by 74.56% obtained for rabbits fed 0.03% enzyme supplementation. The poorest result in crude protein digestibility was obtained for rabbits fed 0.00 and 0.04% enzyme supplementation.

Ether extract and ash digestibilities were not significantly affected (P>0.05) by levels of enzyme supplementation. The best result in crude fibre digestibility (CF) was observed for rabbits fed diets containing 0.02 and 0.03% enzyme supplementation with values of 77.68 and 75.53% respectively. Rabbits fed diets supplemented with 0.02% enzyme showed the best (P<0.05) result in NFE digestibility of 69.53%, while rabbits fed 0.03% enzyme showed a significantly better result (P<0.05) than rabbits fed 0.00 and 0.04% enzyme supplementation.

Table 4.8: Nutrient Digestibility of Weaner Rabbits Fed 20% Maize Husk Based Diets Supplemented with Enzyme

	Enzyme Levels (%)				
Parameters	**0.00**	**0.02**	**0.03**	**0.04**	**SEM**
Dry matter (%)	60.90^{c}	71.98^{a}	70.45^{a}	63.01^{b}	0.89
Crude protein (%)	68.90^{c}	79.88^{a}	74.56^{b}	69.88^{c}	1.04
Crude fibre (%)	68.03^{c}	77.68^{a}	75.53^{a}	70.11^{b}	0.95
Ether extract (%)	70.32	71.81	71.60	70.53	0.79
Ash (%)	69.81	69.15	68.12	68.91	0.88
NFE (%)	64.48^{c}	69.53^{a}	66.98^{b}	65.53^{c}	0.44

NFE= Nitrogen free extract, SEM=Standard error of mean, a,b,c=Means with different superscript on the same row differ significantly ($P<0.05$)

CHAPTER FIVE

DISCUSSION

5.1 Performance of Weaner Rabbits Fed Graded Levels of Maize Husk as Replacement for Rice Offal

The gradual decline in average daily weight gain with increasing levels of maize husk was attributed to the poor nutritive value of maize husk compared to rice offal. Aduku (1993) reported that maize husk contains 2.60% crude protein, 0.97% crude fat and 33.51% crude fibre while rice offal contains 6.0% crude protein, 5.60% crude fat and 31.0% crude fibre. Similarly, Maikano (2007) reported that rice offal consists of rice hulls, rice bran, rice polishing and broken rice grains. Hence, rice offal has higher nutritive value in crude protein, crude fat and minerals such as calcium and phosphorus when compared to maize husk. .

The non-significant decline in average daily feed intake with increasing levels of maize husk was in consonance with the reports of Valencia and Chavez (1997) and Philip *et al.* (2000). Both authors observed a non-significant ($P>0.05$) decline in feed intake when lignified diets were fed to pigs and calves respectively. Terry *et al.* (2012) observed a significant decline ($P<0.05$) with increasing levels of crude fibre and lignin content in grass cutter. Feed conversion ratio (FCR) and feed cost per kilogram weight gain increased as the levels of maize husk increased in the diet of the rabbits beyond 4%. The best results in both parameters were achieved for rabbits fed 0.0 and 4.0% maize husk while higher inclusion levels gave poorer results. This was attributed to the poor nutritive nature of maize husk as reported by Aduku and Olukosi (1990a). The mortality observed for rabbits fed 12.0 and 16.0% maize husk was not attributed to the experimental diet because maize husk does not contain toxic substances.

5.2 Carcass Evaluation of Weaner Rabbits Fed Graded Levels of Maize Husk as Replacement for Rice Offal

The live, dressed, skin and thigh percentages were significantly affected ($P<0.05$) by dietary levels of maize husk. The highest values of dressing percentage and thigh weight were observed for rabbits on the control diet and decreased significantly (P<0.05) with increased levels of maize husk. This could be attributed to the presence of ingestible fibre present (lignin) in maize husk compared to rice offal as reported by Gholizadeh and Naserian (2010). It was reported by Maikano (2007) that rice offal consisted of rice hulls, rice bran, rice polishing and broken rice grains, thus it has a higher nutritive value compared to maize husk. The weights and lengths of internal organs expressed as percentage of the live weight (heart, liver, lungs, kidney, gall bladder and the length of small and large intestines) were not significantly affected (P>0.05) by dietary levels of maize husk. This was because the experimental diets contained no toxic materials as increased sizes in visceral organs indicate poor health status of farm animals.

5.3 Haematological Evaluation of Weaner Rabbits Fed Graded Levels of Maize Husk as Replacement for Rice Offal

Haematological indices are the reflection of the effect of dietary treatments on an animal in terms of type, quality and amount of ingested feed available to meet the animals physiological, biochemical and metabolic necessities (Ewuola *et al.*, 2004). Total protein (TP) was significantly affected (P<0.05) by dietary treatments. TP declined significantly (P<0.05) with increasing levels of maize husk in the diet of the rabbits. This decline in total protein with increasing levels of maize husk was attributed to the low protein content and poor palatability of maize husk due to its lignin content compared to that of rice offal. Result of total protein fell within the range of 5 – 8 g/dl for healthy rabbits as reported by Alade *et al.* (2001).

No significant difference (P>0.05) was observed in haemoglobin level across all dietary treatments. The values obtained were within the range for healthy rabbits which were similar to 10.40 – 12.60g/dl reported by Alade *et al.* (2001). A non-significant (P>0.05) difference was observed in white blood cell count (WBC) across all treatment groups fed graded levels of maize husk. However, these values obtained for WBC were comparable to those reported by Igwebuike (2001) who recorded a range of 5.28 to 9.05 x 10^3 mm^3. Ocheja *et al.* (2011) reported that high white blood cell count was usually associated with microbial infection or the presence of a foreign body antigen in the circulating system which was absent in this study.

The packed cell volume (PCV) values obtained were within the range for healthy rabbit (33.0-50.0%) as reported by Onifade *et al*. (1999) and Fanimo *et al*. (2003). There were no significant differences (P>0.05) in PCV between all treatment groups. Normal values in PCV concentration suggested the absence of toxic factor such as haemagglutinin which could have adverse effect on blood formation (Oyawoye and Ogunkule, 1998). Values obtained for white blood cell count were comparable to those reported by Igwebuike (2001) who recorded a range of 5.28 to 9.05 x 10^3mm^3. Ocheja *et al.* (2011) reported that high white blood cell count was usually associated with microbial infection or the presence of a foreign body antigen in the circulatory system. Since results obtained for PCV were within the range for healthy rabbits, it therefore indicated that the rabbits did not suffer diseases related to microbial infections neither did they have foreign antigens in their circulatory systems.

5.4 Nutrient Digestibility of Weaner Rabbits Fed Maize Husk Based as Replacement for Maize Husk Replaced Rice Offal

The digestibility of nutrients for the different diets showed significant differences (P<0.05). Dry matter digestibility significantly declined (P<0.05) with increasing levels of maize husk thus, rabbits fed 20.0% maize husk showed the poorest result. Crude protein percentage digestibility decreased significantly (P<0.05) with increased levels of dietary maize husk. The decrease in dry matter and crude protein digestibilities with increasing levels of maize husk may have resulted from the increased lignin content of the feed. Thus, the poor DM and CP digestibility at 20% maize husk. The decline in crude fibre digestibility with increasing levels of maize husk agreed with the report of Deblas (1985) who asserted that high crude fibre levels of a diet would result in a corresponding decrease in nutrient digestibility. Similarly, Alawa and Amadi (1991) reported that nutrient digestibility significantly decreased with increasing levels of dietary crude fibre. Gholizadeh and Naserian (2010) asserted that a decrease in digestible fibre fraction was a result of high lignin content in feedstuffs. Nutritionists have asserted that lignin bound to polysaccharides such as cellulose stiffened the plant cell wall thus limiting nutrient availability.

Ether extract, ash and nitrogen free extract percentage digestibility were affected by increased levels of dietary maize husk. This was as a result of the poor nutritive nature of maize husk as reported by Aduku (1993). Also the decrease in nutrient digestibility of these parameters agreed with the report of Debals (1985) who asserted that high crude fiber levels of a diet would result in a corresponding decrease in nutrient digestibility. Similar observations were reported by Alawa and Amadi (1991) who reported that nutrient digestibility significantly decreased with increasing levels of dietary crude fibre.

5.5 Performance of Weaner Rabbits Fed 20% Maize Husk Based Diets Supplemented with Enzyme

The treatment with the least performance in the first experiment (20.0%) maize husk was supplemented with graded levels of enzymes and used for the second experiment. Enzyme supplementation on the diet with the poorest result significantly improved ($P<0.05$) the performance of all productive parameters measured in the second experiment. The poorest result in average daily weight gain was observed for rabbits fed 0.00 and 0.04% enzyme supplementation while the best result in average daily weight gain was achieved at 0.02% enzyme supplementation. This was because 0.02% enzyme level enhanced the release of cell bound nutrients in the feed thereby improving the activity of gut ecology as compared with other levels of enzyme. Similarly, the highest average daily weight gain observed at 0.02% enzyme level could be attributed to the improved digestibility and absorption of different dietary elements such as carbohydrates, fats and proteins that increased with the addition of exogenous enzymes. El-Latif (2008) observed a significant decline ($P<0.05$) in performance and metabolic functions of weaner rabbits fed diets supplemented with enzymes beyond 0.02%. Higher levels of enzyme supplementation beyond 0.02% depressed average daily weight gain as there might have been a rapid impact of the supplemented enzymes on caecal fermentation which resulted in higher digestive activities that was not beneficial to the rabbits as reported by Carabano *et al.* (2008a).

The decline in average daily weight gain with increasing levels of exogenous enzymes was further explained by the report of Jiu *et al.* (2008). According to these authors, exogenous enzyme could increase the activity of endogenous enzymes and interrelating hormones which regulate the endocrine system of the animal body thereby promoting nutrient availability and performance. However, excess exogenous enzymes may inhibit the activity of endogenous enzymes and the secretion of interrelating hormones consequently affecting nutrient availability and performance (Colombatto *et al.* 2003)

Average daily feed intake did not differ significantly ($P>0.05$) across dietary levels of enzyme supplementation. Feed conversion ratio and feed cost per kilogram weight gain showed the best results at 0.02% enzyme level and declined thereafter. The best results in feed conversion ratio and feed cost per kilogram weight gain at 0.02% enzyme supplementation as opposed to higher enzyme levels might have resulted from the improved modifications of the gastro intestinal tract environment, acidification of caecal contents and stabilization of ammonia nitrogen concentrations (Eiben *et al.,* 2004). Alterations of the gastro intestinal tract and stabilization of ammonia nitrogen concentrations as a result of exogenous enzyme supplementation is responsible for improved nutrient digestion and utilization as reported by Abdl-Rahman *et al.*(2010). Mortality observed for rabbits fed 0.04% as a result of coccidiosis.

5.6 Carcass Characteristics of Weaner Rabbits Fed 20% Maize Husk Based Diets Supplemented with Enzyme

Carcass evaluation of eviscerated body parts showed that the live weight, slaughter weight, dressed weight, dressing percentage, head and thigh weights were significantly affected ($P<0.05$) by the levels of enzyme supplementation. Live, slaughter and dressed weights were direct reflections of the results of performance study. Rabbits fed diets supplemented with 0.02% enzyme level gave the best result in dressing percentage while rabbits on the control diet and 0.04% enzyme showed the poorest results. The highest carcass yield at 0.02% enzyme level is similar to the report of Jamroz *et al.* (1996) who observed increased dressing percentage at 0.02% Roxazyme-G supplementation of broiler diets. The decline in dressing percentage at 0.04% enzyme level may have resulted from the rapid impact of the supplemented enzymes on caecal fermentation thus resulting in higher digestive activities which probably was not beneficial to the rabbits. According to Jiu *et al.* (2008) excess exogenous enzymes may inhibit the activity of endogenous enzymes thereby affecting nutrient availability and performance negatively.

Other weights such as the head and thigh were significantly ($P<0.05$) affected by the graded levels of enzyme addition with the poorest results observed for rabbits fed the control diet and 0.04% enzyme supplementation. Weights and lengths of internal organs such as liver, lungs, heart, small intestine, large intestine, kidney, stomach and gall bladder were not significantly affected ($P>0.05$) by enzyme supplementation. This gave an indication that organ development of the rabbits was not compromised by graded levels of enzyme supplementation. This is consistent with the report of Azeezat (2009) who observed no significant effect ($P>0.05$) on weights and lengths of internal organs of weaner rabbits fed maize husk based diets supplemented with maxigrain.

5.7: Haematological Parameters of Weaner Rabbits Fed 20% Maize Husk Based Diets Supplemented with Enzyme

Haematological indices are reflections of the effect of dietary treatments on an animal in terms of type, quality and amount of ingested feed available to meet the animals physiological, biochemical and metabolic necessities (Ewuola *et al*., 2004). Enzyme supplementation on the diet with the poorest result in the first experiment (20% maize husk) significantly affected ($P<0.05$) total protein but did not significantly affect PCV, Hb and WBC. The best result for TP was observed for rabbits fed diets supplemented with enzyme at 0.02 and 0.03%. At these levels (0.02 and 0.03%), digestion and absorption of nutrients may have been enhanced there by resulting in improved blood levels of basic nutrients as was observed with total protein. As the levels of supplemented enzyme increased to 0.04% total protein declined due to the increased digestive activities as a result of the rapid impact of the supplemented enzymes on caecal fermentation. This increased level of enzyme supplementation was not beneficial to the rabbits. TP in all treatments were within the range for healthy rabbits 5 – 8 g/dl as reported by Alade *et al.* (2001).

No significant difference ($P>0.05$) was observed in haemoglobin level across all dietary treatments. A non-significant ($P>0.05$) effect was observed in white blood cell count WBC across all treatment groups, which was in agreement with the study of Igwebuike (2001) who recorded a range of 5.28 – 9.05 x 10^3 mm^3. Ocheja *et al.* (2011) reported that high white blood cell count was associated with microbial infection or the presence of a foreign body antigen in the circulating system. There were no significant differences ($P>0.05$) in PCV between all treatment groups. The PCV values obtained in this study were within the range (33.0-50.0%) for healthy rabbit as reported by Onifade *et al*. (1999) and Fanimo *et al*. (2003). Normal values of PCV values indicated the absence of toxic factors such as haemagglutamin which could have adverse effect on blood formation (Oyawoye and Ogunkule, 1998).

5.8: Nutrient Digestibility of Weaner Rabbits Fed 20% Maize Husk Based Diets Supplemented with Enzyme

Enzyme supplementation on 20% maize husk representing the diet with the poorest performance in the first experiment resulted in significant ($P<0.05$) improvement in nutrient digestibility. Enzyme supplementation of maize husk based diets increased dry matter digestibility of treatments 2, 3 and 4 compared to the control. This corroborates the report of Salobir (1998) who observed improved dry matter digestibility (DM) due to enzyme supplementation. However the best result was observed for rabbits fed diets supplemented with 0.02 and 0.03% enzyme. Similarly, crude protein and crude fibre digestibility increased in diets supplemented with enzyme compared to the control diet. Rabbits fed diets supplemented with 0.02 and 0.03% enzyme showed best results in crude protein, crude fibre and nitrogen free extract because at these levels enzyme supplementation may have reduced intestinal viscosity thereby improving contact between nutrients and digestive enzymes thus leading to improved digestibility coefficients. It could also have resulted from the enhanced effect of exogenous enzymes on gut microflora and volatile fatty acids production thus resulting in improved nutrient digestibility.

The highest CF digestibility at 0.02% and 0.03% enzyme supplementation agreed with the report of Abaza and Omara (2011) who observed similar results in fibre digestibility when corn cobs was supplemented with enzyme in diet of growing rabbits. On the other hand, Daveby *et al.* (1998) reported that enzyme supplementation had no effect on fibre digestibility. No significant difference ($P>0.05$) was observed in ether extract and ash digestibility across all groups fed graded levels of enzyme and the control treatment.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 Summary

Two research trials were conducted to determine the performance of weaner rabbits fed maize husk based diets. In the first experiment, maize husk replaced rice offal at graded levels of 0.0, 4.0, 8.0, 12.0, 16.0 and 20.0% for treatments one to six respectively. Average daily weight gain, average daily feed intake, feed conversion ratio, feed cost per kilogram weight gain, total protein and nutrient digestibility significantly declined ($P<0.05$) as the levels of maize husk increased in the diets of the rabbits. Rabbits fed 0.0 and 4.0% maize husk showed the best result in all parameters studied while the worst result was observed for rabbits fed 20.0% maize husk. 20.0% maize husk which gave the poorest result in the first experiment was supplemented with enzyme at 0.00, 0.02, 0.03 and 0.04% for treatments one to four respectively and used for the second experiment. Rabbits fed diets supplemented with 0.02% enzyme showed the best result in average daily weight gain, average daily feed intake, feed conversion ratio, feed cost per kilogram weight gain, evaluation of carcass characteristics, nutrient digestibility and total protein. These parameters declined with increasing levels of enzyme thus, 0.04% enzyme showed the poorest result in all parameters studied.

6.2 Conclusion

Results obtained from the first experiment showed that the best result in final weight was obtained for rabbits fed 4.0% maize husk while the poorest result was obtained for rabbits fed 20.0% maize husk. It was observed that rabbits could tolerate maize husk up to 4.0% in their diet without negatively affecting weight gain, nutrient digestibility, carcass characteristics, feed conversion ratio, feeds cost per kg gain and haematological evaluation (total protein). Higher inclusion levels of maize husk beyond 4.0% resulted in a decline in performance with regard to nutrient digestibility, carcass and haematological evaluations. The decline in performance with increasing levels of maize husk was attributed to the indigestible fibre content of the husk compared to rice offal.

The treatment that gave the poorest result in the first experiment i.e. (20.0% maize husk) was supplemented with enzyme at levels of 0.00, 0.02, 0.03 and 0.04% and was used for the second experiment. Results obtained showed that all treatments supplemented with enzyme gave a better result in performance, nutrient digestibility, carcass and haematological evaluation compared to the control (0.00% enzyme). Rabbits fed diets supplemented with 0.02%enzyme gave the best result while performance declined with increasing levels of enzyme supplementation .The decline in performance with increasing levels of enzyme was attributed to the rapid impact of the supplemented enzymes on caecal fermentation which resulted in higher digestive activities that was not beneficial to the rabbits. It was therefore concluded that rabbits can tolerate up to 4.0% inclusion level of maize husk in their diet without negative effects on performance. This inclusion level could be increased to 20.0% if enzyme is supplemented at 0.02% thus, improving performance in productive parameters, nutrient retention and evaluation of carcass characteristics.

6.3 Recommendation

This study showed that maize husk can be used as feed ingredient in rabbit diet. The study recommends that rabbit producers can save feed cost on conventional ingredients by incorporating maize husk up to 20.0% with enzyme supplementation at 0.02% level. However if enzymes are not supplemented, maize husk can be incorporated in the diet at 4.0%. The study also recommends that further research should be carried out on maize husk using other enzyme preparations apart from maxigrain to ascertain if higher inclusion levels can be achieved in rabbit diet without negative effects on performance.

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