GROWTH, CARCASS CHARACTERISTICS AND REPRODUCTIVE PERFORMANCE OF WEANED RABBITS (*Oryctolagus cunniculus*) FED DIETS CONTAINING VARYING LEVELS OF HORSERADISH (*Moringa oleifera)* LEAF MEAL

This study was carried out using twenty four (24) female and 4 male weaned rabbits all of New Zealand White, and American Chinchilla breeds aged between 4- 6 weeks with mean weight of between 363- 460 g to evaluate growth, carcass characteristics and reproductive performance of the weaned rabbits fed diets containing varying levels of horseradish (*Moringa oleifera*) leaf meal (MOLM). The rabbits were divided into 4 treatment groups consisting of 6 rabbits per treatment group, replicated in a complete randomized design, and fed four diets designated T_1, T_2, T_3 and T_4 with 0 %, 10 %, 20 % and 30 % M O L M inclusion level, respectively. The experiment lasted for 12 weeks for growth and 16 weeks for reproductive and carcass phase respectively. Results showed that horseradish (*Moringa oleifera*) leaf meal contains the following anti-nutritional factors which were below lethal levels; tannin (21.19 mg/100 g), phytate (2.57 mg/100 g), trypsin inhibitor (3.00 mg/100 g), saponin (1.00 mg/100 g), and oxalates (0.45 mg/100 g) .Parameters evaluated for growth phase, included final body weight, daily weight gain, daily feed intake and feed conversion ratio. (FCR).It was observed from this study that, T_3 (20 %) M O L M inclusion level had the highest significant final body weight (3135.90 g), daily weight gain, (31.90 g) and daily feed intake of (83.42 g) respectively. The significantly lowest feed conversion ratio (F C R) 2.62 recorded for rabbits in 20 % M O L M inclusion level was an indication that at this level there was better utilization by the rabbits, while the highest F C R in T_4 (10.25) indicated poor utilization of the feed at that level of M O L M inclusion. The litter birth weight values ranged from 32.10-38.07 g for T_1 to T_3; T_4 and T_3 recorded the highest values ($p<0.05$) of 55.20 and 59.10 respectively for gestation gain. The weaning traits were significantly affected by the dietary treatments, with T_3 having the highest ($p<0.05$) size (3.33) at weaning and survival rate at weaning 66. 60 %. T_2 and T_3 recorded excellent performance 442.30 g, 408.40 g and 462.52, 421.84 g for mean litter weight at weaning and litter weight gain, respectively. The carcass cuts and organ weights were not significantly ($p> 0.05$) different across the treatments except for lumber-sacral, 13.17 g (T_2,) full intestine 9.95 % (T_4) and abdominal fat, 4.33 (T_2).Based on the findings of this study, it could be concluded that anti-nutritional factors in *Moringa oleifera* leaf meal is below lethal level. At 20 % inclusion level, the animals performed significantly better ($p< 0.05$) for daily weight gain and feed intake over the control group. The best performance for growth and reproduction were observed in rabbit fed 20 % inclusion level of M O L M. Rabbits fed 20 % *Moringa oleifera* were observed to have better digestibility of ether extract, ash and nitrogen free-extract. While those on 10 % and 20 % M O L M had the highest (p <0.05 lumber-sacral weight. The inclusion of MOLM level at 30 %, had the highest ($p <0.05$) values for full intestine and abdominal fat. It was consequently concluded that, 20 % MO L M included to rabbits' diet did not have any deleterious effect on the growth, carcass characteristics and reproductive parameter of rabbits.It was recommended therefore, that, 20 % horseradish (*Moringa oleifera*) leaf meal can be included in rabbit diet for effective growth, reproductive performance and carcass quality.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of study

The Food and Agricultural Organization (FAO), (1995) reported that, there is insufficient food supply in developing countries of the world, including Nigeria. This has resulted in malnutrition, reduced productivity and general underdevelopment. The most important fact of worry is the inadequate animal protein in the diet of an average Nigeria. World Health Organization, (WHO, 2006) stated that on the average, a Nigerian consumes about 5.5 grams of animal protein daily, which is far from the World Health Organization recommended estimate of 60 g per person daily,[World Health Organization (WHO,) 2006]. WHO, (2006) recommended an average animal protein intake of 98 kg per person annually or 65 g per person daily in Europe. With these recognitions, it becomes important to create an intervention to boost the availability of animal protein in the diet of Nigerians to meet the international recommended standard. In Nigeria, cattle, pigs, poultry, sheep and goats have not been able to produce animal protein to bridge the gap between the demand and supply. There should be an expansion in the production of highly prolific, small, livestock, with rapid turnover rates, at very low cost in order to ease the low animal protein problem. This is one of the reasons rabbit production is now receiving attention, as one of the micro livestock in order to alleviate the shortage of animal protein (Igwebuike, Anugwa, Ikurior and Ehiobu, 2001).

Rabbit production has been encouraged by the Food and Agricultural Organization (FAO), for production of meat in the developing countries due to its, high growth rate, outstanding prolificacy, shorter gestation period, and utilization of fibre rich and low grain feeds (Cheeke, Grobner, and Patton, 2006).

Interest in consumption of Rabbit meat is growing because of its low sodium cholesterol, and fat content as compared with other meat sources. Also the rabbit meat is nearly white, fine grained, delicately flavoured, nutritious, appetizing, high in good quality protein, contains a high percent of minerals than other meats like, beef, poultry, mutton and chevon. It has a good meat – bone ratio and is acceptable to the general consumers in most countries of the world.(Amaefule, Iheukwuemere and Nwaokoro, 2005).

The feeding habit of rabbit (*Oryctolagus cunniculus*) does not competition with humans, because it can survive on vegetable basal diets. (Omole and Ajayi, 2006). Rabbit breeders are encountering feeding problems as there is increase rabbit industry in many African countries today and they have solely depended on concentrates for their animals. (Omole and Ajayi, 2006). To make rabbit production more viable as a small scale business, there is need for the development of cheap sources of feed as an alternative to supplement or replace cereal or protein sources in diet of rabbit in order to make production of rabbit more profitable. The high cost of conventionally used plant protein sources mainly soyabean, groundnut and cotton seed cake pose a major problem in their wide spread use as feed stuff for livestock.

It is evident that the conventional sources of feed can no longer adequately supply the needs of the fast growing livestock industry. (Abubakar , 2008). The author also stated that, once the supply of available nutrients for feeding livestock is increased, especially from unconventional sources, the sustainability of animal agriculture will be ensured.
Despite the large number of legume grains in Nigeria, only soyabean, cotton seed cake and groundnut cake are mainly used in livestock feeding. Several other locally available species that exhibit remarkable adaptation to tropical conditions have been underutilized and under-exploited for livestock feeding (Apata and Ologhobo, 2004).Alternative or unconventional plant protein sources are therefore, been sought for, to be adapted in new feeding scheme. (Omole and Ajayi , 2006).

Devendra, (1991) defined Unconventional plant protein sources (UPPS) as all those feeds that traditionally have not been used in animal feeding and /or are not commercially used for livestock rations, examples of unconventional plant protein source are; pigeon pea, locust bean, sunflower and pawpaw leaf meal.

Horseradish *(Moringa oleifera)* leaf meal is a good natural source of protein and can be conveniently used to replace soyabean or groundnut cake in livestock diet (Ozumba, 2000). The author stated that, *Moringa* leaves contain, four times the calcium in milk seven times the vitamin C in orange, three times the potassium in banana, two times the protein in milk and four times the vitamin A in carrot, that *Moringa oleifera* is also a natural source of protein with great potential. The leaves contain magnesium, potassium, and all of the essential amino acids like, cysteine, histidine, arginine, methionine, lysine, phenylalanine, leucine, Isoleucine and valine. *Moringa* leaves are eaten by sheep, pigs, cattle, goats and rabbits, the leaves are also used to feed fishes. *Moringa* leaves are probably ranked as the best of all the vegetables in the tropical. They contain very strong concentration of vitamins A, C and B – complex vitamins, iron, protein, zinc, selenium which is unusual for a plant source, (F A O, 1995).
Church World Service, Dakka, (1994) recommended the addition of dried leaf powder of *Moringa* to improve the protein content of food since 6.7 g of protein is contained in 100 g of fresh leaves. The authors also recommended that during the months of pregnancy or breast feeding, a woman should consume 65 g of protein daily, so 38 % of her protein needs of her protein needs will be satisfy by 100 g of *Moringa* pod. 10.3 % of her protein needs for each day will be satisfy by 100 g fresh *Moringa* leaves. *Moringa l*eaves (fresh) contain more than twice the amount of protein (2.8 g/100 g) found in spinach.(Olugbemi, Mutayoba and Lekunle, 2010).

1.2 Statement of research problem
There is insufficient and high cost of animal protein in Nigeria, which is traceable to high cost of conventional feed ingredients (Omole and Ajayi, 2006).Rabbit breeders and farmers are facing the problem of feed scarcity especially during the dry season as there is scarcely

commercialised cheap rabbit feed. The public are now conscious of high quality animal protein, like rabbit meat hence the need for the use of non-conventional feed ingredient like horseradish (*Moringa oleifera)*, which is draught resistant and unexploited (Ozumba, 2000).

1.3 Justification of the study

High cost of conventional animal feed stuff and high demand for cheap and quality animal protein has made it imperative to use horseradish (*Moringa oleifera*) which is cheap, sustainable and flourishes especially during the dry season as alternative feed source for rabbit.(Ozumba, 2000). Rabbit is prolific, easy and cheap to maintain, produces animal protein of public health interest, consequently rabbit can bridge the gap between the demands and supply of quality animal protein, hence the need for intervention to boost productivity.

1.4 Aim and objectives

The aim of this research work was to investigate the growth, carcass characteristics and reproductive performance of weaned rabbits fed diets containing varying levels of horseradish (*Moringa oleifera)* leaf meal as a protein supplement.

1.4.1 Specific objectives

The specific objectives are to:-

i. Assess the feed intake, feed efficiency, nutrient digestibility and body weight changes of weaned rabbits fed diets containing varying levels of horseradish (*Moringa oleifera)* leaf meal.

ii. Evaluate the reproductive performance of rabbit does fed diets containing varying levels of horseradish *(Moringa oleifera)* leaf meal.

iii. Evaluate the effect of feeding diets containing varying levels of horseradish *(Moringa oleifera)* leaf meal on the carcass cuts and organ weights of rabbits does.

iv. Determine the best inclusion level of horseradish *(Moringa oleifera)* leaf meal in maize based diet for rabbit.

CHAPTER TWO

2.0. LITERATURE REVIEW

2.1. Origin of rabbit

The domesticated rabbits descended from wild rabbit in the Mediterranean countries and were introduced into England in the last eleventh to early twelfth century (Aduku and Olukosi, 1990). They were taken to various parts of the world, including Nigeria by early sailing vessels whose masters wished to have readily available source of meat at various points on their voyages. The authors also stated that, the European rabbits on the other hand were transported to Australia and New Zealand. Domesticated rabbits are descendants of the European wild rabbit, O*ryctolagus cunniculus.* It belongs to the order *lagomorpha and* family *leporidae* (Aduku and Olukosi, 1990). Rabbit is known in the local language as *Zomo* (Hausa), *Adeji* (Igbira), *Ehoro* (Yoruba), and *Ewi* (Ibo). Rabbit is by no means giant rat as erroneously called by some people. (Aduku and Olukosi, 1990).

2.2. Breeds of rabbits

There are now several hundred different breeds and varieties of rabbits throughout the world, varying in types of coat colours and sizes. The coat colour may be solid black, chocolate, grey, white, with spots or mixed colours (Aduku and Olukosi, 1990).The authors also reported that, breed name depends on location or place of origin, colour of coat, size or breeder's nomenclature. The breeds include Californian white, New Zealand White, American Chinchilla, Flemish giant, Satin Angora, French Angora, Mini Satin, English Spot, Florida White and French Lop.(American Rabbits Breed Association, 2005).

Plate 1: New Zealand White

PLATE 11: California White

Plate 111: American Chinchilla

Plate IV: Flemish Giant

New Zealand White: They have a long, muscular body weighing between 4.1-5.4 kg at maturity. The coat colour is majorly white, but blue also exist. They have bright distinctive eyes in ruby red or pale pink colour. They are bred for both meat and fur they have easy and good temperaments which make them a quick favourite as a domestic rabbit. They are also used as show rabbits. They have well rounded body. Their faces are slender and muscular round cheeks, with large hind legs and short front feet. Their ears stand up straight and are long with thick body fur which is shorter at the ears and allows the pink of their skin to show through. The female also have flap of fur as dew lap below the chin which is usually pulled for a nesting box for kindling. (American Rabbits Breed Association, 2005).

California White: This is a large breed weighing between 3.6 -5 kg at maturity. It has white coat colour, with black in the nose, ear, feet and tail. The breed has a firm body with big ears. It is bred for excellent meat qualities. They produce 8-12 kits, which are fast growing and reach fryer size (1.8- 2.3 kg) in 8-12 weeks. The breed is developed for show and commercial purposes. (American Rabbits Breed Association, 2005).

American Chinchilla: It has a medium body and slight arch in the back. The body is compact, Medium built, with short neck, erect ears, and fairly broad head and weighs between 4.1-5.5 kg. It has surface fur grey, under deep blue grey, with belly white, which is long, smooth and glossy. The coat is dense, soft, and silky with medium length hair. The under colour is dark slate blue, with middle band pearl colour and the tips of the hair is grey. The belly, neck, flank and the ears are laced with black. The American Chinchilla rabbit are very gentle and docile natured. It is a large hardy and gentle animal. They produce large litters, and have good mothering instincts. (American Rabbits Breed Association, 2005).

Flemish Giant: It is a gentle giant in the rabbit world. It is a very popular breed and weights between 5.9 -7.3 kg. They are classified as giant breed of rabbit, long and heavy body. They are commonly steel grey in colour, though other colours are seen as sandy, fawn, white, blue and black. The fur is dense and glossy and when stroked from the hindquarters to the head, the fur will roll back to its original position. The rabbits are long with a large full head, long and erect ears. They are intelligent and can be a bit cantankerous if not handled regularly from an early age. They have a great personality; they are always calm and well behaved. They are one of the largest breeds of domestic rabbit; with long body and powerful broad hindquarters. The bucks have a broad and massive head. (American Rabbits Breed Association, 2005).

2.3 Nutritional requirements of rabbits

Rabbits are simple stomached animals and are herbivorous, because their diet comes mainly from plant sources, they have enlarged caecum and therefore can use more forage in their diet than other simple stomached animals, such as swine and poultry. (Cheeke *et al.,* 2006).Rabbits habitually practise coprophagy (eating the soft part of their faeces or dropping) and are sometimes referred to as pseudo ruminants because this practice of coprophagy is similar to rumination practiced by ruminants, in the sense that, it provides a method of passing feed stuffs through the digestive tract a second time. This can also improve digestibility of the feed that was undigested the first time. With this, rabbit fed poor protein diet can be in positive nitrogen balance. Rabbits start this practice of coprophagy when they start eating solid feed at about three to four weeks of age (Aduku and Olukosi, 1990).

2.3.1. Protein requirement of rabbits

Rabbit practice Coprophagy hence quantity and quality of protein are not critical as in poultry. Lysine and methionine are usually the amino acids that are found deficient in rabbit rations, while there is some bacterial protein synthesis in the caecum. It is not enough to meet the essential amino acids requirement of the rabbit (Aduku and Olukosi, 1990). The authors however found that, optimal production can be achieved with high protein and good protein quality. That also, protein requirement of 12–17 %, 0.65 % lysine, 0.60 % methionine, can be met by combining protein source like fish and soyabean meals. The authors revealed that; rabbits accept feed at 20 % crude protein but the performance characteristic were not affected at 18 % crude protein contain. The recommended crude protein level for rabbit's gestation, growth, lactation, maintenance and other production purpose is 16 -20 % (Johnson, 2006).

2.3.2 Fibre requirement of rabbits

Rabbits require 9 % level of crude fibre for normal growth and to reduction in the incidence of enteritis. Aduku and Olukosi,(1990). However, a high fibre level in excess of 20 % may cause ceacal impaction and limit energy intake. Dietary fibre intake should be in the range of 15 – 20 %.*(* Cheeke *et al.,* 2006*).* The authors stated that, crude fibre level of between 10 to 17 % will support weight gain. The optimal level of crude fibre supporting optimal gain of 41.3 g/day /animal was 14.8 %, while a crude fibre level exceeding 17 % reduces performance by limiting energy intake.(Cheeke *et al.,* 2006).

2.3.3 Energy requirement of rabbits

It is believed that rabbits, like many other animals, adjust their energy intake to meet their needs. The energy requirement of rabbits is influenced by the environmental temperature. As the temperature decreases, the rabbit requires more energy to maintain normal body temperature. (Lebas, Coudert, Rouer , Rocham, 1990).

Aduku and Olukosi, (1990), stated that, fibrous and non-fibrous components of the feed are used to meet energy requirement of rabbit in addition to fat added the ration is the best way to increase its energy level of the ration. The authors stated that up to 20 – 25 % fat in a diet can be handled by the rabbits depending on the age and that fat also provides energy as well as supplying essential fatty acids like linoleic. Fat also provides palatability, and reduces dustiness in feed. The authors recommended energy level of between 2390 and 2500 kcal of digestible energy (D E) for growth, lactation, pregnancy and maintenance.

2.3.4. Mineral and vitamin requirement of rabbits

A calcium / phosphorus ratio of 1:1 in rabbit diet will meet the need for these mineral elements. Rabbits can tolerate high levels of calcium in the diet without adverse effects. (Lebas *et al.,* 1990). The authors also stated that, levels of phosphorus above 1 % of the diet reduce the palatability of the diet and may lower feed intake .The use of iodized salt at the rate of 0.5 % of the diet will supply the needed sodium chloride, and iodine for rabbits.((Lebas *et al.,* 1990). The authors also confirmed that, several of the water soluble vitamins, especially pantothenic acid, riboflavin, folic acid, vitamin B_{12} and biotin are synthesized by rabbits in amount sufficient to meet their needs; no additional supplementation of the diet is usually needed for this vitamins.

2.3.5. Water requirement of rabbits

Water is the most important item in the rabbit diet. It is a vital nutrient required by all animals for life, but rabbit requires more water than dogs and poultry.(West, 2005). For example, in one day, a 2.5 kg rabbit requires as much water as a dog weighing 11.5 kg (West, 2005). In fact the average rabbit consumes between 50 and 150 ml of water per kg of body weight per day.(West, 2005).Adequate water should be supplied in order for the rabbit to gain and grow adequately. Water is important to avoid dehydration. Portable water should be given to rabbits 2 – 3 times daily. A doe with a litter drinks about 4 litters of water per day (West, 2005).

2.4. Unconventional feed stuffs for rabbit production

Various leaves and seeds of forest or savannah tree had been tested, evaluated and found to be good replacements for some conventional feed stuffs in rabbits production, (Igwebuike *et al.,* 2001).Rabbit can tolerate up to 40 % *Acacia albida* pods as a replacement for maize and maize bran without adversely affecting the digestibility of the diets. Olayinka et al. (2000) found that, addition of Loofah gourd *(Luffa aegptiaca)* seeds meal serves as a vegetable protein source not competed for as food when compared with soyabeans, cowpea, coconut, groundnut, or other conventional plant protein eaten by human. Rabbits that were fed 5 % Loofah gourd *(Luffa aegptiaca)* seed meal showed optimal performance indices, and exhibited good nutrient and haematological values.

According to Omole and Ajayi (2006), rabbits fed sunflower leaf (*Stylosanthes guianensis)* compared favourably in terms of weight gain, feed intake and feed conversion ratio with those fed other conventional forages The authors found out that, substitution of concentrate diet with Lablab forage meal up to 20 % did not adversely affect weight gain and feed intake. Igwebuike *et al.* (2001), reported that, *Moringa oleifera* leaf meal in cassava based diet, did not impair the growth performance of rabbits, therefore 30 % inclusion level is recommended in the diet of adult rabbits, also the authors reported that with the exception of the caecum, the experimental treatments did not influence organ weight of the rabbits. Cheeke e*t al.* (2006), carried out studies with rabbits, fed fourteen different forages, five of which could be found in the tropics, they found rabbits' preferences by the amount they consumed in four periods as follows: sunflower leaves (98.4 g), green bean vines (95.4 g), carrot tops (92.6 g), core leaves (66.4 g), amaranthus (65.6 g) and grape leaves (56.8 g).

Aduku and Olukosi (1990), in another study on tropical forages exposed New Zealand white rabbit to 100 g of each of sixteen different fresh green forages for four hours period, they found that the more leafy and succulent greens were consumed more than the non-succulent and woody plants. The results showed that more *Tridax procumbens* leaves were consumed than any of the greens. This is because tridax is very succulent in the leaves and stem. In another study, Igwebuike *et al.* (2001) identified some forages which could be used for rabbit feeding as; *Centrosema pubescens*, *Panicum maximum, Manihot esculenta* (tops), Banana leaves, pawpaw leaves, *Telferia occidentalis* and plantain leaves.

2.5. Growth performance of rabbits

Onyekwere, Olabode, Okechukwu and Iheukwumere (2010) incorporated Bambara nut waste meal up to 20 % inclusion level in the ration of growing rabbits, the authors found that there was no deleterious effect on the growth parameters. However, the researchers observed significant (p<0.05) differences in feed intake and their weight gain increased with increase in Bambara nut waste meal inclusion. They also recorded feed conversion ratio of (6.5) at 20 % dietary level inclusion of Bambara nut waste meal. The authors stated that, lower feed conversion ratio is an indication that the diet was better utilized by the rabbits. On the contrary, Apata and Ologhobo (2001) had earlier reported that feed intake reduces with increase in Bambara nut waste meal inclusion.

Feed conversion ratio values of 3.33, 2.75 and 6.00 were recorded at 5 %, 10 % and 15 %, inclusion levels of Loofah gourd seed meal (LGSM) in rabbit diets, respectively. Olayinka *et al*. (2010) reported that, daily weight gain, daily feed intake as well as the feed gain ratio were not significantly (P<0.05) affected by dietary treatment when wild sunflower leaf meal was used to feed rabbit. Crude protein, crude fibre and dry matter digestibility were significantly affected, also dietary treatment had significant (P<0.05) influence on ash, nitrogen free extract and ether extract digestibility. The authors concluded that, wild sunflower leaf meal could be efficiently tolerated and utilized by weaned rabbits without any deleterious effect up to 20 % inclusion level. Lebas *et al*. (1990) reported, feed conversion ratio of 4.53 and 4.87 when rice milling waste was used for rabbit feeding at 20 and 25 % inclusion levels.

Tham, Torres and Campos, (2008), fed rabbits with pressed cassava leaf residues, replacing maize at 5,10, 15 and 20 % inclusion levels, they found that, average weight gain were 25.37 g, 26.00 g, 27.90 g, and 10.60 g. There were no significant (P>0.05) differences in final body weight, body weight gain and feed conversion ratio when palm kernel nuts were replaced with cooked Tallow meal fed to weaned rabbits. (Jiya, Ijaiya, Oguche, Afolayan and Abdulkadir, 2010).The authors also stated that, there were significant (p<0.05) differences in the nutrient digestibility for, crude protein, dry matter ether extract, nitrogen free exact and crude fibre. Aduku and Olukosi, (1990) as well as Adegbola and Okonkwo, (2002) stated that, daily weight gain falls between 15 -30 g and Aduku and Olukosi, (1990) further reported a range of feed conversion ratio of 2.5-3.5, when rabbit were feds with varying levels of cassava leaf meal.

Adegbola and Okonkwo, (2002) obtained crude fibre digestibility of 21.6 % for groundnut haulms and 21.21 % for potato leaves and 29.15% for leuceana leaf meal, when the leaf meals were fed to rabbits at 10, 20 and 30 % inclusion levels, respectively. Omole and Ajayi (2006) reported daily body weight gain of 12 g, when they fed dried brewers' grain to rabbits while a range of 17.65-18.80 g daily weight gain was reported by Tham, *et al*. (2008) on cassava leaf meal.

Ojebiyi, Olota, Farinu, Babatunde, Akande and Olabanji (2009) conducted a study on nutrient digestibility of growing female rabbit fed diets containing processed cassava leaf meal mixture .The authors stated that, the final live weight, dry matter digestibility, ether extract, nitrogen free extract, weight of the rabbits were not (p>0.05) affected by the treatment diets while digestibility of crude protein and crude fibre were significantly affected. The authors concluded that the non-conventional feed ingredients can be included in growing rabbit's diets up to 30 % level.

2.6. Reproductive performance of growing rabbits

Odeyinka, Oyedele, Adeleke, Odedire, Odubote, and Akinnokun (1990) conducted a study on rabbit does to evaluate their reproductive performance on *Moringa oleifera* as a replacement for *Centrosema.* The horseradish (*Moringa oleifera)* leaf meals were offered to the animals at an inclusion level of 0, 25, 50, 75 and 100 % to the concentrate feed and fed at 2 % of live weights respectively. The does on 25 % had the highest DM intake (131.6 g/day) followed by does on 50 % (125.5 g/day) and does on 0 % (122.5 g/day), while does on 100 % *Moringa* had the lowest (112.1 g/day). Does on 100 % horseradish (*Moringa oliefera)* leaf meal had the highest litter birth size of 5.12. Does on 50 % horseradish (*Moringa oliefera)* leaf meal, had the lowest litter size at birth (4.06) and this was significantly ($P< 0.05$) different from that of 100 % horseradish (*Moringa oliefera)* leaf meal fed does (5.81). There was no significant ($P>0.05$) difference in the gestation length and initial bodyweight of the does on the other treatments as well as in the litter birth weights. The average daily weight gains per kitten were 6.78, 8.13, 8.64, 8.06, and 6.99, g/day for does on 75 %, 50 %, 25 %,100 % and 0 %, horseradish (*Moringa oliefera)* leaf meal treatments, respectively. There was a significant difference ($P<0.05$) in average daily weight changes per kitten. The authors concluded that, horseradish (*Moringa oleifera)* leaf meal can be used to replace *Centrosema Pubescens* for effective reproductive performance without adverse effect on rabbits.

Odubote and Akinokun, (1992) obtained a weaning weight of 336.26 g in a study of post weaning performance of rabbits in rainforest ecological zone in Nigeria. Aduku and Olukosi, (1990) reported weaning weight of 306-400 g but Ilori *et al*.(2003) reported weaning weights of 306-358. Parity has been reported to influence weaning weight of rabbits (Prayaga and Eadyu, 2003). The authors also reported post weaning weight of 695.45 g but this was higher than 400 g reported by Adama and Haruna, (2000). Post weaning weight of 695.45 g was reported by Odubote and Akinokun, (1992) when they fed rabbits with dry brewers' grain.

Odeyinka, Olosunde, and Oyedele (2008) in a study, evaluated production performances of local breed of rabbit and Californian breed, reported the following on the performances of local rabbit population such as litter size at birth (6.2), number born alive (5.7), litter size at weaning (5.2), daily weight gain (33.6 g/day), live weight at slaughter (2117.5 g), feed efficiency index (2.16) when bred with Californian male rabbit. The authors stated that, the litter birth size, litter weaning size , daily weight gain from weaning through slaughter, the mean live weight at slaughter, showed significant($P>0.05$) difference.

Isaac, Okonkwo, Unah, Eyoh and Essien (2010) conducted a study on litter traits of different breeds of rabbit and recorded average litter size of 9.25, 7.25 and 5.25 at birth for New Zealand White, American Chinchilla California White and Local breed, respectively. The values were within the reported ranges of 2 to 9 (Odubote and Akinokun, 1992) and 3 to 12 (Lebas *et al.*, 1990) and are in agreement with Odubote and Somade, (1992). Mean values were significantly ($p <0.05$) different, indicating that the different breed had a significant effect on the litter size of the rabbits. The average litter sizes at weaning were 3, 2.3, 3 and 3.5 for the four respective breeds (New Zealand White, Local breed, American Chinchilla and California White). Litter size was not significantly ($p>0.05$) affected by the changes in weight during pregnancy. This was rather low and contradicts earlier report by Prayaga and Eadyu, (2002) who reported the following average weaning weights of litter, 1050, 810, and 475 g for the respective breeds. There were no significant ($p>0.05$) differences in the weaning weights of litters among the different breeds, this indicates that the large litter size at birth will not likely result in a large weight at weaning and contradicts the report of Odubote and Somade, (1992) who reported that litter birth size at was significantly ($p< 0.05$) different among breeds, while litter weaning size, showed no significant ($p>0.05$) difference. The authors also stated that, Litter traits are an indication of good nursing and mothering ability.

2.7. Carcass cuts and organ weights of growing rabbits

Several factors affect the dressing percentage of a rabbit carcass. In Europe, the head and the feet are left on the carcass, so the dressing percentage (60 – 62 %) is higher than the dressing percentage (50 %) in United State where the head and the feet are removed. In Nigeria, the head, skin and legs are left on the carcass, so dressing percentage (74 %) is higher than dressing percentage in Europe. The skin, head, and feet contribute about 11 %, 10 %, and 3 %, respectively of skinned carcass (Aduku and Olukosi, 1990). The carcass and meat quality of two breeds of rabbits (Soviet chinchilla and Grey Giant were studied under warm –humid condition of West Bengal, overall dressing percentage of 47.6, 51.7 and 57.9 % were obtained (Odeyinka *et al*., 1990). Farinu, and Akinola (2006), studied the organ characteristics, carcass quality and growth performance of weaned rabbits fed varying levels of wild sunflower (*Tithoninia diversfolia*) leaf meal. There were no significant ($P >0.05$) difference in the weights of heart, lung, kidney, spleen, stomach, pancreas, large and small intestine for the experimental diet containing 20 % inclusion level of wild sunflower (*Tithoninia diversfolia*) leaf meal.

2.8. Anti-nutritional factors of forage plants

Anti-nutritional factors (A N F) are defined as natural or synthetic substances found in the human diet or animal feed, that have the potentials to adversely affect health and growth by preventing the absorption of nutrients from food (Enechi and Odonwodu, 2003). The authors also reported that, the largest single factor limiting the use of feedstuff are the presence of endogenous anti nutritional factors which are believed to be in animal and fish feeds at high dietary levels. Unfortunately studies on toxicology of these anti nutritional factors have not been performed on the majority of the feedstuff. Enechi and Odonwodu (2003), confirmed that the presence of these factors if untreated normally result in reduced growth rate, poor feed conversion efficiency and anorexia when used at a high dietary concentration. Heat treatment is usually applied to destroy or reduce the effects of these anti nutritional factors to non-lethal levels. Examples of the phytochemicals (anti nutritional factors) found in forage crops include; soponin, flavonoid, tannin and phytate.

2.9. Horseradish (*Moringa olifera)* plant

Horseradish tree *(Moringa oleifera)* commonly called *Moringa* is of the family *Moringaceae.* It grows mainly in subtropical areas and semi-arid tropical It is a soft wood, native of India, occurring wild, in the sub Himalayan region of Northern India (Church World Service, Dakka, 1994).In English language *Moringa* is also known as horseradish tree; never die tree, drumstick, Ben oil tree and tree of paradise. *Moringa* is popularly known as *Zogale* among Hausa speaking Nigerians, *Gawara* in Fulfulde, *Okwe Oyibo* in Ibo and *Ewe Igbate* in Yoruba Language (Ozumba, 2000). *Moringa* can grow naturally at elevation of up to 100 m above the sea level; it grows well on hill, fast growing and has been found to grow up to 6-7 meters in one year in area receiving less than 400 mm mean rainfall. It is now been cultivated throughout the whole of tropical belt of world especially, the Middle East. (Ozumba, 2000).

It was introduced from India to Eastern Africa at the beginning of the 20th century. Horseradish (*Moringa)* is one of the most useful tropical trees. It grows with relative ease and can be propagates through both sexual and asexual means, it requires low soil nutrients and water after being planted. This makes its management and production very easy (Ozumba, 2000).

2.9.1. Description

Horseradish *(Moringa)* is a perennial tree, fast growing, and reaches a maximum height of 7-12 m and diameter of 20-40 cm, with short and straight stem normally, but occasionally poorly formed. It reaches a height of 1.5-2.0 m before it branches reaching up to 3 m. (Church World Service, Dakka, 1994). The branches grow and forms umbrella shaped canopy. The flowers are about 2.50 cm in width, pleasantly scented with drooping panicles about 10 to 25 cm long. They have cream, white and yellowish, colour with dots at the base. The fruits (pods) measure between 20-60 cm in length and are three lobed hanging down the branches. The dried pods open into 3 parts, each pod containing between 2 to 35 seeds; the seeds are brownish semi-permeable, rounded with a seed hull. Three white wings run through hull from top to bottom at 120 degree interval. A tree can produce between 15,000 to 25,000 seeds annually. (Church World Service, Dakka, 1994).

2.10. Horseradish (*Moringa)* as forage plant

According to Dauda, Orunmuyi and Joktham (2009), the best way in assessing the suitability of a feeding material for rabbit nutrition is to include graded levels in the diets at the same time ensuring all that nutrients required by the animal are supplied and the measure of performance to know the optimum inclusion level.

Moringa plant is of great scientific interest, since it possesses many valuable properties (Dauda *et al*., 2009), which include high protein content of the twigs, leaves and stem, the seeds has high protein, oil, and sugar content. *Moringa* has high productivity of fresh material per unit area when compared with other forage crops. The leaves are eaten by rabbits, sheep, cattle, pigs, goats, and can be used to feed fish.(Ozumba, 2000).

Dauda *et al*. (2009).also stated that, chemical compositions of *Moring*a leaves obtained in Nigeria are as follows; crude protein 29.6 %, crude fibre 19.1 %,ether extract 5.2 %, calcium 2.06 %, phosphorous 0.24 %. The high crude protein content reported by Ozumba, (2000) makes it a good protein source for livestock feed. The author also reported that, *Moringa* is very rich in essential amino acids; like phenylalanine, Tyrosine, Valine, Histidine, Alanine, Tryptophan and Arginine. The leaves are also reported to contain Glutamic acid, Aspartic acid, and Glycine, which makes it a good source of protein feed for monogastric animal. The author confirmed that, *Moringa* is sustainable; it does not destroy the environment but instead adds value to it. Olugbemi *et al*. (2010) evaluated the suitability of including horseradish (*Moringa oleifera)* leaf meal as a feed ingredient in cassava (CC) based diet for broiler, the following results were observed, a reduction in performance at inclusion levels beyond 50 %, increased feed intake as inclusion level increased probably due to increased bulk and lower metabolizable concentration, decreased efficiency of feed utilization with increased level of inclusion and a declined final weight gain as inclusion levels increased.

2.11 Importance and uses of horseradish (*Moringa oleifera*)

Some traditional herbalists have for a very long time identified *Moringa* to cure many diseases, and also used it as food and nutritional supplements, but modern scientists began to reap its benefits only recently .(Church World Service, Dakka, 1994). *Moringa* has been found to have the following it is only recently that properties; the powder from the kernels is a natural coagulant, clarifying very turbid water. 99 % of bacteria in the water can be removed in this process. The leaves are organic, natural endurance and energy supplement of health and the most beneficial and purest part of the plant. Horseradish (*Moringa* leaf meal) is produced by drying the fresh leaves under a shade and then grinding into powder.

Church World Service, Dakka, (1994) reported that malnourished little babies in some part of Africa has been given Horseradish (*Moringa* leaf meal).They also stated that; athletes all over the world boost their performance ability by taking huge quantities of the leaf to keep them fit both mentally and physically and is very effective for the senior citizens who are losing their sharpness of mind. Olugbemi *et al.* (2010) identified that, the *Moring*a leaf lower the blood pressure and promote good sleep it has a soothing ability. Traditionally the flowers are used as diuretic, tonic and it is also used for the treatment of muscle diseases, inflammation, enlargement of the spleen and tumours. They also stated that, the roots treat epilepsy, milk mixed with the root juice is considered effective against asthma, various tumours and hiccoughs. Ozumba, (2000) suggested that *Moringa* is one of the most economically important tree crops in the tropics and sub tropics. It has many attributes such as, provision of clean water, its ability to survive under difficult conditions, income yielding and medicinal potentials. Ozumba (2000) concluded that, it is surely no exaggeration to call *Moringa* “The miracle tree’’.

2.12 Phytochemical composition and anti -nutrients in horseradish (*Moringa oleifera*) Leaves

According to Enechi and Odunwodu (2003) *Moringa oleifera* leaves contain tannin, phytate, trypsin inhibitors, saponin, and oxalate. Boiling in hot water reduces anti-nutrients in plants. The authors confirmed, organically bound form of phosphorus in plants is phytate and when they are present in foods, bind with essential minerals (such as magnesium, zinc iron and calcium) in the digestive tract. They form insoluble salts which result in mineral deficiencies, thereby decreasing their absorption or bioavailability.

Tannin is plant polyphenols, which form complexes with metal ions and macro-molecules such as polysaccharides and proteins. (Bello *et al.,* 2008). Dietary tannins reduce weight gain and feed efficiency in rabbits. (Enechi and Odunwodu, 2003).
Saponin is a glycoside, which include saponin, triterpenoid soponin and steroid. High levels of saponin in rabbits feed, affect growth rate and feed intake.(Enechi and Odunwodu, 2003).The authors confirmed that the bitter taste of saponin reduces feed intake due to the irritating bitter taste. Hypercholesterolemia is caused by excess saponin as it binds cholesterol making it unavailable for absorption. It has haemolytic activity against red blood cells. Saponing-protein complex formation can reduce protein digestibility (Enechi and Odunwodu, 2003). Oxalate binds with calcium to form calcium-oxalate crystals which are known as urinary calcium (stones), which cause blockage of renal tubules. Trypsin and chymotrypsin are inhibited by trypsin inhibitor which plays a role in digestion of protein in animals. However, toxic effects could be reduced by soaking of plant materials or boiling in water which improves utilization in terms of protein digestibility and feed intake. (Thompson, 1993). Method of preparation of samples and environmental factors may influence the concentration of tannins in plants but adequate food processing would reduce anti-nutrients (Thompson, 1993).
The Church World Service, Dakka, (1994), on *Moringa* Agenda and nutrition project recommended the use of dried *Moringa* leaf powder should be used as nutritional additive to infant formulas. One or more spoonfuls of *Moringa* leaf powder can be a source of valuable nutrition for people of all ages. All the protein, mineral and vitamin content are bio available. A 100 gram serving of fresh leaves is required by a child aged 1-3 years to provide all his/her daily need of vitamin C. *Moringa* leaves has high concentration of protein, iron, copper, vitamin, and essential amino acids which makes it an important nutritional supplement.

According to Church World Service, Dakka, (1994). To make *Moringa* leaf powder, the leaves are dried under a shade, and then rubbed over a sieve, and the powder stored in a well-sealed, opaque plastic container to prevent direct sunlight which destroys the vitamin A content. Church World Service, Dakka, (1994), also stated that, *Moringa* leaf dried under direct sunlight retains only about 20-40 % of vitamin A, while the *Moringa* leaves dried in the shade retain between 50-70 % of vitamin A, in addition, 23 % of the iron, 40 % of the calcium, and all the vitamin A needs of child is satisfy by one rounded soup (table) spoon of *Moringa* leaf powder. During times of pregnancy and breast-feeding, a woman's daily iron and calcium needs is met by six rounded table spoonfuls of *Moringa* leaf powder.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1. Location of experiment

The research work was conducted at the Federal Capital Territory (F C T) Rabbit Multiplication Centre Zuba, Abuja. F C T is within latitudes 09. 40 ^{o} N, and longitudes 07.29 ^{0} E with altitude 341.92 m above sea level located in the Derived Savannah and Guinea Savannah Agro-ecological zone of Nigeria.(Federal Capital Territory Metrological Records, 2011). It is characterised by two seasons namely, rainy/wet season (April-October) and dry/harmathan season (November-March). The south-westerly wind is the predominant wind during rainy season while north easterlies prevail during the dry season. Dust haze and heat waves are the dominant weather conditions during the dry season, while thunder, lightning, thunderstorm, rainstorm and rain shower occur in the rainy season (Federal Capital Territory Metrological Records, 2011).

The hottest and coldest periods in the F C T are in February and December respectively, Normal mean maximum temperatures range between 29 ^{0} C and 37 ^{0} C while minimum temperature ranges between 18 ^{0} C and 24 ^{0} C. The annual rainfall ranges between 1198 mm and 1940 mm. (Federal Capital Territory Metrological Records, 2011).

3.2 Source and preparation of *Moringa oleifera* leaf meal

Moringa leaves were harvested during the dry season from Eduga farm in Kuje Area Council of Federal Capital Territory, Abuja. The leaves were washed, then spread out on a concrete clean floor and dried for a period of 3-4 days under a shady condition to reduce loss of vitamins, especially Vitamin A as described by the Church World Service, Dakka, (1994). The dried leaves were pounded and sieved. It was then taken to National Institute for Pharmaceutical Research and Development (NIPRD), Idu Industrial Area, Garki, for anti-nutritional factor analysis.

Plate v: Young horseradish *(Moringa oliefera*) plant

3.3 Sources of other feed ingredients and rabbits

All feed ingredients were purchased locally within Federal Capital Territory (FCT) Abuja. Maize was bought from Gwagwalada market, rice offal from rice mills. Ground nut cake, bone meal, lysine, methionine and grower's premix were purchased from Eduga Feed mill in Kuje FCT, Abuja. The Maize grains were crushed in Eduga feed mill and other feed ingredients mixed in their mixer, pelletized and then dried. The weaner rabbits were obtained from the Rabbit Multiplication Centre Bosso, Minna, Niger State.

3.4. Experimental Rabbits and Management

Twenty four (24) female and 4 male weaned rabbits all of New Zealand White, and American Chinchilla breeds between the ages of 4–6 weeks were used for this research work. Two weeks before the arrival of the weaned rabbits, the rabbitry, hutches, feeders and drinkers were properly cleaned, washed and disinfected. The pens were illuminated with electric bulbs to provide warmth for the experimental animals. Each animal was housed in a wooden hutch with wire mesh and net at the base, top and side s of the hutches .The rabbits were administered with 0.5 ml of ivomec each, sub-cutenously for the control of both ecto and endo-parasites and they were allowed a two week period for acclimatization. After the acclimatization period, the rabbits were randomly allotted to four dietary treatments comprising of six rabbits per treatment group of three replicate with two rabbits per replicate using the complete randomized design (CRD). The treatment diets were offered to the rabbits at 8:00 am and 5:00 pm daily. The rabbitry, faeces trays, feeders and drinkers were washed daily and portable water provided *ad-libitum* throughout the experimental periods.

3.5 Composition of the experimental diets

The composition of the experimental diets is presented in Table 3.1.

Four experimental diets were formulated, with crude protein content of 18 % in line with Aduku and Olukosi, (1990). The authors recommended metabolizable energy not lower than 2205.60 kcal, and crude fibres not lower than 9 % and not higher than 19 %. Diet T_1 was the control 0 % horseradish (*Moringa oleifera*) leaf meal, while diet T_2, T_3 and T_4 contained 10 %, 20 % and 30 % horseradish (*Moringa oleifera*) leaf meal, respectively.

Table 3.1: Composition of experimental diet

	Dietary treatments %			
Ingredients	T_1	T_2	T_3	T_4
Maize	46.69	45.13	43.39	41.53
Groundnuts cake	27.91	26.52	24.97	23.15
MOLM	-	2.95	6.24	9.92
Rice offal	20.00	20.00	20.00	20.00
Bone meal	3.00	3.00	3.00	3.00
Growers premix	0.30	0.30	0.30	0.30
Lysine	0.30	0.30	0.30	0.30
Methionine	0.30	0.30	0.30	0.30
Salt	0.50	0.50	0.50	0.50
Palm oil	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00
Crude protein	18.00	18.00	18.00	18.00
Crude fiber	10.17	10.36	10.55	10 .78
Metabolizable energy (Kcal/kg)	2722.25	2712.25	2634.27	2521.57

KEY: MOLM- *Moringa oleifera* leaf meal

T_1 – 0 % MOLM inclusion

T_2 – 10 % MOLM inclusion

T_3 – 20 % MOLM inclusion

T_4 --- 30 % MOLM inclusion

*** vitamine A=10,00011:D_3 =2,000IU :E51U : Nicotinic acid=20mg K=2mg: Riboflvine=4.2mg: =5mg:: B=0.01mg:pantothenic acid**
***Minerals: Se= 100mg: Cu=1.0mg:Fe=20mg:Iodine=0.8mg:Choline=3mg:Mg=56mg:Ca=1.25mg:Lysine,Mehtionine and TeTramycine(Broad – spectrum anti-biotics and promoters)**

3.6 Data collection and duration: The study lasted for 12 weeks for the growth phase, and 16 weeks for the reproductive phase, data were collected on the following parameters for the growth phase

.Feed intake

ii. Body weight changes

iii. Feed conversion ratio

iv. Nutrient digestibility trial

i. **Feed intake (g)**

Feed intake was determined on daily basis by weighing the feed offered to the animals and quantity of left over and the difference between the two for each day. This was computed using the expression,

Feed intake (g) = Quantity of feed given (g) - left over (g).

i. Body weight changes (g)

At the beginning of the experiment, the rabbits on each treatment were weighed and weighed subsequently, on weekly basis throughout the experimental period, and the weekly average body weight was obtained by calculating the difference between the body weight for the preceding and the present week. The daily weight changes/gain was computed using the expression:

$$\text{Daily weight gain(g)} = \frac{\text{Final weight (g)} - \text{Initial weight (g)}}{\text{Number of rabbits x Number of days}}$$

iii. Feed conversion ratio (F C R)

This is expressed as a ratio of the average daily feed intake and the average daily weight gain.

$$\text{F C R} = \frac{\text{Average daily feed intake (g)}}{\text{Average daily weight changes (g)}}$$

3.7 Nutrient digestibility trial

Digestibility trial was conducted at the end of the growth phase. Three rabbits were randomly selected from each treatment and placed in digestibility Cage. 2 days allowance was made for acclimatization and flushing of the gastro–intestinal tract of the previous feed served. Collection of faeces was for 5 days. The faeces were collected on daily basis. Faeces excreted (wet) were weighed and recorded. They were air- dried, bulked together and preserved separately with labels in black nylon bags and stored in a refrigerator. Nutrient digestibility was determined with the following formula:

Apparent nutrient digestibility =

$$\frac{\text{Nutrient intake} - \text{Nutrient in feaces x 100}}{\text{Nutrient intake}}$$

(Aduku and Olukosi, 1990**)**

3.8 Effects of feeding varying levels of horseradish (*Moringa oleifera*) leaf meal on reproductive and carcass characteristics of rabbit does

3.8.1 Reproductive phase

In this experiment, the does (female rabbits) were mated at five months of age and at weight not less than 1.5 kg. The does were weighed prior to mating, before and after parturition and final weights were determined at the end of the experiment. The mating ratio of 1 buck to 6 does as recommended by Aduku and Olukosi, (1990), was adopted. Mating was carried out in the morning and evening and the does were taken to the bucks hutches for mating. Fourteen days after mating, the does were palpated for pregnancy and if no foetus were detected; the does were re-mated.

3.8.2 Birth trait

The following parameters on birth traits were evaluated.

Gestation Length (G L): This is the difference between the date of mating and the date of kindling.
Gestation Gain (G G): The difference between the weight of the doe at mating and its weight one day pre-partum.
Litter size at birth (L S): This is the number of kittens obtained by counting at a single kindling from a doe.
Litter birth weight (L B W): This is obtained by weighing the kittens at birth using a weighing scale.
Kindling loss (K L): The difference between does weight one day pre-partum and its weight a day post–partum.
Neo-natal mortality (N N M): Expressed in percentage and obtained using the formula:

$$\frac{\text{Number of dead when assessing new kittens}}{\text{Total number of kittens born}} \times 100$$

(Aduku and Olukosi ,1990).

Co-efficient of milking capacity was computed using the expression

$$\text{Co-efficient of milking capacity} = \frac{C_2 - C_1}{21 \times C_1}$$

C_1 = Litter weight at birth (g)
C_2 = Litter weight at 21 days post-partum
Ijaiya, (2000) and Egena, (2011).

3.8.3 Weaning traits

The weaning traits measured were as indicated below.
Litter size at weaning (L S W): Number of weaned rabbits obtained by counting.
Litter weight at weaning (L W): Weight of all weaned rabbits measured with a weighing scale.
Litter weight gain (L W G): The difference between litter weight at weaning and litter birth weight (g)
Weaning sex ratio (W S R); Proportion of males to female at weaning.
Survival ratio to weaning (S R W): This is usually expressed in percentage and obtained using the formula

$$\text{S R W} = \frac{\text{Litter size at weaning}}{\text{Litter size at birth}} \times 100$$

(Aduku and Olukosi, 1990).

3.9 Carcass cuts and organ weights

At the end of the reproductive experiment three (3) rabbits were randomly selected from each treatment, weighed before slaughtering in order to evaluate the carcass and organ characteristics. They were fasted for 12 hours in order to clear the gastro intestinal tract. The rabbits were stunned before slaughtering, and they were slaughtered by cutting the jugular vein with sharp knife and fur was removed by scalding. The rabbits were eviscerated, the viscera and intestine were removed, each body part or organ was cut, removed and weighed, and fats found in the viscera was collected and weighed. The dressed carcass, organs and body parts were expressed as percentage of live weight.

3.10 Proximate analysis

The proximate analysis was carried out to determine the ether extract, crude fibre, , crude protein, ash of *Moringa oleifera* leaf meal used in the experimental diet, as well as faeces from nutrient digestibility trial, in accordance with the Association of Official Analytical Chemists, (AOAC) Washington, DC. (1990).

3.11 Statistical Analysis

All data collected for experiment 1 and 2 were subjected to analysis of variance (ANOVA) according to the procedure of Statistical Package for Social Science, 16.00 (SPSS 16, 1980). Means were separated using the Statistical Package for Social Science, 16.00 (SPSS 16, 1980).

CHAPTER FOUR

4.0 RESULTS

4.1 The proximate composition of horseradish (*Moringa oleifera*) leaf meal

The proximate composition of MOLM in Table 4.1 showed that, it contains, crude protein, 26.20 %, crude fibre 10.00 %, ether extract 13.00 %, ash 10.00 %, nitrogen free extract 33.00 % and metabolizable energy value of 3538.00 (kcal/kg).

4.2 The proximate composition of the experimental diet fed to rabbits.

The dry matter values as shown on Table 4.2 ranged from 96.88-97.40 %. It was observed that, the values of dry matter increased with increase in *Moringa oleifera* leaf meal inclusion. The crude protein content ranged from 18.55-18.59 % for T_1 and T_4 respectively. The crude fibre content was highest in T_4 (12.43 %) and least in T_1 (10.30 %) this study showed that the values of crude fibre increased with increases in MOLM inclusion. T_1 has the highest value for ether extract (5.00 %), followed by T_2 (4.50 %), T_3 (4.02 %) and lastly T_4 (4.00 %). The range of ash content falls between 11.00 -13.64 % for T_1 and T_4, the ash content followed the same pattern as the crude fibre which increased with increase in the inclusion level of MOLM. T_1 recorded the highest value (52.03 %) for nitrogen free extract, with T_4 having the least value (48.74 %).The value of nitrogen free extract decreases with increase in the inclusion level of .

From the data it was observed that, as the crude fibre content increased, the values of ether extract decreased and that of ash content increased and the values of nitrogen free extract decreased.

Table 4.1 Proximate composition and energy value of horseradish (*Moringa oleifera)* leaf meal

Nutrients	Composition %
Dry matter	92.20
Moisture	7.80
Crude protein	26.20
Crude fiber	10.00
Ether extract	13.00
Ash	10.00
Nitrogen free extract	33.00
Metabolizable Energy (kcal/kg)	3538.00

KEY: MOLM- *Moringa oleifera* leaf meal

T_1-0 % MOLM inclusion

T_2 -10 % MOLM inclusion

T_3-20 % MOLM inclusion

T_3- 30 % MOLM inclusion

Table 4. 2. Proximate composition of experimental diet fed to rabbits

Nutrients (%)	Dietary treatments (%) T_1	T_2	T_3	T_4
Dry matter	96.88	96.90	97.00	97.40
Moisture	3.12	3.10	3.00	2.60
Crude protein	18.55	18.56	18.57	18.59
Crude fibre	10.30	10.49	11.65	12.43
Ether extract	5.00	4.50	4.02	4.00
Ash	11.00	11.99	13.50	13.64
Nitrogen free extract	52.03	51.36	49.26	48.74
Total	100.00	100. 00	100.00	100.00

KEY: MOLM –*Moringa oleifera*

T_1-0 % MOLM inclusion

T_2 -10 % MOLM inclusion

T_3-20 % MOLM inclusion

T_4- 30 % MOLM inclusion

4.3 The anti nutritional factor analysis of horseradish (*Moringa oleifera*) leaf Meal

The result obtained on anti nutritional factor revealed that MOLM contains 0.45 mg of oxalate, phytate 2.57, trypsin inhibitor 3.0 mg, tannin 21.19 mg and saponin 1.60 mg per 100 g, However, they were found to fall within the normal range (Table 4.3)

4.4 Feed intake and growth performance of rabbits fed diets containing varying levels of horseradish (*Moringa oleifera)* leaf meal.

The dietary treatments, influenced all the parameters examined significantly (P<0.05) except initial body weight. The initial body weight ranged from 460.00 -463.17 for T_1 and T_4, respectively. T_3 (20 %) inclusion level had significantly highest final body weight (3135.90 g), followed by T_2 (1300.00), T_1 (1247.33) and lastly T_4 (1131.59 g).

T_3 (20 %) inclusion ranked significantly highest (2675.90 g) in total body weight gain, compared to T_2 (838.20 g), T_1 (785.16 g) and T_4 (668.42 g). The lowest total body weight gain was recorded in T_4 (30 %) MOLM inclusion, which had the highest crude fibre content, the low body weight gain in the control diet with 0 % MOLM inclusion showed that the inclusion of M*oringa oleifera* leaf meal had positive effect on body weight gain of rabbits especially at 20 % inclusion level.

Daily weight gain value (31.90 g)was highest in rabbits fed diet T_3 (20 % MOLM inclusion), while rabbits on dietary treatments T_2, T_1 and T_4 gained 10.00 g, 9.35 g and 8.00 g, respectively. Total and daily feed intake were significantly highest 7007.28 g and 82.00 g in T_3 (20 % inclusion), While T_1, T_2 and T_4 were not significantly (P>0.05) different in total feed intake 6888.00 g, 6846.00 g, and 6888.00 g respectively and daily feed intake, 82.00 g, 81.50 g, and 82.00 g for T_1, T_2 and T_4. Feed conversion ratio (FC R) values were lowest in T_3 (2.62) does that were fed 20 % MOLM inclusion level.

Table 4.3 Anti nutritional factors of horseradish (*Moringa oleifera*) leaf meal

Anti- nutritional factors	Composition(mg/100 g)	Recommended Safe Level *
Oxalate	0.45	0.54
Phytate	2.57	23.40
Trypsin	3.0	16.90
Tannin	21.19	31.20
Saponin	1.60	7.02

*Kumar and Amit (2010).

Table 4. 4 . Feed intake and growth performance of rabbits fed diets containing varying levels of horseradish (*Moringa oleifera)* leaf meal

	Dietary treatment					
Parameter	T_1	T_2	T_3	T_4	SEM	LS
Initial body weight (g)	462.17	461.80	460.00	463.17	3.04	NS
Final body weight (g)	1247.33^{b}	1300.00^{b}	3135.90^{a}	1131.59^{bc}	4.70	*
Total body weight gain (g)	785.16^{bc}	838.20^{b}	2675.90^{a}	668.42^{c}	4.70	*
Daily weight gain (g)	9.35^{b}	10.00^{b}	31.90^{a}	8.00^{c}	5.60	*
Daily feed intake (g)	82.00^{b}	81.50^{b}	83.42^{a}	82.00^{b}	1.21	*
FCR	8.77^{b}	8.15^{b}	2.62^{a}	10.25^{bc}	0.43	*

KEY: ^{abc} means with different superscript on the same horizontal row are significantly ($p<0.05$) different

S E M-standard error of mean

LS- Level of significance

NS- No significant difference ($p >0.05$)

*- Significant difference ($p<0.05$)

F C R-Feed conversion ratio

MOLM- *Moringa oleifera* leaf meal

T_1-0 % MOLM inclusion

T_2 -10 % MOLM inclusion

T_3-20 % MOLM inclusion

T_4- 30 % MOLM inclusion

4.5 Apparent nutrient digestibility trial of rabbits fed diet containing varying levels of horseradish (*Moringa oleifera*) leaf meal

Crude protein and dry matter were not significant (P>0.05) different in digestibility across the treatments, while other parameters were significantly (p<0.05) different across the treatments. (Table 4.5).The values for dry matter digestibility ranged from 74.02 (T_1) - 74 .65 % (T_4). It was noted that, the dry matter digestibility increased with increase in horseradish (*Moringa oleifera*) leaf meal (MOLM) inclusion. Rabbits fed T_4 (30 %) MOLM inclusion level recorded the highest value (67.81 %) and those fed the control diet (T_1) recorded the lowest value (67.18) for crude protein digestibility though not significantly (p> 0.0.5) different among the treatments. Crude fibre digestibility recorded significant (p<0.05) difference among the treatment groups: T_1 (0 %), T_2 (10 %) and T_3 (20 %) recorded significantly higher crude fibre digestibility of 45.03, 45.19 and 45.98 %, respectively, while T_4 (30 % MOLM inclusion level) had significantly lowest (40.90 %) crude fibre digestibility. The ether extract values were significantly (p<0.05) different among the dietary treatments. T_3 recorded the significantly highest value of 69.25 %, followed by T_2 (68.16 %), T_4 (66.86 %) and T_1(66.08 %). The ash digestibility was significantly different across the treatment. T_3 (20 %) and T_4 (30 %) recorded the significantly highest values,(55.08) and (55.30) %, respectively. It was observed that the digestibility of ash increased as the level of inclusion of MOLM increased. Increase in level of MOLM inclusion, resulted in a decrease in the digestibility of nitrogen free extract from $T_1 – T_4$.

Table 4.5. Apparent nutrient digestibility of does fed diets containing varying levels of horseradish (*Moringa oleifera*)

	Dietary treatment (%)					
Components	T_1	T_2	T_3	T_4	SEM	LS
Dry matter	74.02	74.13	74.35	74.65	0.19	NS
Crude protein	67.18	67.64	67.73	67.81	0.35	NS
Crude fibre	45.03^a	45.19^a	45.98^a	40.90^b	0.57	*
Ether extract	66.08^{bc}	68.16^b	69.25^a	66.86^{bc}	0.41	*
Ash	46.27^c	53.09^b	55.08^a	55.30^a	1.13	*
Nitrogen free extract	88.79^b	88.78^b	87.43^c	90.00^a	0.28	*

KEY: ^{abc} means with different superscript on the same horizontal row are Significantly (p<0.05) different

S E M-Standard error of mean

L S- Level of significance

N S- No significant difference (p >0.05

*-Significant difference (p<0.05)

MOLM- *Moringa oleifera* leaf meal

T_1-0 % MOLM inclusion

T_2 -10 % MOLM inclusion

T_3-20 % MOLM inclusion

T_4- 30 % MOLM inclusion

4.6 Effects of feeding diets containing varying levels of horseradish (*Moringa oleifera)* leaf meal on birth traits of does.

The MOLM had no significant (P>0.05) effect on litter size at birth as shown in Table 4.6. Litter birth weight was significantly (p<0.05) affected by MOLM. T_3 (20 %) MOLM inclusion level recorded the significantly highest values of birth weight compared to others. The dietary treatment had no significant (P>0.05) effects on gestation length across the treatments.

Gestation gain was significantly affected by the dietary treatment. The values obtained were 39.07, 39.07, 59.10, and 55.20 g for rabbits on 0, 10, 20 and 30, % MOLM, respectively. It was observed from the study that 20 % MOLM inclusion level had the significantly highest gestation gain of 59.10 g with T_l and T_2 having the significantly lowest values of 39.07 g. Kindling loss and neo- natal mortality were not significantly (p>0.05) different across the treatments. The co-efficient of milking capacity was significant (P< 0.05) across the treatment, with T_3 having the significantly highest value of 113.70 g while T_1 recorded the significantly lowest value of 101.20 g

Table 4.6 Effects of feeding diets containing varying levels of horseradish *(Moringa oleifera)* leaf meal on birth trait

Parameters	Dietary treatment T1	T2	T3	T4	SEM	LS
Litter size at birth	4.00	4.17	5.00	4.00	0.18	NS
Litter birth weight (g)	32.10^{bc}	33.65^{b}	38.07^{a}	37.40^{ab}	1.33	*
Gestation length (days)	30.50	30.50	31.00	30.33	0.18	NS
Gestation gain (g)	39.07^{c}	39.07^{c}	59.10^{a}	55.20^{b}	180	*
Kindling loss (g)	45.25	4 4.86	45.83	44.50	1.07	NS
Co-efficient of milking Capacity (g)	101.20^{b}	114.50^{ab}	128.60^{a}	113.70^{ab}	0.14	*
Neo-natal mortality (%)	1.33	0.33	0.33	0.50	0.15	NS

KEY: ^{abc} means with different superscript on the same horizontal row are significantly ($p<0.05$) different

S E M-Standard error of mean
L S- Level of significance
N S-No significant difference (p >0.05
*-Significant difference (p<0.05)

MOLM- *Moringa oleifera* leaf meal

T_1-0 % MOLM inclusion

T_2 -10 % MOLM inclusion

T_3-20 % MOLM inclusion

T_4- 30 % MOLM inclusion

4.7 Effects of feeding varying levels of horseradish (*Moringa oleifera)* leaf meal on weaning traits of does

Effects of feeding varying levels of *Moringa oleifera* leaf meal on weaning traits of does showed significant effect of MOLM on litter weaning size at (Table 4.7). The values recorded were T_1 (2.00) T_2 (2.33) T_3 (3.33) and T_4 (2.33). The litter size at weaning was significantly higher in does on 20 % MOLM. The litter weaning weight was significantly (P<0.05) different across the treatments. [T_1(401.60), T_2 (442.30), T_3 (462.52) and T_4 (347.21)]. From this study it was observed that, the weaning weight increased from rabbits fed diets T_1 to T_3 and then decreased in those on diet $T_{4.}$ T_3 (20 %), and T_2 (10%) inclusion level, recorded significantly highest weaning weights.

Dietary treatment affected significantly, the litter weight gain with values ranging from 309.81 in T_4 (30 %) - 424.45 in T_3 (20 %). The litter weight gain followed the same pattern as the litter weight at weaning. T_3 (20 %) and T_2 (10 %) dietary treatments also recorded the significantly highest litter weight gain. T_3 (20 % MOLM inclusion level) had the significant highest survival rate at weaning (66.67 %), with T_4 recording (58.25 %), T_2 (55.88 %) and T_1 (50.00%). The weaning sex ratio revealed that more male rabbits survived to weaning with T_3 having the highest number of males to females at weaning (3:1), followed by T_2 (2:1) and T_4 (2:1) with T_1 recording the least value (1:1)

Table 4 .7. Effects of feeding varying levels of *Moringa oleifera* leaf meal on weaning traits of does

	Dietary treatment					
Components	**T_1**	**T_2**	**T_3**	**T_4**	**SEM**	**LS**

Litter size at weaning (no)	2.00^{b}	2.33^{b}	3.33^{a}	2.33^{b}	0.17	*
Litter weight at weaning (g)	401.60^{b}	442.30^{a}	462.52^{a}	347.21^{c}	10.86	*
Litter weight gain (g)	369.50^{b}	408.25^{a}	424.45^{a}	309.81^{c}	10.85	*
Survival rate to weaning (%)	50.00^{c}	55.88^{b}	66.60^{a}	58.25^{b}	3.05	*
Weaning sex ratio (M:F)	1 :1	2:1	3:1	2:1		

KEY: ^{abc} means: with different superscript on the same horizontal row are significantly ($p<0.05$) different

S E M-Standard error of means

LS - Level of significance

* -Significant difference ($P<0.05$)

NS- No significant difference ($p >0.05$)

M:F - Male to female ratio

MOLM –*Moringa oleifera* leaf meal

T_1 - 0 % MOLM Inclusion

T_2 -10 % MOLM Inclusion

T_3 - 20 % MOLM Inclusion

T_4 - 30 % MOLM Inclusion

4.8 Carcass cuts and organ weights of does fed varying level of horseradish (*Moringa oleifera*) leaf meal

Table 4.8 showed the carcass cuts and organ weights of does fed varying levels of horseradish (*Moringa oleifera*) leaf meal. *Moringa oleifera* leaf meal inclusion into the rabbit diet did not significantly affect the live weight, and carcass weight, carcass cuts and organ weights expressed in percent of live weight, except the lumber-sacral, full intestine and abdominal fat weight. The lumber-sacral weight was significantly affected by the dietary treatment with T_2 recording the significantly highest value (13.7 g), compared to others [T_3 (12.99 g), T_1 (10.76 g) and T_4 (10.31 g)]. The full intestine was significantly ($P< 0.05$) different across the treatments with values ranging from 9.04 g in T_1 - 9.95 g in T_4. Abdominal fat values for T_1, T_2, and T_4 were significantly higher (4.85, 4.22 and 4.33 g,) with T_3 recording the significantly lowest value (3.71 g).

Table 4.8 Carcass cuts and organ weights of does fed diets containing varying levels of horseradish (*Moringa oleifera*) leaf meal.

Dietary treatments

Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**SEM**	**LS**
Live weight (g)	2050.33	2370.00	2709.33	2310.00	73.09	NS
Carcass weight (g)	1397.20	1751.50	2025.30	1655.70	46.26	NS
Dressing (%)	68.36	73.91	74.76	71.57	1.37	NS
Parts and organs expressed in percentage of live weight						
Hind leg	14.30	14.15	12.92	13.34	0.34	NS
Fore leg	13.16	12.39	12.66	12.65	0.37	NS
Cervico-thoracic	9.31	9.41	9.24	9.95	0.17	NS
Lumber-sacral	10.76^b	13.17^a	12.99^a	10.31^b	0.41	*
Neck	4.80	4.60	5.00	5.08	0.32	NS
Head	7.17	7.47	7.38	7.69	0.20	NS
Feet	4.42	4.19	4.29	4.30	0.13	NS
Skin	7.60	7.47	7.63	7.79	0.15	NS
Tail	0.58	0.51	0.48	0.52	0.01	NS
Liver	1.13	1.12	1.13	1.13	0.03	NS
Lungs	1.30	1.11	1.13	1.13	0.03	NS
Heart	0.98	0.89	0.90	0.91	0.06	NS
Spleen	0.14	0.13	0.13	0.13	0.03	NS
Kidneys	1.22	1.24	1.26	1.25	0.03	NS
Full Intestine	9.04^a	8.39^b	8.35^b	9.95^a	0.24	*
Abdominal fat	4.85^a	4.22^a	3.71^b	4.33^a	0.12	*

KEY ^{abc} means with different superscripts on the same row are significantly different 0.05).

S E M- Standard error of means

LS- Level of significance

*-Significant difference (p<0.05)

NS- Non-signifiant (P>0.05)

MOLM –Moringa oleifera Leaf Meal

T_1 - 0 % MOLM Inclusion

T_2 -10 % MOLM Inclusion

T_3 - 20 % MOLM Inclusion

T_4 - 30 % MOLM Inclusion

4.9 Cost benefit analysis of feeding diets containing graded levels of horseradish (*Moringa oleifera*) leaf meal to weaned rabbits

The cost /benefit analysis presented in Table 4.9, indicated progressive decrease in the cost of feed with increase in horseradish (*Moringa oleifera*) leaf meal in the diet. The result showed a significant (P<0.05) difference across the treatments, with T_1 (0 %) MOLM inclusion level having the significantly highest cost per kg weight gain. T_3 (20 %) had the significantly lowest cost of ₦ 3.05 producing one kg weight gain as against ₦12. 85 in T_1

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4.9 Cost/ benefit analysis of feeding diets containing graded levels of horseradish (*Moringa oleifera*) leaf meal to weaned rabbits

Dietary treatments

Parameters	T_1	T_2	T_3	T_4	SEM	LS
Total feed intake (g)	6888.00^b	6846.00^b	7007.28^a	6888.00^b	2.58	*

Cost of feed/kg (₦)	120.00	110.00	97.45	85.70		
Cost of daily feed intake/rabbit (₦)	10.00^{a}	9.00^{ab}	7.84^{b}	6.80^{bc}	0.40	*
Cost of total feed consumed/rabbit (₦)	826.60^{b}	821.52^{bc}	840.84^{a}	826.60^{b}	0.3	*
Ave. body weight gain (g)	9.35^{b}	10.00^{b}	31.90^{a}	8.00^{c}	5.52	*
Cost of feeding /kg weight gain (₦)	12.83^{a}	11.00^{b}	3.05^{d}	10.63^{c}	3.26	*

KEY ^{abcd} means with different superscripts on the same horizontal row are significantly ($p<0.05$) different

S E M- Standard error of means

LS- Level of significance

*-Significant difference ($p<0.05$)

NS- Non-signifiant ($P>0.05$)

MOLM –*Moringa oleifera* leaf meal

T_1 - 0 % MOLM Inclusion

T_2 -10 % MOLM Inclusion

T_3 - 20 % MOLM Inclusion

T_4 - 30 % MOLM Inclusion

CHAPTER FIVE

5.0. DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1. DISCUSSION

5.1.1. Proximate composition of horseradish (*Moringa oleifera)* leaf meal

The crude protein, ether extract and energy content of *Moringa oleifera* as shown on Table 4.1, meets the nutritional needs of rabbits. This conforms to the findings of Gupta *et al*. (1999), Abubakar, (2008), Okereke, Okachukwu and Okereke, (2009) in rabbit feeding. The fibre content (10.00 %) is in line with the recommended range by Aduku and Olukosi, (1990). Ozumba (2000) and confirmed that horseradish (*Moringa oleifera)* leaf meal is a good protein source that can be conveniently used to replace soyabean in rabbit diet, The dry matter and ether extract values are in close agreement with the findings of Onyekwere *et al*. (2010) when they evaluated the effects of Bambara nut waste meal on rabbits.

5.1.2 Proximate composition of experimental diet fed to rabbits

The dry matter values 96.88-97.40 % obtained are in conformity with the values obtained by Lawal, Makinde, Obiageli. Modebe, Ngozi, Nnajiofor, and Abu (2010). When the authors evaluated the effects of soyabean based meal diet on Albino Rats with or without mineral supplementation. The crude protein content range between 18.55-18.59 % for T_1 and $T_{4,}$ respectively. The values fall within the recommended ranges by Johnson (2006), Aduku and Olukosi, (1990) and Cheeke *et al*. (2006). T_1 has the highest value for ether extract (5.00 %), followed by $T_{2,}$ T_3 and lastly $T_{4.}$ These values were higher than the values obtained by Onyekwere *et al.* (2010). The values of ash content are in close conformity with the values obtained by Onyekwere *et al*. (2010) but lower than that obtained by Odeyinka *et al*. (2008). T_1 recorded the highest value for nitrogen free extract, with T_4 having the least value.

5.1.3 The anti-nutritional factors in horseradish (*Moringa oleifera*) leaf meal.

The anti-nutrient content of horseradish (*Moringa oleifera*) leaf meal is below lethal levels. This is in conformity with the findings of Enechi and Odunwodu, (2003), where they stated that, phytochemical composition and anti-nutrients in *Moringa oleifera* leaves are low. This low level of anti- nutrient content as revealed on Table 4.3 makes the inclusion in animal feed non- toxic and will not adversely affect their health and growth as observed by Ozumba (2000), who also stated that *Moringa* is a good source of forage for livestock and fish. Olugbemi *et al*. (2010) in evaluating the suitability of MOLM confirmed that, it contains all essential amino acids, which makes it (*Moringa oleifera*) one of the most valuable sources of feed ingredients for monogastric animals.

5.1.4 Feed intake and growth performance of rabbits fed diets containing varying levels of horseradish (*Moringa oleifera)* leaf meal

All the parameters examined as were shown on Table 4.4 were significantly ($P<0.05$) influenced by the dietary treatments, except initial body weight. The values obtained agrees with those reported by Olayinka *et al*. (2010) and contradictory to the report of Onyekwere *et al.* (2010) when the authors replaced *Moringa oleifera* leaf meal with centrosma leaf meal in rabbits feeding. T_3 (20 %) MOLM inclusion level had significantly highest final body weight (3135.90 g), followed by $T_{2,}$ T_1 and lastly T_4 (1131.59 g).The findings were in close range with that of Farinu and Akinola, (2006) and Donald, (2007) when the authors evaluated the effects of inclusion of varying levels of groundnut cake on palatability of rabbit carcass and the influence of dietary wild sunflower leaf meal on growth and carcass characteristics, respectively.

MOLM inclusion level (20 %) ranked significantly highest (2675.90 g) in total body weight gain, compared to $T_{2,}$ T_1 and T_4 (668.42 g). The values from this study were higher than that of Onyekwere *et al*. (2010) The lowest total body weight gain was recorded in T_4 (30 % of MOLM inclusion), which had the highest crude fibre content, This is in agreement with the findings of Cheeke *et al*. (2006) who stated that, high fibre content had been implicated in lowering

digestive efficiency and that fibre is poorly digested in rabbits as it is rapidly propelled through the colon and excreted as hard faeces. Low body weight gain in the control diet showed that the inclusion of *Moringa oleifera* leaf meal had positive effect on body weight gain of rabbits especially at 20 % inclusion level. This is similar to the findings of Okereke *et al*. (2009) who recommended 30 % replacement of soyabeans cake with *Moringa oleifera* leaf meal. This suggests that, it is a valuable feed ingredient for monogastric animal feeding.
Daily weight gain value was highest in rabbits fed diet T_3 (20 %) MOLM inclusion, which recorded 31.90 g, when compared with $T_{2,}$ T_1 and T_4. The result of this research is in line with the findings of Igwebuike *et al*. (2001), Omole and Ajayi (2006), Odeyinka *et al.* (2008), and Tham, (2010) when the authors experimented with cassava leaf meal, brewer's grain, *Moringa* leaf meal and soaked acasia albida pods respectively for rabbit feeding.

The low F C R (2.62) recorded in 20 % MOLM inclusion level was an indication that the diet was better utilized by the rabbits at this level of inclusion while the highest value of FC R (10.25) in T_4 30 % MOLM inclusion showed that, the feed was poorly utilized at that level of inclusion. This poor feed utilization in T_4 also resulted in lowest significantly daily weight gain, total body weight gain and final body weight. This assertion was equally observed by Dauda *et al.* (2009), and Onyekwere *et al*. (2010). All the values of F C R fall within the reported ranges by Adegbola and Okonkwo, (2002) when they experimented on cassava leaf meal in rabbit diet.

This shows that horseradish *(Moringa oleifera*) leaf meal compared favourably with other non-conventional feed ingredient, such as rice milling waste, cassava leaf meal, pawpaw leaf meal, *Telferia occidentalise,* wild sunflower leaf meal and Bambara waste meal.

5.1.5 Apparent nutrient digestibility trial of rabbits fed diet containing varying levels of horseradish (*Moringa oleifera*) leaf meal

The dry matter values were in close conformity with the findings of Ojebiyi *et al*. (2010) who fed rabbits with cassava peel/blood meal mixtures, but was contrary to the findings of Jiya *et al.* (2010) who fed rabbits with cooked Tallow seed meal. The crude protein digestibility though not significantly ($p > 0.0.5$) different among the treatments, the range falls in line with the findings of Odeyinka *et al*. (2008) and Ojebiyi *et al*. (2010) when the authors replaced centrosema with *Moringa* leaf meal for rabbit diet.
Crude fibre digestibility recorded significant ($p<0.05$) difference among the treatment groups; T_3 (20 %) recorded significantly highest crude fibre digestibility, while T_4 (30 %) MOLM inclusion level had significantly lowest crude fibre digestibility. This was in conformity with the findings of Agunbiade *et al*. (1999), Adegbola and Okonkwo, (2002) who fed rabbits with varying levels of cassava peels and wild sunflower leaf meal. The values obtained from was contrary to the findings of Adama (2002), where the author evaluated the effects of groundnut haulms, potatoes and leuceana leaf meals on performance of rabbit.
The ether extract values were significantly ($p<0.05$) different among the dietary treatments. T_3 recorded the significantly highest value with T_1 having the lowest value. The values obtained were in close agreement with the findings of Apata and Ologhobo, (2004) who worked on Bambara nut waste in rabbit diet at 20 % level of inclusion and equally observed significant (p<

0.05) difference in the ether extract digestibility.
The ash digestibility was significantly different across the treatment. T_3 (20 %) and T_4 (30 %) recorded the significantly highest values. The values recorded were higher than that obtained by Ojebiyi *et al.* (2010) and Oyekwere *et al.* (2010).

Reproductive Performance

5.1.6 Effects of feeding varying levels of horseradish (*Moringa oleifera)* leaf meal on birth traits

Litter birth weight was significantly ($p<0.05$) affected by MOLM. T_3 (20 %) MOLM inclusion level recorded the significantly highest values of birth weight compared to others. The values from this study is in line with the reported values of Aduku and Olukosi (1990), Guptal *et al*. (1999) and Okereke *et al*. (2009) who investigated the factors influencing pre-weaning body weight of rabbits and effect of feeding graded levels of soaked acacia pods in rabbits feeding. The finding in this study contradicted that of Odeyinka *et al*. (2008) who recorded no significant effects on birth weight of litters from does fed varying levels of MOLM replacing Centrosema at 30 % inclusion level.
The dietary treatment had no significant ($P>0.05$) effects on gestation length across the treatments. This is in line with the report of Aduku and Olukosi (1990), and Odeyinka *et al.* (2008).
Gestation gain was significantly affected by the dietary treatment. It was observed from this study that 20 % MOLM inclusion level had the significantly highest gestation gain, which is an indication that 20 % level of MOLM inclusion, showed more positive effects on both litter birth weight and gestation gain.
Kindling loss and neo- natal mortality were not significantly ($p>0.05$) different across the treatments. This finding is in close conformity with the reported values of Donald, (2007) and Odeyinka *et al.* (2008) who fed rabbit does with varying levels of groundnut cake in maize based diet and *Telferia occidentalise* leaf meal, respectively.
The co-efficient of milking capacity was significant ($P< 0.05$) across the treatment, with T_3 having the significantly highest value which is an indication that, at 20 % MOLM inclusion level, the does produced more milk compared with other levels of inclusion.

5.1.7 Effects of feeding varying levels of horseradish (*Moringa oleifera)* leaf meal on weaning traits of does

The data on the effects of feeding varying levels of *Moringa oleifera* leaf meal on weaning traits of does is presented in Table 4.7. There was a significant effect of MOLM on litter size at weaning. The litter size at weaning was significantly higher in does on 20 % MOLM. The values recorded agrees with the reported values of Isaac *et al*, (2010) who reported average litter size at weaning of 3, 2.3, 3 and 3.5 for four respective breeds of rabbits (New Zealand white, American Chinchilla, Giant white and Californian white). The values were lower than the findings of Odeyinka, Olosunde, and Oyedele, (2007), who reported litter size at weaning of (5.2) when the authors evaluated the reproductive effects of feeding does with varying levels of *Moringa* leaf meal replacing centrosema. This finding contradicts the report of Odubote and Somade (1992) who reported no significant ($p> 0.05$) difference for litter size at weaning, when

they investigated the effect of breeds on reproductive performance of rabbits.
Litter weight at weaning was significantly ($P<0.05$) different across the treatments. T_3 had the significantly highest value with T_4 having the lowest. These findings were in line with the reported values by Aduku and Olukosi, (1990), Odubote and Somade, (1992) and in close range with the findings of Ilori *et al*. (2003) in a study of post weaning performance of rabbits in rainforest ecological zone in Nigeria. The values reported by the authors mentioned above, were rather lower than those reported by Prayaga and Eadyu, (2002) who reported significant ($p<0.05$) effects in the weaning weights of litters among the following breeds of rabbits, Flemish Giant, Californian White and American Chinchilla. The authors recorded average weaning weights of litter, of 1050 g, 810 g, and 475 g for the breeds, respectively. The authors indicated that the large litter sizes at birth will not likely result in a large weight at weaning and that parity could influence weaning weight of rabbits.
. The lowest value of litter weight at weaning obtained in T_4 may be an indication that the weaned rabbits may not have been able to digest the fibre content at that level (30 %)MOLM inclusion.

The inclusion of MOLM at 20 %, and 10 % recorded significantly highest weaning weight, which is suggestive that, 20 % and 10 % inclusion level are excellent for weaning weight for weaned rabbits fed maize based diets. This was also observed in the litter weight gain. Litter weight gain was significantly affected by the dietary treatment with values ranging from 309.81- 424.45 g for T_1- T_3. T_3 (20 %) MOLM inclusion level had the significant highest survival rate at weaning. High percentage survival rate at weaning is an indication of good nursing and mothering ability (Isaac *et al*. 2010). The weaning sex ratio revealed that more male rabbits survived to weaning with T_3 having the highest number of males to females at weaning (3:1), T_2 (2:1), T_4 (2:1) and the least T_1 (1:1)

5.1.8 Carcass cuts and organ weights of does fed varying level of horseradish (*Moringa oleifera*) leaf meal

Data in Table 4.8 showed the carcass cuts and organ weights of does fed varying levels of Horseradish (*Moringa oleifera*) leaf meal. The live weight, carcass weight, percentage carcass cuts and organ weights were not significantly affected by the inclusion of *Moringa oleifera* leaf meal into the rabbit diet except the lumber-sacral, full intestine and abdominal fat weight. This is in agreement with the findings of Ghosh and Manda, (2007) who investigated the carcass and meat quality of two breeds of rabbits (Soviet Chinchilla and Grey Giant) under warm -humid condition of West Bengal.

The lumber-sacral weight was significantly affected by the dietary treatment. T_2 had the significantly highest value which was in close agreement with the findings of Donald, (2007). The weight of intestine was significantly ($P< 0.05$) different across the treatments, with T_1 (0 %) recording the least value. This may be attributed to the lowest level of fibre content of the feed as compared with T_4, with high fibre content.
Abdominal fat values for T_1, T_2, and T_4 were significantly highest, with T_3 recording the significantly lowest value (3.71) g.

5.1.9 Cost benefit analysis of feeding diets containing graded levels of horseradish (*Moringa oleifera*) leaf meal to weaned rabbits

The cost /benefit analysis presented in Table 4.9, indicated progressive decrease in the cost of feed with increase in horseradish (*Moringa oleifera*) leaf meal inclusion level. The result showed a significant (P<0.05) difference across the treatments, with T_1 (0 %) MOLM inclusion level having the significantly highest cost per kg weight gain. This is obvious because it was formulated to include only groundnut cake, which is more expensive than MOLM. T_3 (20 %) had the significantly lowest cost of ₦3. 05, producing one kg weight gain as against ₦ 12.85 in T_1 .

5.2. CONCLUSION

It can be concluded based on these results that;
Anti-nutritional factors in *(Moringa oleifera*) leaf meal are below lethal levels. At 20 % inclusion level, the animals performed significantly better in daily weight gain and feed intake over the control group. Rabbits fed 20 % *Moringa oleifera* were observed to have better digestibility of ash, ether extract and nitrogen free-extract. The best performance for growth was observed in rabbit fed 20 % inclusion level of MOLM. The animals fed 20 % inclusion level of *Moringa oleifera* leaf meal performed significantly better in litter birth weight, gestation gain and co-efficient of milking. At 20 % inclusion level, the Rabbits were observed to have significantly superior performance in all the parameters measured in weaning traits of the does. 10 % and 20 % MOLM inclusion level had the highest lumber sacral weight. 30 % had highest significant (p<0.05) values for, intestine and abdominal fat. It is consequently concluded that, 20 % level of inclusion of MOLM to rabbits' diets did not have any deleterious effect on the parameters measured.

5.3 RECOMMENDATION

i. It is recommended therefore that, horseradish (*Moringa oleifera*) leaf meal can be included at 20 % level in rabbits' diet without any deleterious effects on growth, carcass and reproductive parameters.

ii. It is also recommended that further studies on the effects of feeding diets containing horseradish (*Moringa oleifera*) leaves on haematological indices and diseases management should be conducted to harness the role played by the horseradish (*Moringa oliefera*) tree also known and called the "miracle tree".

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APPENDIX

PROCEDURE FOR PROXIMATE ANALYSIS

Proximate analysis to determine the crude protein, fibre, either extracts, ash of *Morings oleifera* leaf meal, and experimental diets as well as faeces from digestibility trial were carried out at the

Animal science Laboratory, Federal University of Technology Minna. According to official method of analysis, 13th edition, Association of Official Analytical Chemist, (AOAC) 1980, Washington DC. Nitrogen free extract was determined (calculated) by difference.

DRY MATTER

About 2 g each of the sample was taken and dried in the oven at 80 $^{o C}$ at a constant weight for 42-72 hours for dry matter determination.

$$\%D\ m = \frac{\text{Final weight}}{\text{Initial weight}} \times \frac{100}{1}$$

Crude protein

2 g of each of the samples was weighed into kjeldahl digestion flask into which 40 mls of concentrated H_2SO_4 was added and digested in the presence of selenium tablet (catalyst) until the digest is clear. The digest was allowed to cool and then poured into 250 mls flat bottom flask using distilled water to rinse the kjeldahl distillation flask, the digest was then made up to mark with distilled water. 20 ml of concentrated NAOH was added into the distillation chamber and was distilled into boric acid indicator solution until the reddish pink colour was obtained. The amount of nitrogen in the solution was calculated and multiplied by 6.25 to obtain the amount of crude protein in the samples.

$$\%\ Cp = \frac{\text{volume of acid used} \times \text{morality} \times 6.25}{\text{Weight of samples}}$$

Ether Extract

1 g of ground sample was weighed into a known weight of filter paper and well folded. The sample was then inserted into the extraction jacked. The jacked was attached to a round bottom flask into which petroleum ether has been poured. The flask was then heated up and the jacket refluxed for about 24 hrs. The fat in the sample was extracted into flask. After the extraction, the sample was removed and allowed to dry in the oven for 1 hr and then the final weight of the sample taken. The percentage ether extract was obtained; thus:

Weight of sample + filter paper before extraction

$$\%\ \text{Ether extract} = \frac{\text{weight of extraction}}{\text{Weight of sample}} \times \frac{100}{1}$$

ONE-WAY ANALYSIS OF OVERALL PERFORMANCE
STATISTICS DESCRIPTIVE/PO
ST-HOC - DUNCAN ALPHA (0.05)

Initial Body Weight

Treatment	N	Subset for alpha = 0.05
		1
3	6	460.0000
2	6	461.8000
1	6	462.1667
4	6	463.1667
Sig		.782

Means for groups in homogeneous subsets are displayed.

Final Body Weight

Treatment	N	Subset for alpha = 0.05
		1
4	6	1131.5850
1	6	1247.3267
2	6	1300.0000
3	6	3135.8967
Sig		.180

Means for groups in homogeneous subsets are displayed.

Daily Weight Gain

Treatment	N	Subset for alpha = 0.05
		1
4	6	7.9574
1	6	9.3471
2	6	9.9786
3	6	31.8559
Sig		.179

Means for groups in homogeneous subsets are displayed.

Daily Feed Intake

Treatment	N	Subset for alpha = 0.05
		1
2	6	81.5000
1	6	82.0000
4	6	82.0000
3	6	83.4167
Sig		.637

Means for groups in homogeneous subsets are displayed.

Feed Conversion Ratio

Treatment	N	Subset for alpha = 0.05

		1	2
3	6	7.3932	
2	6	8.1782	8.1782
1	6	8.8165	8.8165
4	6		10.3366
Sig		.233	.076

Means for groups in homogeneous subsets are displayed.

Dry Matter Digestibility Coefficient

Treatment	N	Subset for alpha = 0.05
		1
3	3	74.0246
4	3	74.1285
1	2	74.3478
2	3	74.6474
Sig		.385

Means for groups in homogeneous subsets are displayed.

Crude Protein Digestibility Coefficient

Treatment	N	Subset for alpha = 0.05	
		1	2
1	3	67.1844	
2	3	67.6446	
3	3	67.7359	
4	3	67.8137	
Sig		.35	

Means for groups in homogeneous subsets are displayed.

Crude Fibre Digestibility Coefficient

Means for groups in

Treatment	N	Subset for alpha = 0.05	
		1	2
4	3	40.8993	
3	3		45.9797
1	3		45.0364
2	3		45.1946
Sig		1.000	.164

homogeneous subsets are displayed.

Ether Extract Digestibility Coefficient

Treatment	N	Subset for alpha = 0.05		
		1	2	3
1	3	66.0816		
4	3	66.8610	66.8610	
2	3		68.1565	68.1565
3	3			69.2519
Sig		.228	.062	.104

Means for groups in homogeneous subsets are displayed.

Ash Digestibility Coefficient

Treatment	N	Subset for alpha = 0.05		
		1	2	3
1	3	46.2739		
2	3		53.0706	
3	3			55.0869
4	3			55.3000

Sig		1.000	1.000	.809

Means for groups in homogeneous subsets are displayed.

BIRTH TRAIT STATISTICS DESCRIPTIVE:

POST HOC – DUNCAN ALPHA (0.05) - Post Hoc Tests: Homogeneous Subsets

Litter Size at Birth

Treatment	N	Subset for alpha = 0.05
		1
1	6	4.0000
4	6	4.0000
2	6	4.1667
3	6	5.0000
Sig		.060

Means for groups in homogeneous subsets are displayed.

Litter Birth Weight

Means for groups in homogeneous subsets are displayed.

Treatment	N	Subset for alpha = 0.05		
		1	2	3
1	6	32.1000	32.1000	
4	6		37.4033	37.4033
3	6			38.0733
2	6		33.6500	
Sig		.208	1.33	0.12

Gestation length

Treatment	N	Subset for alpha = 0.05
		1
4	6	30.3333
1	6	30.5000
2	6	30.5000
3	6	31.0000
Sig		0.18

Means for groups in homogeneous subsets are displayed.

Gestation Gain

Means for groups in

Treatment	N	Subset for alpha = 0.05		
		1	2	3
2	6	39.0700		

1	6	39.0700		
4	6		55.2000	
3	6			59.1000
Sig		1.000	1.000	1.000

homogeneous subsets are displayed.

Kindling Loss

Means for groups in

Treatment	N	Subset for alpha = 0.05	
		1	2
4	6	44.5000	
3	6	45.8333	
2	6	44.8600	
1	6	45.2500	
Sig		1.07	

homogeneous subsets are displayed.

Co-efficient of Milking Capacity

Means for groups in

Treatment	N	Subset for alpha = 0.05	
		1	2
2	6	114.500	114.500
3	6		128.600
4	6	113.700	113.700
1	6	101.20	
Sig		.680	1.000

homogeneous subsets are displayed.

Neo-Natal Mortality

Treatment	N	Subset for alpha = 0.05
		1
2	6	0.3333
3	6	0.3333
4	6	0.5000
1	6	1.3333
Sig		0.15

Means for groups in homogeneous subsets are displayed.

POST HOC TESTS: HOMOGENEOUS SUBSETS

Litter Size at Weaning

Treatment	N	Subset for alpha = 0.05	
		1	2
1	6	1.8333	
2	6	2.3300	
4	6	2.3333	
3	6		3.3333
Sig		1.000	0.176

Means for groups in homogeneous subsets are displayed.

Litter Weight at Weaning

Treatment	N	Subset for alpha = 0.05		
		1	2	3
4	6	347.21		
1	6		401.60	
2	6			442.30
3	6			462.52
Sig		1.000	1.000	.263

Means for groups in homogeneous subsets are displayed.

Litter Weight Gain

Treatment	N	Subset for alpha = 0.05		
		1	2	3
4	6	309.80		
1	6		369.50	
2	6			408.25
3	6			424.48
Sig		1.000	1.000	.467

Means for groups in homogeneous subsets are displayed.

Survival Rate to Weaning

Treatment	N	Subset for alpha = 0.05		
		1	2	3
4	6		58.25	
1	6	50.000		
2	6		55.880	
3	6			66.60
Sig		1.000	1.000	.263

Means for groups in homogeneous subsets are displayed.

CARCASS CHARACTERISTICS

POST HOC TESTS

Homogeneous Subsets

Live Weight

Treatment	N	Subset for alpha = 0.05		
		1	2	3
1	3	2.0503		

4	3		2.3100	
2	3		2.3700	
3	3			2.7093
Sig		1.000	.349	1.000

Means for groups in homogeneous subsets are displayed.

Carcass Weight

Treatment	N	Subset for alpha = 0.05		
		1	2	3
1	3	1.39723		
4	3		1.6557	
2	3		1.7515	
3	3			2.0253
Sig		1.000	.217	1.000

Means for groups in homogeneous subsets are displayed.

Carcass Percentage

Treatment	N	Subset for alpha = 0.05
		1
1	3	68.3612
4	3	71.6740
2	3	73.9068
3	3	74.7559
Sig		.155

Means for groups in homogeneous subsets are displayed.

Hind Leg

Treatment	N	Subset for alpha = 0.05
		1

1	3	295.0000
4	3	308.3333
2	3	335.3333
3	3	350.0000
Sig		.086

Means for groups in homogeneous subsets are displayed.

Fore Leg

Means for groups in

Treatment	N	Subset for alpha = 0.05	
		1	2
1	6	292.3333	
2	6	293.6667	
4	6	310.0000	
3	6	343.3333	
Sig		.103	1.000

homogeneous subsets are displayed.

Lumber-Sacra

Treatment	N	Subset for alpha = 0.05		
		1	2	3
1	3	220.002		
4	3	238.002		
2	3		312.00	
3	3			352.00
Sig		.085	1.000	1.000

Means for groups in homogeneous subsets are displayed.

Neck

Treatment	N	Subset for alpha = 0.05

		1	2	3
1	3	98.5000		
2	3		1.0900	
4	3		1.1733	
3	3			1.9400
Sig		1.000	.083	1.000

Means for groups in homogeneous subsets are displayed.

Head

Treatment	N	Subset for alpha = 0.05			
		1	2	3	4
1	3	1.2617			
2	3		1.5333		
4	3			1.77672	
3	3				2.0000
Sig		1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

Feet

Treatment	N	Subset for alpha = 0.05		
		1	2	3
1	3	69.8333		
2	3		99.1667	
4	3		1.0000	
3	3			1.1633
Sig		1.000	.818	1.000

Means for groups in homogeneous subsets are displayed.

Skin

Means for groups in

Treatment	N	Subset for alpha = 0.05	
		1	2
1	3	175.8667	
2	3	177.0000	
4	3	180.0000	
3	3		206.6667
Sig		.141	1.000

homogeneous subsets are displayed.

Tail

Means for groups in

Treatment	N	Subset for alpha = 0.05	
		1	2
1	3	11.8333	
2	3	12.0000	
4	3	12.0000	
3	3		13.0000
Sig		.212	1.000

homogeneous subsets are displayed.

Liver

Means for groups in

Treatment	N	Subset for alpha = 0.05	
		1	2
4	3	70.0000	
2	3	70.1667	
1	3	70.3333	
3	3		76.1667
Sig		.615	1.000

homogeneous subsets are displayed.

Lungs

Treatment	N	Subset for alpha = 0.05	
		1	2
4	3	26.0000	
2	3	26.3333	
1	3	26.5000	
3	3		28.0000
Sig		.163	1.000

Means for groups in homogeneous subsets are displayed.

Heart

Treatment	N	Subset for alpha = 0.05		
		1	2	3
1	3	19.9667		
2	3	20.6667	20.6667	
4	3		21.0000	
3	3			24.5000
Sig		.076	.360	1.000

Means for groups in homogeneous subsets are displayed.

Spleen

Treatment	N	Subset for alpha = 0.05
		1
1	3	2.8333
2	3	3.0000
3	3	3.0000
4	3	3.0000
Sig		.220

Means for groups in homogeneous subsets are displayed.

Kidney

Means for groups in homogeneous subsets are displayed.

Treatment	N	Subset for alpha = 0.05	
		1	2
2	3	24.8333	
1	3	25.0000	
4	3	25.0000	
3	3		26.0000
Sig		.517	1.000

Intestine

Means for groups in homogeneous subsets are displayed.

Treatment	N	Subset for alpha = 0.05	
		1	2
1	3	197.1667	
2	3	198.8333	
3	3		226.0000
4	3		230.0000
Sig		.514	.140

Abdominal Fat

Means for groups in homogeneous subsets are displayed

Treatment	N	Subset for alpha = 0.05	
		1	2
1	3	99.3333	
2	3	100.0000	
4	3	100.0000	
3	3		101.5000
Sig		.212	1.000

COST/BENEFIT ANALYSIS

POST HOC TESTS

Homogeneous Subsets

Total Feed Intake

Means for groups in

Treatment	N	Subset for alpha = 0.05	
		1	2
1	6	6888.00	
2	6	6846.00	
3	6		7007.28
4	6		6888.00
Sig		0.14	2.50

homogeneous subsets are displayed.

Cost of Daily Feed Intake/Rabbit (₦)

Treatment	N	Subset for alpha = 0.05		
		1	2	3
1	6			10.000
2	6		9.000	9.000
4	6	6.800	6.800	
3	6		7.8400	
Sig		0.35	.360	1.000

Means for groups in homogeneous subsets are displayed.

Average Body Weight Gain (g)

Treatment	N	Subset for alpha = 0.05		
		1	2	3

1	6		9.3500	
2	6		10.000	
4	6	8.000		
3	6		7.8400	31.900
Sig		5.53	.360	1.000

Means for groups in homogeneous subsets are displayed.

Cost of Feeding/kg Weight Gain (₦)

Treatment	N	Subset for alpha = 0.05			
		1	2	3	4
1	6				12.830
2	6			11.000	
4	6		10.630		
3	6	3.0500			
Sig		3.260	3.260	3.260	3.260

Means for groups in homogeneous subsets are displayed.