ENERGY AND PROTEIN PARTITIONING BY BREEDING RABBIT DOES DURING PREGNANCY AND LACTATION

BY

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A THESIS SUBMITTED TO THE SCHOOL OF POST GRADUATE STUDIES AHMADU BELLO UNIVERSITY ZARIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE (MSC) IN ANIMAL SCIENCE

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DECLARATION

I hereby declare that the work in this thesis entitled "Energy and protein partitioning by breeding rabbit does during pregnancy and lactation" was conducted by me in the Department of Animal Science, Ahmadu Bello University Zaria, under the supervision of Dr P. P. Barje and Prof.(Mrs.) G. T. Iyeghe-Erakpotobor. Information derived from literature has been duly acknowledged in the text and list of references provided. No part of this thesis has been presented and will not be presented elsewhere for the award of a degree or diploma.

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LATU MOSES YOHANNA DATE

CERTIFICATION

This thesis entitled “Energy and protein partitioning by breeding rabbit does during pregnancy and lactating” by Latu, Moses Yohanna meets the regulation governing the award of the degree of Masters of Science of Ahmadu Bello University Zaria and is approved for its contribution to knowledge and literacy presentation.

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This thesis is dedicated to GOD Almighty, my mum (Tet'an), wife (Dinatu), sons (Longkat, Plangji and Domkinan), brothers and sisters.

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ABSTRACT

Data from three different experiments conducted in National Animal Production Research Institute (NAPRI) were used to evaluate partitioning of energy and protein by rabbit breeding does during pregnancy and lactation. In experiment 1, concentrate and lablab hay was used and the combinations were 20:130, 40:110, 80:70 and 100:50 in grams. In experiment 2, concentrate and *stylosanthes* hay in the following percentages were used, 20:80, 40:60, 60:40 and 80:20. In experiment 3, soy bean cheese waste plus Brachiaria hay was used in the following percentages, 0, 10, 20, 30, 40 and 100. Calculations were made using reference data. All data were subjected to analysis of variance using general linear model procedure (proc GLM). In experiment 1 for protein, treatment levels, stage of pregnancy and interactions had all their DCP balances positive. Both 80:70 and 100:50 combinations were significantly ($P>0.05$) higher than 20:130 and 40:110 combinations. For energy, treatment, stage of pregnancy and interaction between treatment and stage of pregnancy all had positive DE balances. During lactation, protein DCP balance was negative for all treatments while energy had negative DE balance in three treatment combinations (20:130, 40:110 and 100:50). In experiment 2, the DCP balances of the combinations 80:20 and 60:40 conc.: stylo. were significantly ($P>0.05$) higher than 40:60 and 20:80 combinations. Energy had positive DE balances in all treatments. The DE balances of 80:20 and 60:40 combinations were significantly ($P>0.05$) higher than 40:60 and 20:80 combinations. During lactation in protein, all the treatments had negative DCP balance. In energy, all treatments had positive DE balances. In experiment 3 for protein, all treatments had positive DCP balances except 20%BCW which was negative. Energy during pregnancy had positive balances. During lactation in experiment 3 for protein, all treatments had negative DCP balances. Energy had positive DE balances. All combinations of concentrate and lablab were adequate for pregnant does. During lactation, the combinations were adequate in terms of energy but inadequate for protein. Similarly, all combinations of concentrate and *Stylosanthes* were adequate for pregnant and lactating does. Soy bean cheese waste plus Brachiaria hay was also adequate for pregnancy while for lactation, energy was adequate but protein was inadequate.

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CHAPTER ONE

1.0 INTRODUCTION

Nigeria has not been able to meet the animal protein requirement of its citizens despite the importance of livestock in the economy and the large numbers of different species (Onuekwus and Okezie, 2007). Average consumption of animal protein in Nigeria is estimated at 4,5g/head/day as against a minimum requirement of 35g/head/day recommended by the Food and Agricultural Organization of the United Nations (Atsu, 2002). With the continuous rise in the cost of production of beef, mutton and chicken, the desired protein intake cannot be met (Onuekwus and Okezie, 2007). Therefore, it has become expedient for livestock experts and nutritionist to explore other potential sources of animal protein for human consumption at reasonably affordable price and within a shorter time.

Animals with short production cycle such as rabbits, poultry and pigs constitute better target animal resources to explore. Poultry and pigs require similar food sources as man. Therefore, they are in serious competition with man for feedstuff. Rabbits on the other hand, have short generation interval, large litter size and can be produced on forage and cereal by-products and so do not compete with man for feedstuff (Cheeke *et al*.1986; Onuekwus and Okezie, 2007; Iyeghe-Erakpotobor *et al.*, 2009). There is therefore an urgent need to increase rabbit meat product as a cheap source of animal protein to bridge the wide gap existing between animal protein supply and consumption (Owen and Amakiri, 2010).

The economic viability of commercial rabbit production is heavily dependent on the maintenance of high reproductive rate especially as the rabbit is one of the few farm animal species that have the ability to mate immediately after parturition, implant and thereafter sustain pregnancy concurrently with lactation (Patridge *et al.*, 1986; Iyeghe-Erakpotobor *et al.*, 2006).

Despite the potential capability of utilizing a wide range of feedstuffs, and the limited maintenance requirements of amino acid and vitamins rabbit feeding represents a great challenge in intensive rearing systems (Xiccato and Trocino, 2010). In conditions where the intensification of the reproductive rhythm becomes widespread, (mating or artificial insemination from 1 to 10-11 days after parturition) along with superimposition of pregnancy and lactation, the nutrient requirements of the reproductive does are very high and the voluntary feed intake is often insufficient to supply all the needs such as (milk production and fetal growth (Fortune-Lamothe, 1997). Therefore, body tissue mobilization is necessary to reduce the nutritional deficit more especially at the moment of lactation peak, which results often in poor body conditions and negative energy balance, associated with lower reproductive performance and reduced longevity (Fortune-Lamothe, 1997).

An increase in the digestible energy content of the diet should theoretically decrease the nutritional deficit of the female, and reduce its harmful influences. However, in the rabbit, composition of the diet must present a minimum level of dietary fiber and a maximum level of starch in order to prevent digestive disorders (Fortune-Lamothe, 1997). For this reason, concentrates and forages have been used for the feeding of rabbits.

In addition to supplying of protein and energy, forages supply fiber to aid proper digestion. Rabbits can be raised on diets consisting entirely of forage and cereal by-products as main sources of protein and energy with high level of production (Cheeke *et al.*, 1986; Iyeghe-Erakpotobor *et al.*, 2009). Although, fibrous feeds traditionally depress digestibility of food, some types and sources have been shown not to exert such negative effects on nutrient digestibility (Johnson *et al.*, 2003).

Among dietary factors, feed energy concentration is the main factor responsible for the ingestion of dry matter and consequently other nutrients such as protein, amino acid and vitamins (Xiccato and Trecino, 2010). The knowledge of energy utilization and physiological state of rabbits is essential for formulating diets that will meet the nutritional requirements and support intensive breeding rhythms (Toschi *et al.*, 2004). It is important to estimate precisely the energy values of feeds for adapting feed supply to energy requirements of animals (Noblet, 2007).

1.1 JUSTIFICATION

The challenges of feeding and feed availability for rearing and production of rabbits and other animal species cannot be over emphasized. Most of the conventional feedstuffs are highly competed for by man, hence the need to source for cheaper but readily available feedstuffs. Some of such feedstuffs consumed and accessible to rabbits are forages such as Lablab, *Stylosanthes*, *Brachiaria* and agro-industrial byproducts such as soybean cheese waste. They are cheaper sources of fibre, protein and energy but are often used in combination with other protein and energy rich concentrates feeds for optimal utilization by rabbits. However, there is need to know whether these feeds meet the nutritional requirement and even to support the high reproductive function in rabbits.

1.2 AIMS OF THE STUDY

The aim of the study was to understand partitioning of energy and protein utilized during pregnancy and lactation by rabbit does fed different diets.

1.3 OBJECTIVES

The specific objectives of the study are:

1. To determine partitioning of energy and protein by breeding does fed concentrates and lablab during pregnancy and lactation.
2. To evaluate partitioning of energy and protein by breeding does fed concentrates and stylosanthes during pregnancy and lactation.
3. To evaluate partitioning of energy and protein by breeding does fed soya bean cheese waste plus brachiaria during pregnancy and lactation.

1.4 HYPOTHESIS

1.4.1 Experiment 1: Protein and energy partitioning by breeding rabbits does fed different concentrate and lablab combinations

Null Hypothesis (H_O)

Levels of combination of lablab and concentrate do not affect protein and energy utilization by rabbit does during pregnancy and lactation.

Alternate Hypothesis (H_A)

Levels of combination of lablab and concentrate do affect protein and energy utilization by rabbit does during pregnancy and lactation.

1.4.2 Experiment 2: Protein and energy partitioning by breeding rabbits does fed different concentrate and stylosanthes combinations

Null Hypothesis (H_O)

Levels of combination of stylosanthes and concentrate do not affect protein and energy utilization by rabbit does during pregnancy and lactation.

Alternate Hypothesis (H_A)

Levels of combination of stylosanthes and concentrate do affect protein and energy utilization by rabbit does during pregnancy and lactation.

1.4.3 Experiment 3: Protein and energy partitioning by breeding rabbits does fed different levels of concentrate and soybean waste combinations and bracharia hay

Null Hypothesis (H_O)

Levels of combination of soybean cheese waste do not affect protein and energy utilization by rabbit does during pregnancy and lactation.

Alternate Hypothesis (H_A)

Levels of combination of soybean cheese waste do affect protein and energy utilization by rabbit does during pregnancy and lactation.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 BRIEF HISTORY OF RABBITS

The rabbit is a four-footed animal. It has two ears and a short tail. The fur covers the whole body. It has bright eyes and possesses hind limbs and fore limbs. Rabbits are classified as pseudo-ruminants because of their ability to eat forages and digest some fiber like sheep, goat and cattle although it does not possess a four compartments stomach- rumen, abomasum, reticulum, and omasum (Omole *et al*., 2007).

The wild rabbit (*Oryctologus cuniculus*) of southern Europe and North Africa is thought to have been discovered by Pheonicians when they reached the shores of Spain. The Varons (116 to 27BC) suggested that rabbits be kept in leporaria, stone – walled pens or parks, with hares and other wild species for hunting. These leporaria were the origin of the warrens or game parks that subsequently developed in the Middle Ages (FAO, 1997). The world's domestic rabbit population is estimated at about 709 million (Lukefahr, 1985). About 82% of the worlds production of rabbit meat takes place in the developed nations (Lebas *et al.*, 1984) and only approximately 18% of total rabbit meat production occurs in developing countries (Soyebo, 2006)

The historical record of rabbit keeping in Nigeria is not available, but it is speculated that it commenced with the advent of slave trading and European adventure into Africa when most exotic agricultural important crops and livestock were introduced (Onifade *et al*., 1999).

2.2 BREEDS OF RABBIT

There are different kinds of breeds of rabbits based on origin namely: primitive or primary, and geographic, from which all other breeds have come. It has been suggested that breeds such as Fauve de Bourgogne, New Zealand White and Red and Argenté de Champagne, which are synthetic breeds that came into existence through planned crosses of several breeds, such as Blanc du Bouscat and Californian; Mendelian breeds, obtained by the fixation of a new character of simple genetic determination, appear by mutation, such breeds as Castorrex, Satin and Japanese (Lebas *et al*., 1997).

There are different breeds of rabbits in the world. The breeds vary in sizes, color and weight, type of hair coat, ear and eyes. The common breeds include New Zealand, Chinchilla, Flemish Giant, White California, Britannia Petite, Belgian hare, Cinnamon, Crème D'Argent, Dutch, Crosses and many more (Omole *et al.*, 2007; Onifade *et al*., 1999).

The United States Department for Agriculture (USDA) has classified rabbits according to size, weight and type of pelt. Small sized rabbits weigh about 1.4 – 2kg at maturity, medium breeds 4 – 5.4kg, and large breeds 6.4 – 7.3kg. Based on this classification, two most popular breeds for meat production include the New Zealand white and the Californian. These breeds are most popular because they combine white fur and good growth characteristics. The New Zealand rabbits are slightly larger than the Californian weighing 4 – 5.9kg and 3.6 – 4.5kg respectively on average. The New Zealand rabbit has a completely white, red or black body, whereas the Californian is white with colored nose, ears and feet. The two most popular rabbits for fur production are the Rex and the American Chinchilla. The Rex is slightly smaller than the American Chinchilla, 3.2kg versus 4.5kg (USDA, 1972). At present, there are many breeds of rabbit being used for both meat and skin production in developing countries. For example in

Brazil there are the New Zealand White, Californian, Chinchilla, Palomino, Hollander, Rex, Dalmation, Flemish Giant, New Zealand Red, Barboleta, Champaigne, d'Argent; in Ecuador there are the New Zealand White, Blue Viennese, Silver German and Angora. In Malawi there are the New Zealand White, Californian, Angora, Rex; in Nepal there are the Californian Hybrids while in Ghana there are the Thuringa, Blue Viennese, Flemish Giant, Checkered Giant, Lop, Californian, Alaska, and the Yellow Silver (USDA, 1972).

In Nigeria, the common breeds include the New Zealand White, Californian, Angora, Rex amongst others. All of these breeds of domestic rabbits are descendants of the European wild rabbit, *Oryctolagus cuniculus* (Aduku and Olukosi, 1990).

2.3 IMPORTANCE OF RABBITS

Rabbits are characterized by small body size, short gestation period, high reproductive potential, rapid growth rate, genetic diversity and their ability to utilize forages (Mailafia *et al*., 2010). Rabbits could be produced using inexpensive and renewable resources such as garden "waste" and by products of plants (Lukefahr, 2009). Rabbits are able to thrive on non-conventional feedstuffs (Omole, 1982). Therefore, rabbits do not compete with humans for grains as strongly as chickens (Van Dijik, 2003; Moreki, 2007).

Across the globe, rabbits are an important source of food. Rabbits produce white meat that is fine-grained, high in protein, low in fat, highly palatable and low in cholesterol thus, can be substituted for poultry in most recipes (Sell, 1993; Soyebo, 2006; Omole, 2007). Damron (2006) showed that a piece of rabbit meat is high in protein, 56%; low in fat, 9%; low in cholesterol, sodium and calories, 8%; and contain 28% phosphorus, 13% iron, 16% zinc, 14% riboflavin, 6% thiamin, 35% B12 and 48% niacin. Rao *et al*., (1987) also reported that rabbit meats mainly composed of 18.8 – 19.4% protein, 9.9 – 10.9% fat and 68.5 – 72.0% moisture. Rabbits are also raised for non-food purposes such as high quality rabbit skins used for fur garments and trimmings. Medical and cosmetic research also requires a large number of rabbits each year (Omole, 2007).

Schiere (2004) reported that starting a rabbit project requires minimal initial capital and also can be sold easily when small amount is needed to meet immediate family needs. Rabbit farming help farmers make use of some underutilized resources such as labour or buildings (Soyebo, 2006). Rabbits require small amounts of feed; and use inexpensive, easily constructed housing (Cheeke, 1986). Unlike bigger animals such as cattle, rabbits can be tended by women, children or men as they do not need to be restrained (Schiere, 2004). Rabbit production is a veritable way of alleviating animal protein deficiency in Nigeria (Ajala and Balogun, 2004)

2.4 MANAGEMENT OF RABBITS

Rabbit production in Nigeria at present is traditional, non-conventional oriented, family consumption targeted and smallholder type comprising a range of two to seven does and three bucks on average (Onifade *et al*., 1999).Management of rabbits in Nigeria is traditional or rudimentary but information on housing and management is well developed in research institutes (Onifade et al., 1999). While rabbits can be reared at the backyard in a cage or floor, environmental and breeding conditions greatly vary from poorly controlled rural rabbitries, gardens and houses to fully controlled commercial farms and experimental laboratory facilities (Xiccato and Trocino, 2010)

The type of housing is dependent upon climate, location and size of rabbits. Other factors to be considered when designing house for the rearing of rabbits has been out lined by

Omole *et al.*, (2007) as follows: The housing must be cost effective. Durable and affordable materials should be used for the construction. The house must be able to protect them against rain, sun and wind. Rabbits can be reared either in cages or floor (deep litter). The cage could be built of wood, iron or bamboo depending on the choice of the farmer. The door of the cage could be at the top or at the side. It could be one tier, two ties or three tiers cage. Cage measurement a pair of rabbits are 48 by 36 by 44cm for the length, width and height (Onifade *et al*., 1999). The floor or deep litter could be built of concrete or mud block and the top or side covered with wire net to allow for ventilation. Sufficient room is required for caged rabbits to move around, to feed and drink without difficulty. The minimum legal standards for different classes of rabbits are: doe and litter (5 weeks) 0.56sq.m (total area), doe and litter (8 weeks) 0.74sq.m (total area), rabbits (5-12 weeks) 0.07sqm (per rabbit), rabbits (12weeks and more) 0.18sqm (per rabbit) and adult does and bucks for breeding 0.56sqm cage height (>12 weeks) 45cm (Crusader Team, 2002). In rural areas, house/ hutches are made from planks, woods or wood barks or bamboo or houses but with mud having cemented or non-cemented flours are used (Onifade *et al*., 1999).

2.5 FEEDING OF RABBITS

Feed is a very important factor of production. The performance of rabbit depends mainly on the quality of the feed and other management practices (Omole *et al.*, 2007). Despite the potential capability of exploiting a large number of feed stuffs and the limited maintenance requirements of amino acids and vitamins, rabbit feeding represents a great challenge in intensive rearing systems for both economic and sanitary reasons (Xiccato and Troccino, 2010). The major problems for most producers are the high cost of feed and the use of feed materials that are in great demand or in competition with man (Iyeghe-Erakpotobor *et al*., 2006).

Exploration for cheap non conventional feed resources has revealed that rabbits can be fed forages and agricultural by-products that are not suitable for human consumption. Studies have shown that rabbits can utilize 50g of concentrate with forage grasses or legumes without adverse effect on growth (Bamikole and Ezenwa, 1999, Iyeghe-Erakpotobor et al., 2002, 2003; Iyeghe-erakpotobor, 2006) or raised on diets consisting entirely of forage and cereal by- products (Cheeke, 1986). In addition to supply of protein and energy, forages supply fibre to aid proper digestion. It helps to maintain high rate of passage, avoiding the accumulation of digesta in the ceacum that reduced feed intake (De Blas and Meteos, 1998). Moreover, fibre is a substrate for cecal micro organisms where its fermentation product is mainly volatile fatty acids (VFA) which may reduce the incidence of digestive disorders and mortality (Safwat *et al*., 2014). The parts of legumes rich in nitrogen are the seeds and leaves. Some plant leaves and seeds have been used as feedstuffs for rabbits and other animals as a partial or complete substitute for the conventional grains and forages such as mulberry (*Morus spp*) leaves Bamikole *et al*. (2005), cassava peel Omole and Sonaiya, (1981), *Tridax procumbent* forage Adeyemo *et al*. (2014), *Moringa oleifera* leaves Odetola *et al*. (2012) and Peageon pea (*Cajanus cajan*) Farinu *et al*. (2008): Safwat, *et al*. (2014). Forage legumes are usually adequately supplied with protein for livestock feeding even when harvested at an advanced stage of maturity. Utilization of forages by rabbits is higher for leafy and succulent grasses than non-succulent woody plants (Aduku *et al*., 1986). Once an appropriate balance of nutrients is available in the forage as shown in alfalfa meal, the forage can replace grain in rabbit diet and therefore reduce concentrate need of the rabbit (Aduku *et al.*, 1986). Although, fibrous feeds traditionally depress digestibility of feed, some types and source have been shown not to exert negative effects on nutrient digestibility (Johnson *et al*., 2003). These show great potential for practical use during gestation especially those that are readily fermented and have no adverse effect on reproductive performance (Pond *et al.*, 1985). Omole *et al.* (2007) concluded that sole feeding of *Stylosanthes guinensis* and *Lablab purpureus* compared favorably in terms of feed intake, weight gain, feed conversion ratio, nutrient digestibility and carcass analysis to the widely used common rabbit feed or sunflower.

Other common feedstuffs would include grains such as maize, sorghum, wheat, guinea corn and millet. Industrial by-product would include wheat bran, corn bran, brewer's dry grain and maize bran. Tubers like cassava, sweet potato and cocoyam and household wastes such as cooked rice or jollof, yam peel, cow pea bran and plantain peel. Sources of protein for rabbits include groundnut cake, soya bean meal or cheese waste, fish meal, cotton seed meal. Rabbits could be produced using inexpensive and renewable resources such as garden "waste" and by-products of grains (Lukefahr, 2009). Green leaves such as sweet potato leaf, cocoyam leaf, cassava leaf, leucaena leaf, pawpaw leaf, tridax, brachairia, sunflower, lablab and *Stylosanthes hamata* (Omole *et al.*, 2007).

Concentrates are also used in the feeding of rabbits, although the use of concentrates alone has not given optimum results. (Iyeghe-Erakpotobor, 2007; Bamgbose *et al*.,2003). Studies have shown that rabbits can utilize 50% of concentrate with forage grasses or legumes without adverse effect (Iyeghe-Erakpotobor *et al*., 2006).

2.6 NUTRITIONAL REQUIREMENTS OF RABBITS

Nutrients are the chemical and biological elements that are digested, absorbed and utilized by all animals for maintenance, growth and production. The nutrients that rabbits require in their diet are grouped in the following categories; protein, energy (carbohydrate and fat), minerals and vitamins (Halls, 2010).

2.6.1 Protein

Protein is one of the most important and most expensive nutrients to provide. To synthesize proteins (for meat, milk and hair proteins), the rabbit require all amino acids. The requirements of animals, therefore, are for amino acids rather than for protein (Fraga, 1998). However, data on amino acids digestibility in different feedstuffs are still limited. Therefore, the calculation of daily protein requirements (expressed as gDCP/day) of rabbits are used (Fraga, 1998). According to Pond *et al*. (1995), dietary protein quality is particularly important for rapidly growing weaning rabbits which may not have well developed caecal fermentation capacity.

Rabbits increase their amino acids intake from the consumption of their caecotrophs or soft faeces. Thus, their total protein intake is supplied by the dietary intake plus ingestion of the soft feces. Restricting caecotrophy can reduce protein digestibility by as much as 20% (Halls, 2010).

Protein requirement in does shows a wide variation. Lactating does require higher dietary protein when they are also concurrently pregnant (Fraga, 1998) (Fraga, 1998). These extremely high levels of requirement often result in a negative balance of protein and the doe must pull protein from their own body reserves (de Blas and Wiseman, 2003, Halls, 2010). Also, the dietary protein level necessary to meet the requirement of rabbit vary according to its amino acids profile, the degree to which the protein is digested and the amount of feed ingestion should come which in turn depends upon the dietary digestible energy (DE) concentration (Halls, 2010). The recommended crude protein level (dry matter) in the rabbit rations is over 18% for newly weaned rabbits, 16 – 18% for rabbits from 12 – 24 weeks, 15 – 17% for breeding does and 12 – 14% for all other stocks (Fielding, 1991). NRC (1977) in Obinne and Okorie (2008) recommended 16% protein and 10.46MJ per Kg digestible energy for high meat production in temperate climate. Obinne and Mmereole (2010) found that a diet containing digestible energy level of 8.7MJ/Kg in combination with 16% protein was adequate for the optimum growth of rabbits in the tropics. Carabano *at al*. (2008) reported higher requirements for protein (around 20%) for reproductive performances which is more than those needed for growth. Current commercial levels of dietary protein for fattening and reproductive does averages from 16 to 18 (Carabano *et al.*, 2008) while Omole (1982) reported a protein range of 18-22% for efficient rabbit production in the tropics.

Protein levels around 14% fed to rabbits from weaning (at 35 days old) to slaughter (2 to 2.7 kg) did not impair growth performance (Carabano *et al*., 2008). However, this level may not be enough to meet the growth requirements in post weaning diets fed to very young animals (21 to 35 days old). Protein and amino acids requirements are relatively high in young rabbits not only for tissue accretion but also because of the high needs for intestinal growth and maintenance of the intestinal mucosa functionality (Carabano *et al.*, 2008). Accordingly, very low levels of protein (12%) have been related with low growth performance and incremental increase in mortality rate. For lactating does, Carabano *et* *al.*, (2008) reported that, a reduction of protein level (from 18-16%) in the late lactation (21 to 35 day) did not affect performance of rabbit does and litters in temperate environment. The protein supply to lactating does after the 21 day of lactation could be decreased taking into account the decrease in milk yield (Carabano *et al.*, 2008).

2.6.2 Energy

Energy is the potential ability to produce work and is derived from the metabolism of carbohydrate, protein and lipids. The important carbohydrates in rabbit feed are starch (digestible) and fiber (indigestible). Starch provides energy that is readily available and easily digestible. Although, grains are good sources of starch, rabbit diets high in grain can cause a starch overload in the hindgut, leading to enteritis (Halls, 2010).

Healthy rabbits will consume sufficient amount of feed to meet their digestible energy (DE) requirements. Rabbits will consume more feed if they are fed a low energy diet and will consume less feed if they are fed a high energy diet. Increase in DE can affect the composition of body gain and the percentage of energy retained as protein and fat in the body (Halls, 2010).

Maintenance energy requirements (2100-2200 kcal/Kg) comprise the majority of the rabbits energy needs. Reproduction and growth require 300- 500 kcal/Kg more than maintenance requirements. Due to the high energy demands for pregnancy and lactation, does often have a negative energy balance. As a result, does will utilize body tissues (fat and protein) as sources of energy to compensate for insufficient DE intake. Also, the energy output in the milk during lactation is extremely high in the rabbit (200-300g/day) compared to other mammalian species (de Blas and Wiseman 2003, Xiccano and

Trocino, 2010). However, does are very efficient in utilizing dietary energy, which is thought to be due to the body fat mobilization for milk synthesis, particularly during mid lactation when milk production is at its peak or when pregnancy is concurrent with lactation (de Blas and Wiseman 2003, Halls, 2010). It has been reported that energy requirement of rabbits to ranged between 2390 kcal/kg and 2500 kcal/kg to 2700 kcal/kg digestible energy (Xiccano and Trocino, 2010).

Fat also functions primarily as an energy source. It contains, on the same weight basis, slightly 2 $^{1}/_{4}$ times more energy than carbohydrates. The addition of fat in a rabbit diet also increases palatability, reduces fines and aids in the absorption of fat-soluble vitamins (A, D, E and K) in the digestive system. Caecotrophy consumption supplies volatile fatty acids (VFA) in the diet, which are a major energy source for the rabbit (Halls, 2010). Rabbits do not have specific requirement for fat apart from small amount of esterified fatty acids (EFA), (Lebas, 1989). Rabbit fat is easily met by the lipids contained in the conventional raw materials used in the formation of compound feeds (Xiccato, 1998).

2.6.3 Mineral and vitamin requirements

Minerals are important constituents of the skeletal structure. Minerals are grouped into two categories – macro minerals and micro minerals. Macro minerals include calcium, phosphorus, sodium, magnesium and potassium and are required in grams per day. Trace or micro minerals include copper, zinc, manganese, iron, iodine, selenium and cobalt and are required in milligrams per day. A mixed diet that will supply the needed energy, will generally also supply the minerals required with the exception of salt (sodium chloride) (Halls, 2010). Legumes are high in calcium and are good sources of phosphorus. Rabbit milk is very rich in both calcium and phosphorus thus; lactating does have higher requirements for these minerals than growing or non- lactating does (Halls, 2010).

Vitamins are essential nutrients required in small amounts which are necessary for normal body function (Mateos and de Blas, 1998). Vitamins are divided into two categories – fat-soluble and water-soluble vitamins. B vitamins and vitamin C are water soluble while vitamin A, D, E and K are fat soluble vitamins. Fat soluble vitamins can be stored within the liver and fat deposits, and if eaten in large amounts, are not needed on a daily basis. Water soluble vitamins are not stored within the body and any unused portions are excreted via the urine. However, the majority of B vitamins are synthesized by the hindgut bacteria and consumed during caecotroph and thus are not necessarily required in the diet (McDonald *et al*, 1995; Halls, 2010). Toxic levels of vitamin A can cause reproduction issues in does, including abortion, high kit mortality, hydrocephalus, weak small litters and fetal resorption. Since these signs can also indicate deficiency, both aspects must be taken into consideration when these symptoms occur (Halls, 2010).

2.6.4 Water requirement

Water is very important constituent of the body of rabbits and the feed. It is not a nutrient per se, but plays important role as solvent. Water is contained in all feed materials ranging from about 10% in dry feeds to over 80% in fresh forage (Esonu, 2000). Dry matter is an indication of how much water (or lack of water) there is in the feed (Omale *et al.,* 2007). Water is an often overlooked yet critical nutrient required by rabbits. Animals can condone the lack of other nutrients longer than the lack of water. They can survive a complete loss of fat, half loss of protein but the loss of only 10% of body water can cause death. A deficiency can lead to dehydration, electrolyte imbalance and blockages forming in the gastrointestinal track. These all lead to death and along the way a decrease in milk production and reduced overall production (Halls, 2010; Omale *et al.,* 2007). Daily water intake of rabbits depends on several factors such as age of the rabbit, season, stage of production, type of feed given and health status of the rabbit (Omale *et al.*, 2007). Normally, water is provided ad-libitum and should be clean.

2.7.0 FEED RESOURCES OF RABBITS

2.7.1 *Stylosanthes hamata* (*Verano stylo*)

The genus *Stylosanthes*, a legume native to South America, is an important commercial legume genus in tropical areas around the world. It is widely used for forage, green manure, cover crops, erosion control and commercial hay and meal production (Kezian, 2000). It is a short-lived perennial legume (2 to 3 years) which grows into a small shrub with some woody stems. It is adapted to a wide range of soils and climates but also grows on infertile acid soils. Since *Stylosanthes spp* are tolerant of drought and infertile soils and have multiple uses and high nutritive value, the genus is being more widely used in northern Australia, Thailand, India, China, Nigeria and other West Africa countries for raising cattle, sheep and goats (Kexian, 2000). It is cut and fed and also used to make hay and *Stylosanthes* leaf meal (SLM) for feeding poultry, cattle, swine, and rabbits (Kexian, 2000).

Nitrogen concentrations of *Stylosanthes* spp range from 1.5 to 3%, but dry matter digestibility of young plant material lies between 60 and 70%, however, with increasing age and lignification, this may be reduced to below 40%. Crude protein figures range from 12.1 to 18.1% for the whole plant but up to 21% has been reported for leaves (Huy *et al*., 2000).

2.7.2 Lablab (*Lablab purpureus*)

Lablab is a forage that is not utilized by man for food or widely fed to animals but it have been reported as a valuable legume that can be used in the tropical farming systems (Murphy *et al*., 1999). It is a warm season annual forage legume in Australia, Brazil and other tropical countries. It is highly cultivated in Northern part of Nigeria where it is used as cover crop and forage for feeding ruminants (Otaru *et al*., 1998: Odunsi *et al.*, 2006). Lablab has also been used to feed broiler chickens, cattle, sheep and goats with good results and no adverse effect on the health status of the animals (Babayemi, *et al*., 2006: Odunsi, *et al.*, 2006). Lablab forage has a good potential in reducing concentrate usage by rabbits raisers and would also elicit positive effect on nutrient digestion and reproduction of rabbit does (Iyeghe-Erakpotobor *et al*., 2009). Rabbits performed well with ground nut and lablab mixed forage meal diets (Iyeghe-Erakpotobor, 2012).

Lablab- with an average crude fibre of 28% is slightly above average when compared with other tropical legumes and has considerable more protein than tropical grasses (Murphy and Colucci, 1999). The chemical composition of dry lablab forage was reported to be 59.2% for dry matter, 16.7% for crude protein, 29.8% neutral detergent fiber (NDF), 18.0% acid detergent fiber (ADF), 4.8% acid detergent lignin (ADL), 4.9% ether extract (EE) and 9.2% for ash (Otaru *et al*., 1998: Odunsi *et al*., 2006: Babayemi *et al*., 2006). Evans (2002) reported a range between 12.7 – 14.1% proteins for the whole plant.

2.7.3 Grasses

Most of the grasses (e.g. Setaria, Brachiaria, Elephan grass) are less palatable than legumes. Guinea grass is the most productive forage grass in tropical areas and produces high yields of palatable fodder. The highest nutritive value is obtained at the cutting height of 60 – 90cm, but for higher yields, it can be cut up to 1.5m height. The digestibility in rabbits of some tropical forage fed in fresh (wilted) have been reported (Raharjo *et al*., 1986).

Brachiaria have also been proven to be well accepted and utilized by rabbits. It is said to have 6% CP and 2000 Kcal ME/Kg DM (Patridge, 1989). Studies have shown that rabbits can utilize 50% of concentrate with forage grass or legumes without adverse effect on growth (Bamikole and Ezenwa, 1999; Iyeghe- Erakpotobor *et al*., 2002; Iyeghe-Erakpotobor, 2006). Safwat *et al*. (2014) reported the used of many grasses and forages which includes *Tridax procumbent* forage Adeyemo *et al*. (2014), dried *Leucaena leucocephala* leaves Ani and Ugwuowo (2011), Hybrid poplar foliage (*populous spp*) (Ayers *et al*., 1996).

2.7.4 Maize

Maize has remained the major source of energy supply in livestock diets. Maize has been and continues to be an indispensable cereal grain in the diets of monogastric and pseudo-ruminant animals and it typically forms between 50 to 60% of such diets (Omage *et al*., 2009). The normal maize variety used in livestock diets is low in protein (9 – 10%) and does not provide the essential amino acids; (lysine and tryptophan) in sufficient quantities for the nutritional needs of farm animals (Omage *et al*., 2009). However, livestock diets based on normal maize are supplemented with protein – rich feed ingredients such as soybean meal, fishmeal and synthetic lysine to compensate for the deficient lysine.

2.7.6 Agro – Industrial by – Products

With the takeoff of the agro-industrial revolution in Nigeria, many agricultural and industrial by-products were produced in such quantities that they constituted a problem of waste disposal. The trend has changed now and agricultural by-products such as cassava peels, poultry manure, cocoa husks, maize cobs, maize and wheat offals among others are widely used as animals feed (Iyeghe-Erakpotobor *et al*., 2002). Soybean cheese waste is a by-product of milk and cheese from soybean. This product is available in towns and villages especially in Northern Nigeria where soybean cheese is widely eaten while soybean cheese waste meal is used for feeding animals such as cattle, sheep and goats. Soybean- full fat soya bean contains 38% CP and 3300 kcalME/kg while soy bean cake contains 44% CP and 2420 kcal ME/ kg (Aduku, 1992). This is an indication that soybean waste meal might contain adequate amount of protein and energy that can meet the requirements of rabbits. Soybean cheese waste was reported to have compared favorably with the rabbit meal that was fed to rabbits (Iyeghe-Erakpotobor *et al*., 2006).

Other by-products that could be used for the feeding of rabbits in rural areas includes groundnut haulms, sweet potato vines, soybean forage and cassava meal, peels, leaf and hay (Iyeghe-Erakpotobor *et al*., 2002). Cassava leaf/hay contains high levels of nutrients, especially protein. It has been found that cassava hay harvested at a young state of growth (3 months) contained up to 25% CP and with a good profile of amino acids (Omole and Sonaiya, 1981). It has also been reported that inclusion of 5% palm oil in rabbit diets containing cassava peel meal reduced the toxic effect of cyanide and increase the urinary excretion of thiocynate (Omole and Onwudike, 1983).

2.8 REPRODUCTION IN RABBITS DOES

Reproduction success in farm animals is determined by numerous interactive factors including the genetic makeup of the animal, temperature, photoperiod, stress and nutrition. Of these factors, nutrition has a major influence on the reproductive ability of an animal (Iyeghe-Erakpotobor and Ashworth, 2003). Generally, a doe is ready for mating from 16 weeks of age and bucks mature at 18-20 weeks. Breed will vary in age of sexual maturity with most New Zealand Whites and Californians ready to breed at 4.5 to 5.5 months whereas Flemish Giant are not ready until 6-7 month (Crusader Team, 2002). According to Cheeke, (1986), medium weight breeds (4.5 to 6kg) are able to start breeding at 6 to 7 months of age, with males maturing one month later than females. Rashwan *et al*. (2003) reported an average of 31 – 36 days gestation while Moriwoto, (2009), reported an average of 28 – 36 days gestation in different breeds. Orunmuyi *et al*. (2006) reported a gestation period of 30.3 days. The gestation period is 32 days and may vary between 29-33 days depending on the litter size. Large litter tends to have shorter gestation periods (Crusader Team, 2002).

2.9 FACTORS THAT AFFECT REPRODUCTIVE PERFORMANCE OF RABBITS

Reproductive activity is firmly under the control of the neuro-endocrine axis but genetic, feeding and management factors strongly modify such hormonal release (Cesare *et al.*, 2010). There exist breed and seasonal variations in reproductive performance of rabbits (Iyeghe-Erakpotobor *et al.*, 2001). Work done in temperate regions show marked variation in breed (Lukefahr *et al.*, 1985) and environment (Lebas, *et al.*, 1986) on the performance of rabbits. Iyeghe-Erakpotobor *et al.* (1999) reported the influence of breed on several parameters such as, litter size at birth, litter size alive at birth and at weaning, kit weight at birth, still birth and pre weaning mortality and reported that breed of doe had significant effect on all parameters measured except average weaning weight.

High ambient temperature under tropical conditions does not allow for efficient intake of nutrient dense diets. This further limits possibility of achieving very high reproductive efficiency under tropical conditions especially during hot seasons (Iyeghe-Erakpotobor *et al.*, 2005). Also, rabbits are susceptible to heat stress due to the fact that they have few functional sweat glands (Cheeke *et al*., 1986) which has an indirect effect on fertility and prolificacy (Kumar *et al*., 2005). The adverse effects of high temperature on spermatogenesis, fertilization failure and embryonic mortality have also been established (Kumar *et al*., 2005). It has been reported that though rabbits can be bred all year round, the best season for rabbit breeding in sub-humid environment is the hot-dry (February-May) season, although maximum temperature was observed to be more critical to rabbit production as it negatively influenced more litter parameters than other environmental factors studied (Iyeghe-Erakpotobor *et al.*, 2001).

Kumar *et al*. (2005) reported that the reproductive parameters at 5^{th} and 6^{th} parity were not comparable due to the low number of kindlings. This is an indication that long years of kindling have an adverse effect on reproduction.

The age of the female at service had no significant effect on gestation length and sex ratio; however, there is a possible decrease in reproductive efficiency in older females with advancing age (Kumar *et al*., 2005). According to these authors, the decrease in reproductive efficiency with increasing maternal age could be attributed to uterine aging, inadequate environment and a reduced rate of uterine flow.

The relationship between nutrition and reproduction is a topic of increasing importance among producers, veterinarians, feed dealers and animal nutrition experts. This is due to the recognition of the fact that high reproductive efficiency is dependent upon good nutrition and management (Lanyasunye *et al.,* 2005). Recent research indicates that the nutritional environment in utero may affect an offspring's long term growth, health and reproductive ability often called "fetal programming" (John, 2010). According to the authors, it appears that fetal nutrition may activate different genes in which it affects biological processes later in life. Nutrition is an important factor in does because it affects litter size. A reproductive response to changes in nutritional status is an increase ovulation rate (Britt *et al*., 1988). In rabbits, nutrition is an important factor affecting litter size of does and litter size is one of the most important factors affecting productivity of rabbit does (Iyeghe-Erakpotobor *et al*., 2005).

2.10 NUTRITIONAL STRATEGIES TO ENHANCE REPRODUCTIVE PERFORMANCE OF RABBITS

The main objectives for application of nutritional strategies are to improve reproductive performance of young does and to prolong their reproductive life pan (Rick, 2004). Improved reproductive performance implicates improvement of several reproductive factors such as kindling rate, litter size, kit survival at kindling and during lactation and milk production. To prolong lifespan of the does, a low culling rate during reproduction should be achieved (Rommers, 2004). Improved reproduction has been achieved in farm animals, by increasing feed intake or nutrient content above the maintenance level (flushing) for a short period before mating to increase litter size in pigs (Ashworth, 1991). Increasing the plane of nutrients, for 4 days before and 1 day after mating resulted in considerable improvement in fertility of rabbits (Broeck and Lampo, 1978). Iyeghe-

Erakpotobor *et al*., (2005), concluded that flushing does with 20 and 24% CP diets produced larger litter size at 21 days postpartum, heavier litters at 7 to 21 days postpartum with lower kit mortality rates.

Several studies attempted to increase the feed intake during the first lactation by feeding the young females with a fibre-rich diet to improve their reproductive performance (Arias-Alverez *et al*., 2008). Feeding of young does a high-fibre diet until their first kindling reduced the chemical and energy body deficit at the end of the first lactation (Xiccato *et al.*, 1999). The inclusion of fat in the diet of reproductive does would be of interest to increase its energy content without decreasing too much its fibre level (Fortun-Lamothe, 1997). However, some technological problems are associated with inclusion of fat in diet. For instance, pollution occurs when fat is added at level higher than 30-40g/kg and rancidity could occur with animal fat which could decrease the diet palatability (Fortun-Lamothe, 1997).

In intensive production systems, the young rabbit does show low reproductive performance and a brief lifespan, as a consequence of energy deficit which they experience in order to sustain the high nutritional requirements for their concurrent lactation and pregnancy (Xiccato, 1996). Among the approaches to resolve the problem of energy deficit, an adapted rearing program seems to be suitable (Rommers *et al.*, 2004). During rearing, *ad libitum* feeding determines an excessive formation of fat deposits in growing female, which interfered negatively with the subsequent reproductive activity.

2.11 THE ROLE OF ENERGY IN REPRODUCTION

Energy availability appears to control reproduction primarily through pathways that permit or block the release of gonadotrophic releasing hormones (GnRH) from the hypothalamus and luteinizing hormones (LH) from the pituitary (John, 2010). Energy substrates or metabolic responses to energy availability may also act upon the ovary to influence specific growth, estrogen production and circulating progesterone levels (John, 2010). During lactation, the high energy output associated with milk production is not entirely compensated by feed intake. Rabbit does meet this energy deficit by increasing the mobilization of body energy which impacts negatively on reproduction performance (Cesare *et al*, 2010). Several factors affect energy balance that is particularly negative in primiparous does because the energy requirement must sustain lactation, pregnancy as well as body growth for the achievement of adult weight (Parigi Bini and Xiccato, 1998). In prolific strains, lactation takes a priority as a physiological function and the rabbit mobilize a large part of its body reserve to satisfy its requirements, In many species, the partition of nutrients toward lactation leads to lower body condition and higher infertility in females (Lucy 2003 in Cesare *et al.*, 2010).

2.12 THE ROLE OF PROTEIN IN REPRODUCTION

Protein is important in the nutrition of rabbits. During pregnancy, 20% of digested nitrogen is retained for conceptus growth and doe body tissue accretion while milk yield during lactation is affected by protein level (Partrige and Allan, 1982, Iyeghe-Erakpotobor and Adeyinka, 2008). A significant positive correlation exists between protein content of feed and crude protein digestibility (Fekete and Gippert, 1986; Villamide and Fraga, 1998). This implies that, the higher the protein content of the diet, the higher the digestibility of protein by rabbits. This could translate into more amino acids in circulation which might consequently result in higher ovulation rates and litter size (Iyeghe-Erakpotobor and Adeyinka, 2008). Rick (2004) summarized the effects of inadequate protein on the reproductive efficiency to be delayed puberty, suppressed libido and ovulation, low spermatozoa production, suppressed estrus, low conception rate, fetal re-absorption, premature parturition and weak offspring.

2.13 ENERGY PARTITIONING

Feed is the greatest single factor in animal production. Energy accounts for the largest proportion of the cost of production (Soenke *et al.*, 2005). Therefore, it is critically important that the energy component of a diet is known. Energy is not a nutrient *par se* but a quality associated with the nutrient content of feedstuffs and mixed diets. Carbohydrates (starch, sugar and fibre) serve as substrates for oxidation (the process that converts carbon from the diets to carbon dioxide, CO_2) to provide energy for metabolic processes (Noblet, 2007). Protein and lipids in a diet mostly serve as components of body protein and lipids deposition but can also be oxidized to provide energy for metabolic processes. The amounts of energy that can be derived from dietary nutrients differ between protein, lipids and carbohydrates (Noblet, 2007). Energy evaluation and the use of the most accurate system to describe this energy are of central importance in the formulation and assessment of diets (Soenke *et al.*, 2005). Feed energy within the animal is partitioned into the following

Gross energy (GE) or heat of combustion defined as energy released by burning a sample of feed. Gross energy of feed (GE) is not totally available for meeting the requirement of animals since it does not take into account any of the losses of energy during ingestion, digestion and metabolism of feed, that is, energy lost in feces, urine, as gas of fermentation (methane and hydrogen) and as heat or heat increment. In fact, 1kg of starch has about the same gross energy content as 1kg of straw even though the energy in straw cannot be used by monogastrics (Soenke *et al*, 2005; Noblet, 2007).

Digestible energy (DE) referred to as the gross energy of feed minus the gross energy of feces. This energy system takes into account the digestibility of feed even though energy of gas and feed originating from hindgut fermentation is not considered in the calculation. This energy system is widely used in North America and in a variety of European countries, predominantly because it is easy to measure (Soenke *et al.*, 2005; Noblet, 2007; Villamide *et al.*, 1998).

Metebolizable energy (ME) is defined as the digestible energy minus energy excreted in urine and as combustible gases (e.g. methane). By taking into account these losses, metabolizable energy gives a better estimate of the energy available to animals for protein and lipid synthesis. ME corrects digestible energy for some of the effects of quality and quantity of protein (Urine energy) and fibre (methane) (Soenke *et al*, 2005; Noblet, 2007). On the other hand, in practical feeding, urinary energy (UE) loses are closely linked to the total intake of digestible protein (DP). For this reason, when common compounded diets with 120-150g DP/kg are fed to rabbits, the DE and ME are closely correlated and the ME is about 0.94-0.96 to DE (Parigi Bini and Xiccato, 1998). This system is widely used in Europe and North America (Soenke *et al.*, 2005).

Net energy (NE) defined as metabolizable energy minus the heat increment that which is the heat produced (and thus energy used) during digestion of feed, metabolism of nutrients and excretion of waste. The energy left after these losses is the energy actually used for maintenance and production (growth, digestion, lactation). This means that, net energy is the only system that describes the energy that is actually used by the animal. Net energy is therefore the most accurate and unbiased way, to date, of characterizing the energy content of feed (Noblet, 2007).

However, NE is much more difficult to determine and more complex than DE or ME which may be a reason why it is not as widely used as it should be (Soenke *et al.*, 2005; Noblet, 2007).Therefore, the real choice is between DE and ME systems. ME is the system preferred for poultry, because birds excrete urine and feces together. ME and DE values are highly correlated in normal diets, only a small amount of energy is lost in urine and ME represent almost a constant fraction of DE: about 0.95 (Parigi Bini and Xiccato, 1998). For this reason, DE values are still commonly used both in studies on energy metabolism and in practical rabbit feeding (Parigi Bini and Xiccato, 1998, de Blas and Wiseman, 1998). Feed energy partition involves the metabolism of feed and energy transfer from one form to another. For instance, chemical energy can be transferred to mechanical energy. The body requires two levels of energy, the energy for maintenance and the energy for production (Esonu, 2000).

Energy for maintenance **-** The concept of a maintenance energy requirement has been widely adopted by animal nutritionist, even though, it may be difficult to define and/or measure (Knap, 2000). A substantial amount of the feed energy consumed by animals is used to support vital body functions such as metabolism, mastication, respiration and heat regulation. The demand for feed for these vital processes is the maintenance requirement of that animal (Esonu, 2000). Therefore maintenance requirement of nutrients for the continuity of vital processes within the body is such that the net gain or loss of nutrients by the animal as a whole is zero (Van Millen and Noblet, 2003). When energy is based on digestible energy (DE), retained energy (RE) can be related to DE intake thus, the efficiencies of utilization of DE intake (DEI) by rabbits for maintenance, growth, lactation and pregnancy have been estimated (Parigi Bini and Xiccato, 1998).

If the amount of energy supplied by the diet exceeds the requirements for maintenance, then some of the extra energy is available for the process of animal production such as during pregnancy and lactation because during pregnancy, does undergo wide variations in body composition, tissue deposition and energy retention (Esonu, 2000). During early and mid gestation (0-21 days) the live weight increase is similar to that of non-pregnant does. During late pregnancy (21-30 days) the empty body weight decreases as a result of a protein and fat loss and a transfer of energy to the rapidly growing fetuses. The transfer of energy from the body of does to the fetuses leads to an energy deficit that is particularly concentrated in the last 10 days of pregnancy in sows (Noblet and Close, 1990). The efficiency of utilization of DE for maternal tissues accretion in pregnant or non- pregnant does was estimated to be 0.49 while the efficiencies of utilization of dietary DE for fetal growth were 0.3 in pregnant nulliparous does and 0.27 in lactating and pregnant does (Parigi Bini and Xiccato, 1998).

The energy output in the milk during lactation is exceptionally high in rabbits, compared with other species due to the rate of production, (200-300g/ day), high concentration of DM (300-350g/ kg), protein (100-150g/ kg) and fat (120-150g/ kg) in the milk (Fraga *et al.*, 1989 and Parigi Bini *et al.*, 1992). The chemical composition of rabbit milk changes substantially during lactation, in particular the DM content decreases in the first 1-3 days as colostrum becomes milk, then remains constant for 2-3 weeks and finally increases as the milk yield decreases (Parigi Bini *et al.*, 1992). On the other hand, composition of milk

DM tends to remain unchanged except for a constant reduction in lactose level and therefore the caloric volume of milk is strictly dependent on the variation of DM content (Parigi Bini *et al.*, 1992, Xiccato *et al.*, 1995).

2.14 PROTEIN PARTITIONING

Feed protein partitioning involves the synthesis and transfer of protein from one form to another (Villamide *et al.*, 1998). Dietary proteins are digested through the action of proteolytic enzymes to amino acids. These amino acids are then absorbed through the small intestine into the portal blood (Esonu, 2000). The use of crude protein (CP) and amino acids to formulate diets for rabbits is still common (Villamide *et al.*, 1998). The commonly used measure of protein is crude protein (CP) which is based on the nitrogen content of the feed. Metabolizable protein (MP) is an estimate of the protein reaching the small intestine and absorbed by the small intestine (de Blas and Wiseman, 1998). While a more refined estimate of protein of the diet, metabolizable protein cannot be measured directly by chemical analysis and must be estimated from digestion trials of similar feedstuffs. For grains and oilseeds, estimate of MP are fairly accurate, however, estimating MP values of forage is more challenging due to wide variations resulting from species, soil fertility and plant maturity (John, 2010). It has been shown that the use of digestible instead of crude unit for expressing protein value considerably improves the accuracy of feed evaluation (Villamide *et al*., 1998).

The body also requires two levels of protein, the protein for maintenance and for production. There are unavoidable losses of amino acids from the body that requires replacement to maintain constant body condition (Fraga, 1998). These losses are important in tissues where there is significant sloughing of cells such as in skin, hair and intestinal mucosa. The requirements to support these activities are called maintenance requirements. There are few data on maintenance requirements for amino acid in rabbits, but the value for crude protein (CP) is 3.7g digestible CP/kg $LW^{0.75}$/ day in doe rabbits (Fraga, 1998).

During pregnancy, amino acids are retained in the conceptus, in the mammary gland and in the maternal body (de Blas, Wiseman, 1998). The importance of protein changes in the body of the doe during pregnancy is higher whenever the does are concurrently lactating (Fraga, 1998). In simultaneous pregnancy and lactation, the overlapping of pregnancy and lactation increases the protein requirement in response to the concurrent high demands for protein for fetal growth and milk yield (Fraga, 1998). Some amino acids may also be used for gluconeogenesis by does fed diets with low starch levels in which case the uptake of glucose from the gut may be insufficient to meet the requirements for milk lactose synthesis and mobilization of body protein may occur to support synthesis of milk protein, especially when lactation and pregnancy are simultaneous (Fraga, 1998)

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 STUDY SITE

The study was conducted in the Rabbit Research unit of the National Animal Production Research Institute, Shika, Nigeria. Shika is located in the Northern Guinea Savana, on the latitude 11^0 and 12^0N , Longtitude 7^0 33'E with an Altitude of 646m above sea level (Meteorological unit, IAR, 2011).

3.2 EXPERIMENTAL ANIMALS

A total of 130 nulliparous and primiparous crossbred rabbit does about 8 months were used for this study. The rabbits were progenies obtained from mating between New Zealand White and California breeds. The does were treated routinely against ecto- and endo-parasites using ivomectin and coccidiostat (Amprolium).

3.3 HOUSING

The rabbits were individually housed in metal cages of dimensions 120 x 60 x 50 cm located in a well-ventilated house. The house is completely walled with wide, open windows covered with wire mesh and mosquito netting. The experimental animals were kept, maintained and treated in adherence to acceptable standards for the humane treatment of animals.

3.4 EXPERIMENTAL PROCEDURES

Three experiments were conducted. The detailed experimental procedures for each experiment are as described below:

3.4.1 Experiment 1: Protein and energy partitioning by rabbit does fed concentrate and Lablab hay diets

Twenty-eight does of about eight months were randomly allocated to four concentrate and lablab treatment combinations. The treatments consisted the following concentrate and lablab combinations on a gram: gram basis: 20:130, 40:110, 80:70 and 100:50 of a 150g air-dry/day total feed supply or on percent basis: 13:87, 27:73, 53:47 and 67:33 respectively. Each diet combination constituted a treatment and were designated treatment 1, 2, 3 and 4 respectively. The does concentrate meal consisted of 22% CP and 2600kcal ME/kg. The does were fed 350g air – dried feed/ head/day after kindling. The composition of the concentrate diet is shown in Table 3.1.

TABLE 3.1: Composition of concentrate diets fed to rabbit does during pregnancy and lactation

Ingredient	Composition (%)
Maize	39.24
Groundnut cake	42.26
Maize offal	15.00
Bone meal	3.00
Vitamin/minerals premix	0.25
Total	**100.00**

Lablab forage was cut at harvest after seeds were removed and air-dried in a well ventilated room to retain its green colour and quality. Lablab was chopped before feeding. At 08.00 hours the various levels of concentrate and lablab were weighed and offered separately in earthen feeders. Leftovers and wastage were weighed daily before feeding. Water was supplied *ad libitum* daily in earthen waterers. Does were mated to intact bucks. Pregnancy diagnosis was done by palpation and weight method. Does were weighed, mate at the beginning of the experiment and at weekly intervals during pregnancy. Earthen nesting pots were supplied to each doe on the 25th day of pregnancy.

Digestibility study was conducted in the second and fourth weeks of pregnancy and during lactation. Fecal and urine samples were collected daily for four days and stored at –20°C in a deep freezer immediately after collection. At the end of each collection period, fecal samples were bulked for each animal for proximate analysis (AOAC, 1980). Urine samples were bulked for nitrogen analysis. Composition of the concentrate and lablab were determined (AOAC, 1980). Feed and nutrient intake, digestibility coefficients and nitrogen retention were determined. Dry matter content of the diet and feces were determined after pre-drying the samples at 60°C for 24h and then at 105°C in a vacuum oven. Ether extract was determined using Soxhlet extraction procedure. Crude fibre was determined as the fraction remaining after digestion with standard solutions of sulphuric acid and sodium hydroxide under controlled conditions. Ash content was determined by ashing at 550°C. Total nitrogen contents of the diets, urine and feces were determined by the macro-Kjeldahl method. Nitrogen content of the diets, urine and feces was converted to crude protein by multiplying the N with the factor 6.25 (AOAC, 1980).

3.4.2 Experiment 2: Protein and energy partitioning by rabbit does fed concentrate and Stylosanthes hay diets

Forty-eight nulliparous crossbred does, were allocated to four treatments in a completely randomized design. The treatments comprised the following concentrate and *Stylosanthes hamata* (stylo) combinations (%) respectively: 20:80 40:60, 60:40 and 80:20 designated treatment 1, 2, 3 and 4 respectively. The concentrate used consisted approximately 22% CP and 2600kcal ME/kg. Concentrate diet composition is shown in Table 3.1. The stylo was harvested, dried at room temperature and chopped before feeding. The concentrate and stylo were fed in the morning at 08.00 hour in separate feeders while clean water was supplied daily in earthen pots. Proximate composition of the concentrate meal and stylo were analyzed according to (AOAC, 1980). The study lasted four months.

Each doe was offered 150g/day of feed during pregnancy and 350g/day during lactation. Feed and forage leftovers and wastage were collected and weighed daily before fresh feed were offered. All rabbits were weighed at the beginning of the experiment and at weekly intervals during pregnancy and lactation. Mating was done by taking the buck to the doe. Pregnancy diagnosis was done by palpation and weight method. Does were supplied earthen nesting pots on day 25 of pregnancy. Kits were counted and weighed at birth. Parameters monitored were doe feed intake, doe weight during pregnancy and lactation, litter size and weight at weaning.

Proximate composition of the concentrate diet and Stylo were analyzed according to (AOAC, 1980).

3.4.3 Experiment 3: Protein and energy partitioning by rabbit does fed Soybean Cheese Waste and Brachiaria hay diets

Fifty four nulliparous and primiparous age eight months old were used for this study. Six concentrate diets were formulated. 0% soya bean cheese waste, 10% soya bean cheese waste, 20% soya bean cheese waste, 30% soya bean cheese waste, 40% soya bean cheese waste and 100% of soya bean cheese waste replacement for groundnut cake. The rabbits were randomly allocated to the treatments in a completely randomized design (n=9 rabbits/treatment). Bracharia grass hay was fed to all the groups at 60g/rabbit/day. Water was supplied in waterers (earthen pots) daily.

Table 3.2: Composition of Experimental Diets fed to Rabbits during Pregnancy and Lactation

	Levels of Soy Bean Cheese Waste (%)					
Ingredients	**0**	**10**	**20**	**30**	**40**	**100**
Maize	42.46	34.86	27.26	19.66	15.66	- -
G.nut cake	39.04	36.64	34.24	31.84	25.84	- -
SCW	- -	10.00	20.00	30.00	40.00	40.00
Maize offal	15.00	15.00	15.00	15.00	15.00	56.50
Bone meal	3.0	3.00	3.00	3.00	3.00	3.00
Salt	0.25	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00	100.00

G.nut cake = Groundnut cake, SCW= Soybean cheese waste

The rabbit does were fed with the diet for one week period of adjustment, and then mated to intact bucks. After mating, the does were fed 100g concentrate up to the third week of pregnancy and subsequently fed 200g/day from the middle of the third week of pregnancy to the first week of lactation. Feed supply was increased to 350g in the second week of lactation. The feeding of the experimental diets was terminated at the end of the second week of lactation and the does were fed control diet during the third week, following observed contamination of the soybean based concentrate diets, possibly due to poor drying of the soybean diets.

Concentrates and forages were weighed and fed separately in flat bottom earthen pots daily. Both concentrates and forages left over and wastages were collected and weighed daily. The does were weighed at the onset of the study and at weekly intervals during pregnancy and lactation. The parameters measured were; feed intake (concentrate, forage and total feed intake), doe weight, litter size and weight at 21 days. The study lasted for 11 weeks.

3.5 DATA COLLECTION AND EVALUATION

Estimation of Digestible Energy (DE) and Digestible Crude Protein (DCP) during pregnancy and lactation were carried out and the reference data used in the calculations of the parameters recorded were according to Parigi Bini and Xiccato (1998) and Fraga (1998) as shown below:

i. Milk production- using live weight of kits at 21 days (LW21).

ii. Lactation milk yield at 21 days

iii. Caloric value of milk = 8.4MJ/kg

iv. Caloric value of fat in maternal body = 36.5MJ/kg

v. Efficiency of DE utilization for milk energy (E_{milk}) = 0.63

vi. Efficiency of body energy utilization for milk ($E_{milk}BE$) = 0.78

vii. Efficiency of DE utilization for maternal tissue accretion ($DE_{mt\ accr}$) = 0.49

viii. Efficiency of DE intake (dietary) for fetal growth (DE_{fg}) = 0.31

xix Efficiency of utilization of dietary digestible crude protein (DCP) for milk protein synthesis = 0.76

x Efficiency of utilization of dietary DCP for fetal growth = 0.42

Other calculations carried out included:

i. Digestible energy intake (DE_{int}) Mj/kg = 17.79 CP_g/kg – 0.136 CF_g – 0.48 ash % (AOAC, 1980).

ii. Total Milk Production (TMP) = 1.77+1.39LW21 where LW21 is the litter weight (Kg) at 21 days of lactation.

iii. Daily milk production (Daily mp) = TMP divided by 21 days of lactation.

iv. Energy in milk (E_{milk}) kg/day = milk produced x caloric value of milk

v. Digestible Energy for maintenance (DE_m)**kj**/day = 430kj/day/kgLW^{075}

vi. Digestible Energy requirement for milk production (DE_{milk}) KJ/day = E_{milk} divided by Efficiency of utilization of milk.

vii. Total Digestible Energy requirement (DERQT) **kj**/day = DE_{mtacc} + DE_{milk}.

viii. Digestible Energy balance (DE_{bal}) **kj**/day = DERQT – DE_{int}.

ix. Energy in milk from dietary Energy (E_{milk}FE) = E_{milk} – deficit balance from DE $_{bal}$ x. Efficiency of utilization of milk energy.

ix. Energy in milk from body energy (E_{milk}BE) = E_{milk} – E_{milk}FE.

xii. Body Energy retain ($BE_{retention}$) = E_{milk}BE divide by Efficiency of body energy utilization for milk.

xiii. Fat loss = BE_{retain} divide by caloric value of fat in maternal body.

xiv. Total fat loss = fat loss x 21 days of lactation.

xiv. Digestible Energy for fetal growth (DE_{fg}) = Efficiency of utilization of dietary DE for fetal growth x DE_{int}.

xv. Digestible Energy for maternal tissue accretion (DE_{mtaccr}) = Efficiency of utilization of DE maternal tissue accretion x DE_{int}.

xvi. Actual DE_{mtaccr} = DERQT – DE_{mtaccr}.

xvii. Digestible Crude Protein intake (DCP_{int}) = 0.83CP(g) – 2.5 (AOAC, 1980).

xviii. Digestible Crude Protein in milk (DCP_{milk}) = milk produced x Efficiency of utilization of dietary digestible protein for milk.

xix. Digestible Crude Protein for maintenance for pregnant and lactating does = 3.7 to 3.8 $DCPkg/LW^{075}$/day.

xx. Digestible Crude Protein for fetal growth (DCP_{fg}) = Efficiency of utilization of dietary DCP for fetal growth x DCP_{int}.

xxi. Digestible Crude Protein requirement (DCPRQT) = DCP_m + DCP_{milk}.

xxii. Digestible Crude Protein balance (DCP_{bal}) = DCPRQT – DCP_{int}.

3.6 ANALYSIS

The data collected were subjected to analysis of variance using General Linear Model Procedure (PROC GLM) of SAS (1987). Pair wise difference (pdiff) method was used to separate significant means (SAS, 1987). The model is shown below:

$$Yijkl = \mu + TiBjSk + Mi + (TixBj) + (TixMl) + eijkl$$

Yijkl = Response Variable (energy + protein partitioning)

Ti = Fixed effect of the Treatment (diet combinations)

Bj = Fixed effect of reproductive status (pregnant or lactating)

Mi = Fixed effect of stage of pregnancy

TixBj = Interaction effect between j^{th} treatment and reproductive status

TixMl = Interaction effect between l^{th} treatment and stage of pregnancy

eijkl = Random residual error

CHAPTER FOUR

4.0 RESULTS

4.1 Experiment1: Protein and energy partitioning by rabbit does fed concentrate and lablab combinations

4.1.1 Protein partitioning by rabbit does during pregnancy and lactation

Table 4.1 shows protein partitioning by pregnant does fed rations containing different concentrate and lablab hay combinations. There were no significant differences (P>0.05) in DM intake, DCP_m, doe live weights and metabolic weights across treatments. Digestible crude protein (DCP) intake increased (P<0.05) significantly as the amount of concentrate offered increased and lablab hay decreased, intake for 80:70 and 100:50 concentrate: lablab combination was significantly higher than 20:130 and 40:110 concentrate: lablab combinations. Total DCP requirement were not significantly (P>0.05) different between does fed 80:70 and100: 50 concentrate and lablab combinations. The values were however, significantly (P=0.008) higher than for does fed either 20: 130 or 40:110 concentrate and lablab combinations, the DCPs of which were similar (P>0.05). Digestible crude protein for fetal growth (DCP_{fg}) was similar (P>0.05) in does fed 80:70 and 100:50 concentrate and lablab combinations. However, DCP_{fg} values for combinations were significantly (P<0.05) higher than for does fed either 20:130 or 40:110 concentrate and lablab combinations, which are statistically (P>0.05) similar. Digestible crude protein balance (DCP_{bal}) also was not significantly different in does fed either 80:70 or 100:50 concentrate and lablab combinations. These were significantly (P>0.05) higher than for does fed either 20:130 or 40:110 concentrate and lablab combinations.

Table 4.1 Protein Partitioning by Pregnant Rabbit Does Fed Rations with different Concentrate and Lablab Combinations

	Concentrate: Lablab levels (g)					
Parameters	20:130	40:110	80:70	100:50	SEM	P value
LW kg	2.58	2.53	2.64	2.61	0.04	0.7736
DM Intake g/d	135.02	131.19	130.64	121.53	4.09	0.3619
DCP intake g/d	20.83[b]	21.98[b]	26.32[a]	25.44[a]	0.57	0.0064
DCP_{req} g/d	16.27[b]	16.64[b]	18.71[a]	18.29[a]	0.41	0.0082
DCP_{m} g/d	7.52	7.41	7.65	7.60	0.13	0.7871
DCP_{fg} g/d	8.75[b]	9.23[b]	11.06[a]	10.69[a]	0.37	0.0063
DCP_{bal} g/d	4.57[b]	5.34[b]	7.62[a]	7.15[a]	0.51	0.0102
DCPreq/$LW^{0.75}$/d	2.03	2.01	2.07	2.06	0.02	0.7935

Means within rows with different superscripts are significantly different (P<0.01, P<0.032 P<0.006,P<0.0001,) LW =Live weight, DM Intake = Dry matter intke, DCP intake = Digestible crude protein intake, DCP_{req} = Digestible protein requirement, DCP_{m}= digestible crude protein for maintenance, DCP_{fg} = Digestible protein for fetal growth DCP_{bal} = Balance Digestible crude protein, DCPreq/$LW^{0,75}$/d= Digestible crude protein requirement per metabolic weight per day

Partitioning of protein by rabbits in different stages of pregnancy is shown in Table 4.2. Dry matter intake, crude protein intake, DCP_{req}, DCP_{fg} and DCP_{bal} were significantly (P<0.05) higher in 4^{th} weeks of pregnancy than 2^{nd} week of pregnancy. However, there were no significant (P>0.05) differences in DCPm, doe live weight, doe metabolic body weight between the 2^{nd} and 4^{th} weeks of pregnancy.

Table 4.2 Protein Partitioning at different Stage of Pregnancy by Rabbit Does Fed Rations with different Concentrate and Lablab Combinations

	Stage of Pregnancy (Weeks)			
Parameters	2	4	SEM	P value
LW kg	2.58	2.60	0.04	0.7579
DM Intake g/d	117.78^{b}	141.42^{a}	4.09	0.0002
DCP intake g/d	21.49^{b}	25.79^{a}	0.57	0.0011

DCP_{req} g/d	16.55[b]	18.40[a]	0.41	0.0021
DCP_{m} g/d	7.52	7.57	0.13	0.7606
DCP_{fg} g/d	9.03[b]	10.83[a]	0.37	0.0011
DCP_{bal} g/d	4.95[b]	7.39[a]	0.51	0.0013
DCPreq/$LW^{0.75}$/d	2.04	2.05	0.02	0.7555

Means within rows with different superscripts are significantly different (P<0.05). LW=Live weight,DM intake = Dry matter intake, DCP intake=Digestible crude protein intake, DCP_{req}=Digestible crude protein requirement, DCP_{m}= Digestible crude protein for maintenance, DCP_{fg}= Digestible crude protein for fetal growth, DCP_{bal} = Digestible crude protein balance, DCPreq/$LW^{0.75}$/d = Digestible crude protein requirement per metabolic per day

Table 4.3 shows the effect of interaction between level of concentrate and lablab hay combinations and stage of pregnancy on protein partitioning in breeding does fed concentration and lablab hay combinations. There were no significant interactions effect between levels of concentrate and lablab hay and stage of pregnancy on live weights, dry matter, total digestible crude protein for requirements, digestible crude protein requirement for maintenance, digestible crude protein requirement for fetal growth, digestible crude protein balance and metabolic weights.

Landscape table 4.3 interaction protein lablab

Table 4.4 shows protein partitioning by lactating does fed different concentrate and lablab hay combinations. There was no significant (P>0.05) difference in DM intake in does fed 20:130 and 40:110 concentrate and lablab combinations, however, these were significantly (p=0.01) higher than in does fed either 80:70 or 100:50 concentrate and lablab combinations which have similar responses. Digestible crude protein intake, TMP, DailyMP, DCPreq, DCPm, DCPmilk were not significant across combinations. All does were in negative digestible crude protein balance during lactation (DCP_{bal}) with does fed 80:70 and 100:50 concentrate and lablab combination being statistically similar and in higher (P>0.05) negative protein balance.

Table 4.4: Protein Partitioning by Lactating Does Fed different Combinations of Concentrate and Lablab

Parameters	Concentrate: lablab levels (g)				SEM	P value
	20:130	40:110	80:70	100:50		
L wt Kg/d	2.38	2.33	2.58	2.40	0.08	0.7014
DM Int g/d	202.04^{a}	185.93^{a}	154.98^{b}	147.96^{b}	9.69	0.0012
DCP int g/d	21.07	20.45	19.04	17.76	1.16	0.3801
TMP kg/d	3.39	3.23	3.27	3.27	5.90	0.3803

DailyMP g/d	161.51	153.79	155.44	104.56	11.51	0.3808
DCP_{req} g/d	23.32	22.64	22.12	21.04	1.88	0.3741
DCP_{m} g/d	7.31	7.10	7.65	7.54	0.28	0.4968
DCP_{milk} g/d	16.01	15.54	14.47	13.49	1.88	0.3742
DCP_{bal} g/d	-2.25^{bc}	-2.19^{c}	-3.08^{ab}	-3.29^{a}	0.42	0.0521
LWT 3 g/d	1166.67	1050.00	1075.00	717.26	90.38	0.4256

Means within rows with different superscripts are significantly different (P<0.01, 0.05). L wt= Live weight, DM int = Dry matter intake, DCPint = Digestible crude protein intake, DCP_{req} = Digestible crude protein for requirement, DCP_{m}= digestible crude protein for maintenance, DCP_{fg} = Digestible protein for fetal growth,DCP_{bal} = Digestible crude protein balance,LWT3= Litter weight at 3 weeks

4.1.2 Energy partitioning by rabbit does during pregnancy and lactation

Table 4.5 shows energy partitioning by pregnant does fed rations containing different combinations. There was no significant (P>0.05) difference for dry matter (DM), DE_{in}, DE_{req}, DE_{m}, $DE_{fg,}$ ADE_{mtacc}, DE_{bal} and Digestible energy requirement per metabolic weight (DELw $^{0.75}$).

Table 4.5: Energy Partitioning by Pregnant Rabbit Does Fed Rations with different Concentrate and Lablab Combinations

	Concentrate: Lablab levels (g)					
Parameters	20:130	40:110	80:70	100:50	SEM	P value
DE intake kj/d	2076.62	1972.96	2205.77	1921.18	69.53	0.1620
DE_{req} kj/d	1358.86	1316.42	1411.42	1318.78	16.47	0.1786
DE_{m} kj/d	715.11	704.81	727.66	723.22	8.27	0.7837
DE_{fg} kj/d	643.75	611.62	683.79	595.57	14.04	0.1620
DEm acckj/d	1017.54	966.75	1080.83	941.38	22.20	0.1620
DE_{bal} kj/d	717.76	656.54	794.32	602.39	32.14	0.2156
DEreq/$LW^{0.75}$/d	670.61	657.23	686.46	641.11	8.01	0.2643

Means within rows with different superscripts are significantly different (P<0.05).

DM intake=Dry matter intake,DE_{req}=Digestible energy requirement, DE_m=Digestible energy for maintenance, DE_{fg}=Digestible energy for fetal growth, DEm acc=Digestible energy for maternal accretion, DE_{bal}=Digestible energy balance, DEreq/$LW^{0.75}$/d= Digestible energy requirement per metabolic weight per day

Table 4.6 shows the energy partitioning by rabbits at different stages of pregnancy. The results show that DE intake, DE_{req}, DE_{fg}, DE_{macc}, DE_{bal} and DELw $^{0.75}$ were significantly (P>0.05) higher during the 4th than 2nd week of pregnancy. However, DE_m was not significantly different at the different stages of pregnancy.

Table 4.6: Energy Partitioning at Different Stage of Pregnancy by Rabbit Does Fed Rations with different Concentrate and Lablab Combinations

	Stage of Pregnancy (Weeks)			
Parameters	2	4	SEM	P value
DE intake (Kj/d)	1826.18[b]	2262.09[a]	69.53	0.0001
DE_{req} kj/d	1281.28[b]	1421.48[a]	16.47	0.0003
DE_m kj/d	715.16	720.23	8.27	0.7652
DE_{fg} kj/d	566.12[b]	701.25[a]	14.04	0.0001
DE m acc kj/d	894.83[b]	1108.42[a]	22.20	0.0001
DE_{bal} kj/d	544.90[b]	840.61[a]	32.14	0.0001
DEreq/$LW^{0.75}$/d	631.63[b]	696.08[a]	8.01	0.0006

Means within rows with different superscripts are significantly different (P<0.01,P<0.0003,P<0.0001) DM intake=Dry matter intake, DE_{req}= Digestible energy for requirement, DE_m=Digestible energy for maintenance, DE_{fg}=Digestible energy for fetal growth, DEm acc=Digestible energy for maternal accretion, DE_{bal}=Digestible energy balance, DEreq/$LW^{0.75}$/d= Digestible energy per metabolic weight per day.

Table 4.7 shows the effect of interaction between level of concentrate and lablab hay combinations and stage of pregnancy on energy partitioning in breeding does fed concentration and lablab hay combinations. There were no interactions between levels of concentrate and lablab hay and stage of pregnancy on live weights, metabolic weights, dry matter intake, total digestible energy for requirements, digestible energy requirement for maintenance and digestible energy balance.

Table 4.7 Interaction Energy lablab Landscape

Table 4.8 show energy partitioning by lactating does fed different concentrate and lablab hay combinations. The results showed that there was no significant (P>0.05) for DE intake, TMP, DailyMP, DE_{req}, DE_{m}, DE_{milk}, E_{milk}, DE_{bal}, DE metabolic weight, $E_{milk}FE$, $E_{milk}BE$, BE_{retain}, Fat loss and Total body loss.

Table 4.8: Energy Partitioning by Lactating Does Fed different Combinations of Concentrate and Lablab

	Concentrate: lablab levels (g)					
Parameters	20:130	40:110	80:70	100:50	SEM	LOS
L wt kg	2.38	2.33	2.57	2.40	0.15	0.7014
DE int kj/d	2671.79	2641.18	3024.48	2074.25	157.17	0.7798
TMP kg/d	3.39	3.23	3.27	3.27	1.03	0.3803
DailyMP g/d	161.51	153.79	155.44	104.56	21.72	0.3808
TDE_{req} kj/d	2976.46	2862.09	2945.93	2272.26	152.47	0.4187
DE_{m} kj/d	823.02	811.61	873.39	948.77	26.77	0.3741
DE_{milk} kj/d	2153.44	2050.47	2072.54	2066.85	40.16	0.8353
E_{milk} kj/d	1356.67	1291.80	1305.70	1180.72	37.20	0.4967
DE_{bal} kj/d	-304.67	-220.91	78.55	-116.27	53.66	0.1350

$LW^{0.75}$/d	1.92	1.89	2.03	2.03	0.08	0.3794
DEreq/ $LW^{0.75}$/d	1567.11	1516.65	1456.03	1233.57	57.18	0.2999
LWT3(g)	1166.67	1050.00	1075.00	717.26	189.01	0.4253
E_{milk} FE (Kj/d)	1046.64	953.01	864.21	711.78	47.21	0.1597
E_{milk} BE (Kj/d)	310.03	338.79	441.49	329.83	19.31	0.1361
BE $_{retain}$ (Kj/d)	397.47	434.35	566.02	422.85	24.80	0.1361
Fat loss (kj/d)	10.89	11.90	15.51	11.59	0.68	0.1363
T B loss (kj/d)	228.68	249.90	325.65	243.29	14.25	0.1361

L wt= Live weight, DM int=Dry matter intake, DE_{req}= Digestible energy for requirement, DE_{m}=Digestible energy for maintenance, DE_{fg}=Digestible energy for fetal growth, DEm acc=Digestible energy for maternal accretion, DE_{bal}=Digestible energy balance, LWT3= Litter weight at 3 weeks, DE_{milk}=Digestible energy requirement in milk, E_{milk}=Energy in milk,E_{milk}FE=Energy in milk from dietary energy, E_{milk}BE=Energy in milk from body energy,BE_{retain} =Body energy retain, TB loss= Total body loss

4.2 Experiment 2: Protein and energy partitioning by rabbit does fed Concentrate and *Stylosanthes* combinations

4.2.1 Protein partitioning by rabbit does during pregnancy and lactation

Table 4.9 shows protein partitioning by breeding does fed different concentrate and *Stylosanthes* hay combinations. There was significant increase in digestible crude protein intake by does as the amount of concentrate offered increased with decreasing amount of *stylosanthes* in all combinations. DCP_{int}, DCP_{req}, DCP_{fg}, DCP_{bal}, metabolic weight and live weight by does fed 80:70 and 60:40 concentrate and Stylosanthes was statistically ($P>0.05$) similar and higher than does fed either 40:60 or 20:80 concentrate and Stylosanthes combinations.

Table 4.9: Protein Partitioning by Pregnant Rabbit Does Fed Rations with different Concentrate and *Stylosanthes* Combinations

	Concentrate: *Stylosanthes* levels (%)					
Parameters	20:80	40:60	60:40	80:20	SEM	LOS
Live wt kg/d	2.50[c]	2.58[b]	2.50[c]	2.83[a]	0.38	0.0307
DCP int g/d	10.16[c]	14.61[b]	21.74[a]	23.60[a]	9.46	0.0001
DCP_{req} g/d	11.62[c]	13.67[b]	16.49[a]	17.97[a]	0.20	0.0001
DCP_{m} g/d	7.35[c]	7.53[b]	7.36[c]	8.06[a]	0.08	0.0319
DCP_{fg} g/d	4.27[c]	6.14[b]	9.13[a]	9.91[a]	0.19	0.0001
DCP_{bl} g/d	-1.46[b]	0.95[b]	5.25[a]	5.63[a]	0.29	0.0001
$DCPreq/LW^{0.75}/d$	5.84[c]	6.77[b]	8.32[a]	8.26[a]	0.29	0.0001

Means within rows with different superscripts are significantly different (P<0.01,P<0.032,P<0.006,P<0.0001,) Live wt= Live weight, DCPint= Digestible crude protein intake, DCP_{req} = Digestible protein for requirement, DCP_{m}= digestible crude protein for maintenance, DCP_{fg} = Digestible protein for fetal growth,DCP_{bl} = Balance Digestible crude protein, $DCPreq/LW^{0.75}/d$= Digrstible crude protein requirement per metabolic weight per day

Table 4.10 shows the effect of stage of pregnancy on protein partitioning of rabbits does fed different concentrate and *Stylosanthes* combinations. DCP intake, DCP_{req}, DCP_{fg}, and DCPbal were significantly (P<0.05) higher during the 4^{th} week of pregnancy than the 2^{nd} week.

Table 4.10: Protein Partitioning at Different Stage of Pregnancy by Rabbit Does Fed Rations with different Concentrate and *Stylosanthes* Combinations

	Stage of Pregnancy (Weeks)			
Parameters	2	4	SEM	LOS
Live wt (kg)	2.57	2.64	0.38	0.3877
DCP intake g/d	15.98[b]	19.08[a]	0.46	0.0023
DCP_{req} g/d	14.21[b]	15.66[a]	0.20	0.0010
DCP_{m} g/d	7.50	7.64	0.08	0.4017
DCP_{fg} g/d	6.71[b]	8.01[a]	0.19	0.0123
DCP_{bal} g/d	1.77[b]	3.42[a]	0.29	0.0092

Means within rows with different superscripts are significantly different (P<0.05). Live wt= Live weight, DCP intake = Digestible crude protein intake, DCP_{req} = Digestible protein for requirement, DCP_{m}= digestible crude protein for maintenance, DCP_{fg} = Digestible protein for fetal growthDCP_{bl} = Balance Digestible crude protein

Table 4.11 shows the effect of interaction between treatment level of concentrate and *Stylosanthes* combination and stage of pregnancy on protein partitioning in breeding does. The results shows that DCP_{int}, DCP_{req}, DCP_{fg},DCP_{bal} and metabolic weight were significantly ($P<0.05$) different in the two stages of pregnancy (2^{nd} and 4^{th} week) with increases as the weeks of pregnancy increases. There was no significant difference in digestible crude protein requirement for maintenance and doe weight.

Landscape table 4.11 interaction protein stylo

Table 4.12 shows protein partitioning by lactating does fed different concentrate and *Stylosanthes* hay combinations. The result showed that DCP_{int}, DCP_{req}, DCP_{m},DCP_{fg},DCP_{bal},Doe weight and metabolic weight were not significantly ($P>0.05$) different.

Table 4.12: Protein Partitioning by Lactating Does Fed different Combinations of Concentrate and *Stylosanthes*

	Concentrate: *Stylosanthes* levels (%)					
Parameters	20:80	40:60	60:40	80:20	SEM	LOS
DCP intake g/d	15.60	15.83	16.64	16.02	0.49	0.8931
DCP_{req} g/d	19.43	20.58	20.25	19.74	0.52	0.8660
DCP_{m} g/d	7.58	8.55	7.61	7.56	0.43	0.7795
DCP_{milk} g/d	11.85	12.03	12.64	12.18	0.37	0.8933
DCP_{bal} g/d	-3.84	-4.75	-3.61	-3.71	0.46	0.7745
LSB	4.00	5.00	5.00	4.80	0.37	0.7117
LSA	4.00	4.44	4.86	4.20	0.36	0.8667
DCPreq/$LW^{0.75}$/d	9.50	9.45	9.92	9.77	0.30	0.9208

DCP intake = Digestible crude protein intake, DCP_{req} = Digestible crude protein for requirement, DCP_m= digestible crude protein for maintenance, DCP_{fg} = Digestible protein for fetal growth, DCP_{bal} = Balance Digestible crude protein, DCPreq/$LW^{0.75}$/d=Digestible crude protein requirement per metabolic weight per day, LSB=litter size at birth,LSA= Litter size at parity

4.2.2 Energy partitioning by rabbit does during pregnancy and lactation

Table 4.13 shows energy partitioning of breeding doe offered different concentrate and *Stylosanthes* combinations. There were no significant difference between 80:20 and 60:40% concentrate and stylosanthes combinations, although these were significantly (P>0.05) higher than 20:80 and 40:60% concentrate and *Stylosanthes* combinations, which were similar. The results show that there was increase in dry matter intake (DMint), digestible energy intake, digestible energy requirement, digestible energy requirement for maintenance, digestible energy for maternal accretion, digestible energy balance and metabolic weight as the amount of concentrate increased and *Stylosanthes* decreased.

Table 4.13: Energy partitioning by Pregnant does fed different concentrate and *Stylosanthes* combinations

Concentrate: *Stylosanthes* levels (%)

Parameters	20:80	40:60	60:40	80:20	SEM	P value
LW kg	1.99^{b}	2.04^{a}	1.99^{b}	2.18^{a}	0.02	0.0305
DM Int g/d)	88.62^{b}	110.09^{b}	152.54^{a}	159.20^{a}	3.28	0.0001
DEint kj/d	1739.24^{b}	2180.70^{b}	3006.63^{a}	3173.38^{a}	14.45	0.0001
DE_{req} kj/d	1238.73^{c}	1392.20^{b}	1631.98^{a}	1750.28^{a}	19.03	0.0001
DE_{m} kj/d	699.56^{b}	716.19^{a}	699.92^{b}	766.53^{a}	7.80	0.0322
DE_{fg} kj/d	539.16^{b}	676.02^{b}	932,05^{a}	983.75^{a}	18.75	0.0001
DEmacckj/d	852.23^{b}	1068.54^{b}	1473.25^{a}	1554.96^{a}	29.64	0.0001
DE_{bal} kj/d	500.51^{b}	788.49^{b}	1374.65^{a}	1423.10^{a}	43.76	0.0001
DEreq/$LW^{0.75}$/d	622.99^{b}	689.91^{b}	823.33^{a}	804.80^{a}	10.88	0.0001

Means within rows with different superscripts are significantly different ($P<0.05$). LW= Live weight, DM int=Dry matter intake, DEint=Digestible energy intake, DE_{req}= digestible energy for requirement, DE_{m}=Digestible energy for maintenance, DE_{fg}=Digestible energy for fetal growth, DEm acc=Digestible energy for maternal accretion, DE_{bal}=Digestible energy balance, DEreq/LW0.75/d= Digestible energy per metabolic weight per day

Table 4.14 shows the effect energy partitioning by rabbits at different stages of pregnancy. The result shows that there was increase (P=0.01) in dry matter intake (DMint) and digestible energy intake (P=0.0001) in the 4th week of pregnancy. Digestible energy requirement also increased in the 4th week of pregnancy significantly (P>0.05) higher than in the 2nd week. However, the increase in digestible energy requirement for maintenance was not significant. Digestible energy for fetal growth and digestible energy for maternal tissue accretion also increased in the 4th week of pregnancy. Similarly, digestible energy balance in the 4th week of pregnancy was also significantly (p>0.05) higher than the 2nd week of pregnancy. There was no significant difference in metabolic weight or digestible energy per metabolic weight between the stages of pregnancy.

Table 4.14: Energy partitioning at different stage of pregnancy by rabbit does fed rations with different concentrate and *stylosanthes* combinations

Parameters	Stage of Pregnancy (Weeks) 2	4	SEM	P value
LW kg	2.03	2.07	0.02	0.3928
DM Intake g/d	116.07[b]	139.16[a]	3.28	0.0014
DE int kj/d	2301.01[b]	2748.96[a]	14.45	0.0008
DE_{req} kj/d	1426.95[b]	1579.64[a]	19.03	0.0003
DE_{m} kj/d	713.64	724.46	7.80	0.3403
DE_{fg} kj/d	713.31[b]	852.18[a]	18.75	0.0008

DEm acckj/d	1127.50^{b}	1346.99^{a}	29.64	0.0008
DE_{bal} kj/d	874.06^{b}	1169.31^{a}	43.76	0.0021
DEreq/LW$^{0.75}$/d	705.81^{b}	764.70^{a}	10.88	0.0119

Means within rows with different superscripts are significantly different ($P<0.05$). LW= Live weight, DM int=Dry matter intake, DEint=Digestible energy intake, DE_{req}= digestible energy for requirement, DE_{m}=Digestible energy for maintenance, DE_{fg}=Digestible energy for fetal growth, DEm acc=Digestible energy for maternal accretion, DE_{bal}=Digestible energy balance, DEreq/LW0.75/d= Digestible energy per metabolic weight per day

Table 4.15 shows the effect of interaction between concentrate and stylosanthes and stage of pregnancy on energy partitioning of breeding does fed concentrate and *Stylosanthes* combinations. The results shows that there was no significant difference between 80:20 and 60:40% concentrate and stylosanthes combinations in DMint, DEint, DEreq, DEm, DEfg, DEmacc, DELW0.75 and metabolic weight in the 4th week of pregnancy, although these were significantly (P>0.05) higher than 20:80 and 40:60% concentrate and *Stylosanthes* combinations.

Landscape table 4.15 interaction Energy stylo

Table 4.16 show energy partitioning by lactating does fed different concentrate and *Stylosanthes* hay combinations. The results showed that all the values in the combinations were not significantly ($P>0.05$) different.

Table 4.16: Energy partitioning by lactating does fed different combinations of concentrate and *Stylosanthes*

	Concentrate: *Stylosanthes* levels (%)					
Parameters	20:130	40:110	80:70	100:50	SEM	P value
Live wt Kg	2.60	3.16	2.62	2.60	0.23	0.7499
DM int g/d	124.78	123.13	127.03	116.36	3.54	0.8003
DE int kj/d	4822.82	4523.79	4555.68	3676.10	165.0	0.1890
TMP Kg	3.21	3.36	3.34	3.41	0.09	0.8932
DE_{req} kj/d	2920.96	3127.63	3004.94	3043.68	87.36	0.8586
DE_{m} kj/d	880.78	993.81	883.87	878.47	49.85	0.7795
DE_{milk} kj/d	2040.18	2133.83	2121.08	2165.21	54.34	0.8951

E_{milk} kj/d	1285.31	1344.31	1336.28	1364.08	34.23	0.8952
DE_{bal} kj/d	1901.86	1396.16	1550.73	632.42	213.27	0.3289
$LW^{0.75}$/d	2.04	2.31	2.05	2.04	0.12	0.7785
DEreq/LW $^{o.75}$/d	1426.92	1426.36	1463.83	1505.22	36.06	0.8766
LWT3 g	2.60	3.16	2.62	2.60	0.61	0.7499
E_{milk} FE kj/d	809.74	846.91	841.86	859.37	57.05	0.8952
E_{milk} BE kj/d	475.57	497.40	494.42	504.71	33.51	0.8951
BE_{retain} kj/d	609.70	637.69	633.88	647.06	42.96	0.8952

Live wt= Live weight, DM int=Dry matter intake, DE int=Digestible energy intake TMP= Total milk production,DE_{req}= Digestible energy for requirement, DE_m=Digestible energy for maintenance, DE_{fg}=Digestible energy for fetal growth, DEm acc=Digestible energy for maternal accretion, DE_{bal}=Digestible energy balance, $LW^{0.75}$=Metabolic weight. DEreq/$LW^{0.75}$/d= Digestible energy per metabolic weight per day,LWT3= Litter weight at 3 weeks, DE_{milk}=Digestible energy requirement in milk, E_{milk}=Energy in milk,E_{milk}FE=Energy in milk from dietary energy, E_{milk}BE=Energy in milk from body energy, BE_{retain}= Body energy retain

4.3 Experiment 3: Protein and energy partitioning by rabbit does fed levels of Soybean cheese waste plus Brachiaria

4.3.1 Protein partitioning by rabbit does during pregnancy and lactation

Table 4.17 shows the protein partitioning of rabbit does fed soybean cheese waste plus brachiaria hay. The result showed that all parameters were not significantly different although, 0% soybean cheese waste recorded high values than other combinations.

Table 4.17 Protein partitioning by pregnant does fed different soybean cheese waste plus Brachiaria hay

	Soy bean cheese waste (%)							
Parameters	0	10	20	30	40	100	SEM	P value
DCP intake g/d	16.19	14.14	12.43	14.88	14.46	14.51	0.29	0.1172
DCP_{req} g/d	13.99	13.29	12.60	12.94	12.62	12.69	0.19	0.4156
DCP_m g/d	7.19	7.35	7.38	6.69	6.54	6.60	0.14	0.3266
DCP_{fg} g/d	6.80	5.94	5.22	6.25	6.08	6.09	0.12	0.1177
DCP_{bal} g/d	2.20	0.85	-0.17	1.94	1.85	1.82	0.22	0.0872
$LW^{0.75}$/d	7.14	6.78	6.24	6.91	7.00	6.94	0.11	0.4545

DM int = Dry matter intake, DCP_{req} = Digestible crude protein for requirement, DCP_m= digestible crude protein for maintenance, DCP_{fg} = Digestible protein for fetal growth, DCP_{bal} = Balance, $LW^{0.75}$= Metabolic weight

Table 4.18 shows protein partitioning by rabbit does at different stages of pregnancy. The results show that digestible crude protein intake, digestible crude protein requirement, digestible crude protein requirement for fetal growth digestible crude protein balance and digestible crude protein per metabolic weight in the 4th week of pregnancy were significantly (P>0.05) higher than in the 2nd week of pregnancy.

Table 4.18: Protein partitioning by pregnant does fed different soybean cheese waste plus Brachiaria hay at different stages of pregnancy

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Stage of Pregnancy (Weeks)

Parameters	2	4	SEM	P value
DCP intake g/d	5.96[b]	22.91[a]	0.29	0.0001
DCP_{req} g/d	9.22[b]	16.82[a]	0.19	0.0001
DCP_{m} g/d	6.72	7.20	0.14	0.122
DCP_{fg} g/d	2.50[b]	9.62[a]	0.12	0.0001
DCP_{bal} g/d	-3.27[b]	6.09[a]	0.22	0.0001
$LW^{0.75}$/d	4.96[b]	8.71[a]	0.11	0.0001

Means within rows with different superscripts are significantly different ($P<0.05$). DCP intake = Digestible crude protein intake, DCP_{req} = Digestible crude protein for requirement, DCP_{m}= digestible crude protein for maintenance, DCP_{fg} = Digestible protein for fetal growth, DCP_{bal} = Digestible crude protein balance, $LW^{0.75}$=Metabolic weight

Table 4.19 shows the effect of interaction between treatment level of soybean cheese waste plus brachiaria hay and stage of pregnancy on protein partitioning in breeding does. The results showed that DCP_{int}, DCP_{req}, DCP_m, DCP_{bal} and $DCPLW^{0.75}$ were not significantly different in the two stages of pregnancy.

Table 4.19 Interaction protein SBW Landscape

Table 4.20 shows protein partitioning of lactating does fed rations containing different soy bean cheese plus Brachiaria. Lactation digestible crude protein intake, total digestible crude protein requirement, digestible crude protein requirement for maintenance, digestible crude protein for milk, digestible crude protein per metabolic weight, digestible crude protein balance does live weight, litter size alive at parity (LSP) and litter size at birth (LSB) were not significant (P>0.05) different. 0% Soy bean cheese waste was significantly (P<0.05) higher in litter weight at weaning (21 days).

Table 4.20 Lactation protein SBW

Landscape

4.3.2 Energy partitioning by rabbit does during pregnancy and lactation

Table 4.21 shows energy partitioning of breeding does fed different soybean cheese waste levels plus Brachiaria hay. The result shows that the difference in digestible energy intake was significant ($P<0.05$) while there was no significant ($P>0.05$) different across soybean cheese waste levels plus Brachiaria hay in total dry matter (DM), digestible energy requirement, digestible energy requirement for maintenance, digestible energy for maternal tissue accretion, doe weight and metabolic weight.

Table 4.21 Energy pregnancy SBW   Landscape

Table 4.22 shows energy partitioning by rabbit does fed different levels of soybean cheese waste plus brachiaria diets at different stages of pregnancy. The result shows that dry matter (DM) intake, DEint, DEreq, DEfg, DEmacc,DEbal and DELW0.75 were significantly ($P<0.05$) higher in the 4th week of pregnancy than the 2nd week of pregnancy. Digestible energy requirement for maintenance, doe weight and metabolic weight were however not significant ($P>0.05$).

Table 4.22: Energy partitioning by pregnant does fed different soybean cheese waste plus Brachiaria hay at different stages of pregnancy

	Stage of Pregnancy (Weeks)			
Parameters	2	4	SEM	P value
Live weight kg	2.30	2.43	0.06	0.305
DM Intake g/d	72.30^{b}	203.30^{a}	2.34	0.0001

DE int kj/d	1354.05^{b}	3785.34^{a}	10.38	0.0001
DE_{req} kj/d	1076.36^{b}	1858.30^{a}	19.34	0.0001
DE_{m} kj/d	656.61	684.34	13.64	0.313
DE_{fg} kj/d	419.76^{b}	1173.46^{a}	13.46	0.0001
DEm acckj/d	663.49^{b}	1854.82^{a}	21.28	0.0001
DE_{bal} kj/d	277.68^{b}	1927.05a	32.70	0.0001
DEreq/$LW^{0.75}$/d	578.72^{b}	964.06^{a}	12.98	0.0001
$LW^{0.75}$	1.87	1.95	0.04	0.322

DEintake=Digestible energy intake, DE_{req}=Digestible energy for requirement, DE_{m}=Digestible energy for maintenance, DE_{fg}=Digestible energy for fetal growth, DEm acc=Digestible energy for maternal accretion, DE_{bal}=Digestible energy balance, DEreq/$LW^{0.75}$/d=Digestible energy per metabolic weight per day, $LW^{0.75}$= Metabolic weight

Table 4.23 shows the effect of interaction between treatment levels of soybean cheese waste plus brachiaria hay combinations and stage of pregnancy on energy partitioning of breeding does. The results shows that the differences in the treatment values were statistically ($P>0.05$) similar, however, treatment values of the 4th weeks of pregnancy were higher than the treatment values recorded in the 2nd weeks of pregnancy.

Table 4.23 Interaction Energy SBW Landscape

Table 4.24 shows energy partitioning of lactating does fed rations containing different soy bean cheese waste and Brachiaria. The result shows that total milk production (TMP), daily milk production, digestible energy for milk, digestible energy balance, energy in milk from feed energy (E_mFE), energy in milk from body energy (E_mBE) and body energy retention ($BE_{retention}$) were however significantly (P<0.05) higher on 0% and 20% soy bean cheese waste than other treatments. There was no significant difference in difference in digestible energy intake, digestible energy requirement digestible energy requirement for maintenance, doe weight, metabolic weight and digestible energy for metabolic weight ($DELW^{0.75}$) across treatments.

Table 4.24 Lactation Energy SBW

Landscape

CHAPTER FIVE

5.0 DISCUSSION

5.1 Experiment 1: Protein and energy partitioning by rabbit does fed concentrate and lablab combinations

5.1.1 Protein partitioning by rabbit does during pregnancy and lactation

Protein partitioning of pregnant does shows that dry matter intake was not affected by levels of concentrate and lablab forage. Ojewola *et al*. (1999) noted that rabbits performed better when fed mixture of forages and concentrates. Onwudike (1995) also reported that better growth rate was obtained on mixed than sole forage or concentrate diets. Similarly, digestible crude protein requirement (DCP_{req}), digestible crude protein requirement for maintenance (DCP_{m}) and digestible crude protein for fetal growth (DCP_{fg}) increased as concentrate offered increased and lablab hay decreased. This might be because hay was used instead of fresh lablab. Lablab is said to have an average crude protein of 17% and crude fibre of 28% which is slightly above average when compared with other tropical legumes and has considerably more protein than tropical grasses (Murphy and Colucci, 1999). This might explain the reason behind the positive balances recorded in all the treatment levels (4.57, 5.34, 7.62 and 7.15).

In the treatment levels, the highest positive balance was recorded in the combination 80:70 (concentrate: lablab) which corresponds with the findings of Iyeghe-Erakpotobor *et al.,* (2009) who reported that a higher digestion efficiency was observed for rabbits on 80:70 concentrate: lablab combination. This might be because the higher the digestion of nutrients, the more nutrients would be available to the does which apparently indicates that the dietary composition is balanced adequately. This further confirms that the higher the DCP intake the higher the DCP balance of the animals. In this study, dry matter intake increased in the 4th week of pregnancy. Decreased intake with increase in weeks of pregnancy was attributed to the reduction in stomach capacity of does with progression of pregnancy (Iyeghe-Erakpotobor *et al*., 2009). However, higher digestibility of nutrients in the 4th week of pregnancy compared to that of 2nd week of pregnancy have been reported (Iyeghe-Erakpotobor *et al*., 2009). This might be to compensate for the high demand for organ formation of the fetus. Digestible crude protein intake (DCP_{in}) total digestible crude protein requirement ($TDCP_{req}$), digestible crude protein for maintenance (DCP_m) and digestible crude protein for fetal growth (DCP_{fg}) all followed the same trend. Again, the digestible crude protein balance (DCP_{bal}) was high in the 4th week of pregnancy. This could be attributed to dry matter intake observed.

Similar increase in dry matter intake and digestible crude protein intake in the 4th week of pregnancy was observed in the interaction between stage of pregnancy and treatment levels. The increase was reflected in total digestible crude protein requirement, digestible crude protein for fetal growth and digestible crude protein balance. Again, all DCP_{bal} were positive. Generally, feeding concentrates and lablab during pregnancy gave a satisfactory result as all the DCP_{bal} were positive. The combination 80:70 and 100:50 gave higher DCP_{bal} as compared to 20:130 and 40:110 combinations. This might be connected with the high concentrate intake which would have more positively influenced the digestion of less digestible lablab cell wall and fibre content in the two diets than others.

During lactation, the dry matter intake and digestible crude protein intake dropped with increase in concentrate which is a reverse of what was observed in pregnancy where intake increased with increase in concentrate and later dropped when concentrate level reached 100g. Gidenne *et al*., (1998) reported that an increase in fibre intake stimulates food transit and this increase rate of passage in the overall tract. This might explain the high dry matter intake (DCP_{in}) in this study noted in diets with high proportions of lablab as fibre source. Lactation digestible crude protein requirement ($LDCP_{req}$), digestible crude protein requirement for maintenance and digestible crude protein in milk followed similar trend. The non-significant difference observed in DCP intake, DCP_m and DCP_{milk} though dry matter intake was significantly higher on 80:70 and 100:50 than 20:130 and 40:110 concentrate:stylo combinations could be because DCP intake is determined by dietary palatability which depends on dry matter and crude fibre content of the feed while DCP_{in} and DCP_{milk} are determined by the content of utilization of protein content of the ingested and digested feed. Also the nutrient utilization for milk synthesis of all the does was a function of the quantity of milk produced which was similar for all the combinations during lactation. However, the negative DCP balance in all treatment combinations further indicates the high protein demand of rabbit does for milk production, which was not met from the immediate feed consumed but by an additional protein draw down from body reserves.

The mobilization of protein from body reserves for milk production during lactation has been reported (Patridge *et al*., 1986, Toschi *et al.*, 2005). This statement seems to explain the result of this study which showed that the LDCP balances of all the treatment levels are negative. This is a reverse of the early results on protein which showed positive balance during pregnancy and indicates that lactation is a more protein demanding phase than pregnancy.

5.1.2 Energy partitioning by rabbit does during pregnancy and lactation

Energy partitioning of pregnant rabbit does showed that dry matter intake was not affected by varying levels of concentrates and lablab forage but digestible energy intake (DE_{in}) was significantly reduced by high concentrate and low lablab forage levels. Voluntary DE intake has been demonstrated to be unaffected by dietary energy concentration above the critical level of 290 to 310 kcal /d/kg BW$^{0.75}$ in reproducing rabbit (Lades, 1989; Xiccato *et al*., 1999).

The total digestible energy requirement, digestible energy requirement for maintenance and digestible energy for maternal accretion were not affected by varying level of concentrate and lablab. This might have to do with the similar dry matter intake and body weight of the does. Digestible energy for fetal growth, actual digestible energy required for maternal accretion varied significantly within the treatments with 80:70 concentrate and lablab combination being significantly higher than 100:50 concentrate and lablab combination. This might indicate a likely high availability of nutrients from the lablab forage in conjunction with the concentrate level offered indicating the adequacy of energy releasing potential of lablab forage at 80:70 concentrate and lablab combination to the rabbit does for utilization. The positive digestible energy balance observed on all treatments indicates a possibility of maintaining rabbits on combinations of concentrate and lablab without adverse effect on reproduction as earlier observed (Iyeghe- Erakpotobor *et al*., 2009). The increase in dry matter and digestible energy intake in the 4th week of pregnancy could be attributed to a need to meet the higher energy compulsorily required for faster foetal growth (increase in size) in the 4ththan 2nd week of pregnancy, when at such early period, energy need is more for cell and organ differentiation which is not as energy demanding. The consequences of this high intake was seen in total digestible energy requirement, digestible energy requirement for maintenance, digestible energy for fetal growth and digestible energy for maternal tissue accretion where all were high in the 4th week of pregnancy. This is because there was higher digestion of nutrients in 4th week as reported earlier in order to satisfy different energy needs. This resulted in the significantly higher digestible energy balance recorded in the 4th week of pregnancy. This is in agreement with the conclusion made by Iyeghe-Erakpotobor *et al*., (2009) that nutrient digestibility was higher for does on 80:70 conentrate and lablab combination in the fourth week of pregnancy.

Dry matter intake, digestible energy intake (DE_{in}), total digestible energy requirement, digestible energy requirement for maintenance and digestible energy for maternal accretion and digestible energy for fetal growth were not affected by varying level of concentrate and lablab in the interaction between treatment and stage of pregnancy Similarly, there was no significant different across treatments in the above mentioned parameters during lactation. There was negative digestible energy balance in three treatments; 20:130, 40:110 and 100:50 concentrate and lablab combinations with only 80:70 concentrate and lablab combination having positive digestible energy balance.

5.2 Experiment 2: Protein and energy partitioning by rabbit does fed concentrate and *Stylosanthes* combinations

4.2.1 Protein partitioning by rabbit does during pregnancy and lactation

Protein partitioning of pregnant does show significant increase in digestible crude protein intake as the amount of concentrate offered increased. Iyeghe-Erakpotobor *et al*. (2008) reported an increase of 16% in total feed intake of rabbits fed 40:60 concentrate and stylo over those fed 20:80 concentrate: Stylo and also 16% higher on 60:40 than 40:60 and only 6% higher on 80:20 than 60:40 treatments. Total digestible crude protein requirement, digestible crude protein requirement for maintenance and digestible crude protein for fetal growth were all affected significantly with increase in concentrate and decrease in stylosenthes. Though, widely used, its palatability have been reported to be relatively low (Aduku *et al*.,1989).

Digestible crude protein balance obtained showed that rabbits fed 20:80 concentrate: stylosanthes were on a negative DCP balance. This may be attributed to high proportion of forage which resulted in the high crude fibre content of stylosanthes and attendant lower digestibility of stylosanthes as opposed to what was obtained with lablab forage hay. This high crude fiber content could be because stylosanthes had advanced in growth prior to preservation as hay used in the study. Manntje and Lones (1992) reported that with increase in age and lignifications, the dry matter digestibility of stylosanthes would be reduced to below 40%. Dietary combinations of 60:40 and 80:20 concentrate: stylosanthes had better performances in terms of digestible crude protein balance (5.25 and 5.63) than 20:80 and 40:60 concentrate: stylosanthes combinations (-1.46 and 0.95).

During the 4th week of pregnancy, DCP intake was higher as was observed in concentrates and lablab combinations. The trend was followed in total digestible crude protein requirement and digestible crude protein requirement for maintenance though they did not vary significantly while digestible crude protein for fetal growth was affected significantly with stage of pregnancy. Although there was a slight increase in the 4th week of pregnancy, both stages were in positive DCP balance. Iyeghe-Erakpotobor *et al*. (2008) reported a high feed intake of concentrate stylo during pregnancy as compared to lactation.

The interaction between treatment and stage of pregnancy showed that digestible crude protein intake varied significantly across treatment in the two stages of pregnancy. Similar to concentrate and lablab, increase in DCP intake was observed in the 4th week of pregnancy as compared to the 2nd week of pregnancy. This was also reflected in total digestible crude protein requirement, digestible crude protein requirement for maintenance and digestible crude protein for fetal growth. Despite the increase in digestible crude protein intake in 20:80 Conc:

Stylo, in the 4th week of pregnancy, does in this treatment still had a negative DCP balance along with those in the 2nd week of pregnancy, however, as concentrate level increased the DCP balances also increased positively. This suggests that rabbit utilization of non succulent and woody plants was poor as reported by Aduku *et al.,* (1986). During lactation, all parameters were not affected by treatment level however the digestible crude protein balance showed that rabbits on all the treatments were on negative balance. This results agrees with Partridge *et al*.,(1986) who reported that lactating does were mobilizing body tissues to support milk production synthesis especially during early and mid-lactation.

5.2.2 Energy partitioning by rabbit does during pregnancy and lactation

The trend of increase in dry matter and digestible energy intake of pregnant does fed 60:40 and 80:20 above does on 20:80 and 40:60 concentrate: stylosanthes was also observed for total digestible energy requirement, digestible energy requirement for maintenance, digestible energy for fetal growth and digestible energy for maternal tissue accretion in this study. This could be as a result of higher feed intake of does as concentrate level increased (Iyeghe-Erakpotobor *et al*., (2008). Similarly, the positive digestible energy balances observed for all treatment levels is a sign of good performance of the combinations in terms of energy as reported by Bamikole and Ezenwa, (1999) and Iyeghe-Erakpotobor *et al*., (2006). Higher total pregnancy dry matter (TPDM) and DE intake, total digestible energy requirement, digestible energy requirement for maintenance, and digestible energy for fetal growth and digestible energy for maternal tissue accretion in the 4th week than 2nd week of pregnancy is similar to what was observed for does fed concentrate: lablab combinations. Positive digestible energy balance observed for both stages of pregnancy is an indication that all combinations supplied adequate nutrients to pregnant does as asserted by Iyeghe- Erakpotobor *et al*. (2008) that feeding rabbits concentrate and stylosanthes did not affect performance, especially kindling status and litter size. The interaction between treatment and stage of pregnancy similarly shows that TPDM and DE intake varied significantly within treatments in the two stages of pregnancy. This trend was also observed in total digestible energy requirement (TDE_{req}), DE maintenance DE fetal growth and DE maternal tissue accretion. However, the DE balance shows positive trend across treatments in the two stages of pregnancy in contrast to trend in protein balance where some values were negative. Lactation was not significantly affected across treatments and all the digestible energy balances were positive.

5.3 Experiment 3: Protein and energy partitioning by rabbit does fed levels of Soybean cheese waste plus Brachiaria

4.3.1 Protein partitioning by rabbit does during pregnancy and lactation

Protein partitioning of pregnant does shows that DCP_{in}, DCP_{reg}, DCP_{m}, DCP_{fg} and DCP_{bal} did not vary significantly across treatments, however, the control 0% BCW was slightly higher as compared with other treatments. On the contrary, the negative balance observed in 20%BCW could be attributed to lower digestible crude protein intake. Digestible crude protein intake however varied significantly with stage of pregnancy. At 4th week of pregnancy, does had higher DCP intake which was reflected in total digestible crude protein requirement, DCP requirement for maintenance and DCP requirement for fetal growth along side with higher feed intake during the 4th week of pregnancy than the 2nd week of pregnancy. This could be because in the first two weeks of pregnancy, fetal development is concentrated on organ development which does not require high nutrient input as increase in body size that is noticed in the 4th week of pregnancy (Iyeghe-Erakpotobor *et al*., (2006). This trend was observed in total digestible crude protein requirement, DCP maintenance and DCP fetal growth. Digestible crude protein balance similarly varied significantly with stage of pregnancy. The negative DCP $_{bal}$ observed during the 2nd week of pregnancy and 4th week of pregnancy indicates the inability of the does to adjust and increase nutrient intake to accommodate DCP requirement as pregnancy advances. The ability of does to meet requirement for maintenance and fetal growth depends on the digestible crude protein intake (Iyeghe-Erakpotobor, 2009). Low DCP intake was observed during the 2nd week resulted in negative balance which could be attributed to the high demand to meet bodily needs for initiation of pregnancy.

Lactation digestible crude protein intake was unaffected by treatment except 100% BCW intake was slightly higher for rabbit does fed the control (0%SBW) than other treatments. This might indicate that the control diet was likely more palatable to rabbits than the soybean cheese waste diet. Digestible crude protein requirement, DCP maintenance and DCP milk followed the same trend where the control was slightly higher than other treatments. Digestible crude protein balance was unaffected by treatment levels but all were in a negative balance. The negative balance of protein during lactation seems to explain the high protein demand for milk synthesis by rabbit does. This also indicates that there was much mobilization of protein from body reserves for milk production during lactation (Patridge *et al*., 1986, Toschi *et al*., 2006).This could also be attributed to the inclusion of Brachiaria. Though, Brachiaria has been proven to be well accepted by rabbit, the forage was reported to have low crude protein (6% CP) (Partridge, 1989).

5.3.2 Energy partitioning by rabbit does during pregnancy and lactation

Energy partitioning of pregnant does shows that total dry matter and digestible energy intake were similar in most of the treatments. Total digestible energy requirement and digestible energy requirement for maintenance were not affected across treatment. Digestible energy balance was unaffected by levels of treatments. However, all treatments were in positive DE balance. This is an indication that any combination here is adequate in terms of energy .Iyeghe-Erakpotobor *et al*. (2005) reported that soy bean cheese waste/ maize offal diets treatments compared favorably with the standard rabbit meal offered. As was observed for protein, the total dry matter and digestible energy intake varied significantly with stage of pregnancy where the 4th week of pregnancy had higher intake than the 2nd week of pregnancy. The high intake could be the same reason with protein, this is again reflected in total digestible energy requirement for maintenance, fetal growth and maternal tissue accretion though, DE maintenance was not significant.

Digestible energy balance showed significant difference in the 2nd and 4th weeks of pregnancy, however, all treatments were adequate as they were in positive balance as compared to protein were the 2nd week of pregnancy was in negative balance. Total lactation dry matter (TLDM) and digestible energy intake were not affected across treatments. Total milk production (TMP) varied within treatments. Similarly, total digestible energy requirement for maintenance and energy requirement for fetal growth also varied within treatments. Digestible energy balance also varied however, all were in positive balance compared to digestible crude protein balance where all were in negative balance. This is an indication that in terms of energy, the dietary energy levels in this study was adequate for lactating does. This agrees with the conclusion of Iyeghe-Erakpotobor *et al*., (2005) who concluded that soy bean cheese waste compared favorably with standard rabbit meal in terms of intake, weight gain and feed efficiency.

CHAPTER SIX

6.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 SUMMARY

In the first experiment (concentrate and lablab) during pregnancy, there was significant difference between the first two combinations (20:130, 40:110 conc: lablab) and the last two combinations (80: 70, 100:50 conc: lablab) combinations in most of the parameters with 80:70 combination having the highest. All treatments were on positive digestible crude protein balance.

Energy during pregnancy revealed that there was no significant difference across combinations in almost all parameters. Digestible energy balance was also positive for all combinations.

Stage of pregnancy for protein shows that 4th week of pregnancy was significantly ($P<0.05$) higher than the 2nd week in DCP intake, DCP requirement, DCP for fetal growth and DCP balance. Digestible crude protein balance was positive for all stages of pregnancy. The result for energy shows that the 4th week of pregnancy was significantly ($P<0.05$) higher than 2nd week of pregnancy in DCP intake, DCP requirement, DCP for fetal growth and DCP balance. Digestible energy balance was also positive for the two stages of pregnancy. The result of interaction between treatment and stage of pregnancy for protein revealed that digestible crude protein intake was not significant but digestible crude protein balance was significantly affected with treatment levels. All the balances were positive while the results for energy were significant in all parameters across treatments. Digestible energy balance was also positive for all treatments in all stages of pregnancy.

During lactation, the result for protein show significant different in only dry matter intake and digestible crude protein balance .Digestible crude protein balance was however negative across treatments. The result for energy during lactation was not significant across treatments in all parameters. Digestible energy balance was positive across treatments also.

In the second experiment (concentrate and stylosanthes) during pregnancy, protein results showed significance different across treatments in digestible crude protein intake, digestible crude protein for requirement, digestible crude protein for maintenance, digestible crude protein for fetal growth, digestible crude protein balance and digestible crude protein requirement per metabolic weight. Digestible crude protein balance was negative in 20:80 conc: Stylo combination and positive in other treatments. Energy during pregnancy shows that 60:40 and 80:20 conc: Stylo combinations were statistically similar but significantly higher than 20:80 and 40:60 conc: Stylo combinations. Digestible energy balance was positive across treatments. The finding for stage of pregnancy for protein shows that only digestible crude protein intake, digestible crude protein requirement, digestible crude protein for fetal growth and digestible crude protein balance were significant higher in the 4th week of pregnancy while other parameters were not significant. In both stages (2nd and 4th weeks of pregnancy) the digestible crude protein balances were positive. For energy during the two stages of pregnancy shows that digestible energy intake, digestible energy for requirement, digestible energy for fetal growth, digestible energy for maternal accretion, digestible energy balance and digestible energy per metabolic weight were significantly higher in the 4th week of pregnancy while digestible energy for maintenance was not significant. In both stages, all the digestible energy balances were all positive. The interaction between stage of pregnancy and conc: Stylo combinations for protein shows that all the parameters were significantly higher in the 4th week of pregnancy except doe weight which was not significant. The combination 20:80 had negative balance in the two stages while other treatments had positive balances. The result for interaction for energy shows that there was significant different across treatments in all the parameters except digestible energy for maintenance. Digestible energy balances were all positive for all stages.

During lactation, protein result shows no significant effect across treatments with all digestible crude protein balances being positive. Similarly, there was no significant difference across treatments in energy intake and utilization. Digestible energy balance was also positive across treatments.

In the third experiment, feeding soy bean cheese waste and Brachiaria during pregnancy showed no significant difference in protein between treatments. Digestible crude protein balance reflects positive balance signal except the treatment with 20% soy bean cheese waste. Energy during pregnancy revealed that only digestible energy intake and digestible energy for fetal growth were significantly different across treatments. Digestible energy balance was also positive across treatments.

The 2nd week of pregnancy was on negative digestible crude protein balance while the 4th week was positive. Similarly, energy for stage of pregnancy was significantly higher in the 4th week of pregnancy in DM intake, DE intake, DE requirement, DE for fetal growth, DE for maternal accretion, DE balance and DE requirement per metabolic weight. In the two stages of pregnancy, digestible energy balance was on positive balance. The result of interaction for protein showed no variation, however, protein utilization in all groups during the 2nd week of pregnancy was in negative balance in contrast to trends in the 4th week of pregnancy indicating positive balance. Similarly, difference in energy was not significant across treatments in all the parameters. Digestible energy balance however, was positive across treatments in the two stages of pregnancy.

During lactation, protein result shows that lactation digestible crude protein intake, digestible crude protein for milk and total digestible crude protein requirement were significant while digestible crude protein for maintenance and digestible crude protein balance were not significant across treatments. Lactation digestible crude protein balance showed that all treatments were on negative balance. Energy result during lactation revealed that most of the parameters were significant. Digestible energy balance shows that all treatments were on positive balance.

Generally, in the three different feed combinations used, some showed negative balances while others showed positive balances after partitioning. For concentrate: lablab combinations, both protein and energy shows positive balances during pregnancy. While during lactation energy shows positive balance in 80:70 combination, deficit in three combinations (20:130, 40:110 and 100:50) and the only positive balance was recorded in (80:70) combination, but protein shows negative balances in all treatments. For concentrate: Stylosanthes, during pregnancy the combination 20:80 was the only one having negative balance in protein while for energy all were positive. Lactation on the other hand shows a negative balance for protein while energy was all positive. For soya bean cheese waste and Brachiaria, all were positive for both protein and energy during pregnancy while during lactation; digestible crude protein balance was negative and digestible energy balance was positive. The combination 10, 20, 30 and 40% soy bean cheese waste seems to compare favourably with the control (0% soy bean cheese waste) for protein and energy during pregnancy and lactation.

6.2 CONCLUSION

From the results obtained, the following conclusions are drawn.

1. During pregnancy, rabbits on all levels of concentrates and lablab were all on positive balances for both protein and energy.
2. Protein and energy balance for all stages of pregnancy were positive.
3. During lactation, rabbits on concentrate and lablab were in negative balances for protein and energy except 80:70 combinations which was positive in energy.
4. Rabbits on concentrate and stylosanthes, during pregnancy were on positive balance for protein in all combinations except 20:80 combinations while for energy, all were on positive balance.
5. 60:40 and 80:20 concentrate and stylosanthes combinations were higher than 20:80 and 40:60 in all partitioned parameters in both protein and energy.
6. At both stages of pregnancy (2nd and 4th weeks) rabbits were all in positive balances for both protein and energy.
7. During lactation, rabbits on concentrate and stylosanthes were all in positive balances for energy while protein was all negative.
8. During pregnancy, rabbits on soy bean cheese waste and Brachiaria were on positive balance for protein in all combinations except 20% soy bean cheese waste combination while for energy all combinations were on positive balance across treatments.
9. During the 2nd week of pregnancy, rabbits on soy bean cheese waste were on negative protein balance but on reaching the 4th week of pregnancy, the balance turn to positive while energy was positive for both stages.
10. During lactation, rabbits on soy bean cheese waste and Brachiaria were on negative protein balance but on positive energy balance.

6.3 RECOMMENDATIONS

The following recommendation can be made from the results obtained in this study.

1. All combinations of concentrate and lablab were suitable for feeding of pregnant does while rabbits on 80:70 and 100:50 concentrate: lablab performed alike.
2. During lactation for concentrate and lablab, more protein source is recommended while energy is suitable.
3. The combination 80:20 and 60:40 concentrate and stylosanthes are recommended for both pregnant and lactating does. The inclusion of stylosanthes is recommended not to exceed 40% for better performance.
4. Soy bean cheese waste is suitable for the feeding of pregnant does from 10% to 100%.
5. During lactation for soy bean cheese waste, more protein source is recommended.

REFERENCES

Adeyemo, A.A., Taiwo, O.S., Adeyemi, O.A. 2014. Performance and carcass characteristics of growing rabbits fed concentrate to forage ratio. *International Journal of Modern Plant and Animal Sciences*. 2: 33-41

Aduku, A.O. (1992). Nutrient requirements of the chicken: feed ingredient analysis able and their uses. In: Revamping poultry production management and feeding S. O.Ogundipe, oveo. Oni and A.A. Sekoni (Eds) *NAPRI publication,* Pp 44-48

Aduku, A.O., Okoh, P.N, Njoku, P.C, Orjichie, E.A, Aganga, A.A, Dim, N.I, (1986). Evaluation of cowpea (*Vigna unguiculata*) and peanut (*Arachis Hyogaea*) Haulms as feed stuffs for weanling rabbit in a tropical environment (Nigeria) *Journal of Applied Rabbit Research,* 9:178-179

Aduku, A.O. and Olukosi, J. O. (1990) Rabbit Management in the Tropics: Production, Processing, Utilization, Marketing, Economics, Practical training, Research and Future Prospects. Living Books Services, G.U.Publications, Abuja.

Ajala, M. K. and Balogun, J. K. (2004). Economic of rabbit production in Zaria, Kaduna State. *Tropical Journal of Animal Science*. 7 (1): 1 - 10

Ani, A.O., Ugwuowo, L.C. 2011. Response of weaner rabbits to diets containing graded levels of processed velvet beans (*Mucuna pruriens*). *African Journal of Biotechnology*. 10: 14984-14989.

AOAC, (1980) Association of Official Analytical chemists. Official method of Analysis, thirteenth edition, Washington, Dc.

Arias-Alvarez, M., Garcia-Garcia, R.R., Revuelta, L., Cuadrado, M., Millan, P., Nicodemus, N., Rebollar, P.G. and Lorenzo, P.L. (2008) Short term effects of different diets on ovarian function and Oocyte maturation of rabbits nulliparous does. *9th world Rabbit Congress, Verona-Italy:* Pp 279-284

Ashworth, C.J. (1994). Nutritional factors related to embryonic mortality in the domestic species In: R.D. Geisert and M. J. Zary (Eds) *Embryonic mortality in domestic species*. CRC. Press.Pp. 83 – 199.

Ashworth, G.C.J. (1991). Effect of pre-mating nutritional status and post-mating progesterone. Supplementation on embryo survival and conceptus growth in gilts. *Animal Reproduction Science,* 26:311-321

Atsu, D. W. (2002). Contributory role of animal production in national development. Proceedings of 7th Annual Conference of Animal Science Association of Nigeria (ASAN). Sept. 16 – 19, Abeokuta, Ogun State.

Ayers, A.C., Barrett, R.P., Cheeke P.R. 1996. Feeding value of tree leaves (Hybrid Poplar and black locust) evaluated with sheep, goats and rabbits. *Animal Feed Science and Technology*. 57: 51-52

Babayemi, O. J., Ajayi, F.T., Taiwo, A.A., Bamikole, M.A. and Fajimi, A.K. (2006). Performance of West African Dwarf Goats fed *Lablab purpureus*, *Leucaena leucocephala* and *Gliricidia sepium* foliages. *Nigerian Journal Animal Production* 33;102-111

Bamgbose, A.M., Abimbola, M.O., Olayemi, W.A., Osofowora, A.O., Oso, A.O. and Ojo, O.T. (2003). Performance of weaner rabbits fed supplemented *Tridax procumbens* diets, In: A.O. Fanimo and J.A. Olanite (Eds) *Proc. 7th Ann. Conf. Anim. Sci.Asso. of Nig.* (ASAN) Sept. 16-19, 2003, Uni. Of Agric. Abeokuta, Nigeria. Pp 69-70

Bamikole, M.A. and Ezenwa, I. (1999). Performance of rabbits on guinea grass and Verona stylo hays in the dry season and effect of concentrate supplementation. *Animal Feed Science and Technology*, 80(1):67-73

Bamikole, M.A., Ikhatua, M.I., Ikhatua, U.J., Ezenwa, I.V. 2005. Nutritive Value of Mulberry (*Morus spp*) leaves in growing rabbits in Nigeria. *Pakistan Journal of Nutrition*. 4: 231-236

Britt, J.H., Armstrong, J.D., Cox, N.M. (1988). Metabolic interfaces between nutrition and reproduction in pigs. *Proceedings of the 11th international congress on Animal Reproduction and Artificial Insemination*. 5, 117 – 125.

Broek, L.V and P. lampo, (1978). Influence of three feeding levels on the feeding behavior and fertility of future breeding female rabbits of 4 months of age. In: G.T. Iyeghe-Erakpotobor and I.A. Adeyinka, (2008). Effect of flushing on Body weight changes, Nutrient Digestibility and Litter size of Nulliparous does, *Asian Journal of Animal and veterinary Advances* 3(3) :155-161

Carabano, R. Villamidr, M.J., Garcia, J., Nicodemus, D., Garcia-Rebouor, P. Garcia-Ruiz A.I., and de blass J.C (2008). New concepts and objectives for protein amino acid nutrition in rabbits. *9th World Rabbit Congress. Verona, Italy.*

Cesare Castellini, Alessandro Dal Bosca, Maria Arias-Alvarez, Pedro L. Lorenzo, Raffaella Cardinali and Pillar Garcia Rebollar, (2010). The main factors affecting the reproductive performance of rabbit does: A review. *Animal Reproduction Science*, 122 (3-4): 174- 182

Crusader Team. (2002). Meat rabbit farming-An introduction.CSIRO livestock industries. CSIRO Crusader Rabbit webpage www. CSIRO. Au/crusader. Pp 1-10

Damron, W. S. (2006). Introduction to animal science, Global, Biological and Industry Perspective (3rd Ed.) U. S. A: Pearson Educational Inc.

de Blas, C. and Julian Wiseman (1998). The nutrition of the rabbit. CABI publishing, Wallingford Oxon. U.K. Pp 103-143

de Blas, C. and Julian Wiseman (2003). The nutrition of the rabbit. CABI publishing, wallingford Oxon. U.K. In: Halls, E. Amy (2010). M.Sc – Monogastric Nutrition. Nutritional requirements for rabbits. Shur-Gain, Nutreco Canada Inc.

de Blas, C. and Mateos, G. G. (1998). Feed Formulation. In: de Blas, C. and Julian Wiseman (Eds). *The nutrition of the rabbit*. CABI publishing, Wallingford Oxon U.K. Pp 241-253

Esonu, B.O. (2000). Animal Nutrition and Feeding: A functional Approach. Rukzeal & Rukson. Associates, memory press (Publishers) Owerri, Imo state, Nigeria. Pp 16-18

Evans, D.O, (2002). Sustainable agriculture in Hawaii, Green manures: Legumes, Lablab. http: //www 2.ctahr Hawaii edu/ sustainag/ sustainale Ag/ Green Manures/ Lablab. Asp.

Farinu, G.O., Ojebiyi, O. O., Akinlade, J.A., Ajibola, H. O., Olaniyonu,B. I. 2008. Evaluation of thenutritive potential of pigeon pea (*Cajanus cajan*) grain and leaf meals on growth performance of pre-pubertal rabbits. *Bowen Journal of Agriculture*. 5: 102-108

Fekete, S. and Gippert T. (1986). Digestibility and nutritive value of nineteen important feedstuffs of rabbits. *Journal Applied Rabbits Research,* 9:103-108.

Fortune-lamothe L., (1997). Effects of dietary fat on reproductive performance of rabbit does. A review. *World rabbit service,* 5(1): 33-38

Fraga, M.J. (1998). Protein requirements, In; C.de Blass and J. Wiseman, (eds), the nutrition of the rabbit. CABI publishing, Wallingford Oxon UK. Pp 133- 143

Fraga, M.J., Lorente, M., Carabano, R.M. and de Blas, J.C. (1989). Effect of diet and remating interval on milk production and milk composition of the doe rabbit. *Animal Production,* 48: 459-406

Gidenne, T., Carabano, R., Garcia, J., de Blas, C. (1998). Fibre digestion, In: C. de Blas, J. Wiseman (eds).The Nutrition of the Rabbit. CABI publishing Wallingford. Oxon, UK. Pp 69-88

Halls, E. Amy (2010). Nutritional requirements for rabbits. Shur-Gain, Nutreco Canada Inc, Pp 1 - 9

Huy, L.k., An, L.V., Ly, N.T.H., Phoung, D.T., Toan, N.H. (2000). Leguminous forages as a protein source for livestock animals in upland farming systems. SEAFRED, Forages for smallholder projects.

Iyeghe-Erakpotobor, G.T. (2012). Utilization of *Arachis hypogeal* (G,nut) and *Lablab purpurus* (Lablab) forage meal fed sole or mixed by growing rabbits. *TROPICULTURA*, 30 (4): 199 – 203.

Iyeghe-Erakpotobor, G.T. (2005). Effect of flushing on reproductive performance of rabbits. *Nigerian Journal of Animal Production.* 37(1): 134-14

Iyeghe-Erakpotobor G.T. and Ashworth C.J, (2006). Relationship between live weight, liver weight and progesterone metabolism of Landrace Large white and Meishan pigs in early pregnancy. *ASSET Series A.* 3 (2):1-9

Iyeghe-Erakpotobor, G.T., Adeyinka I.A (2008). Effect of flushing on Body weight changes, Nutrient Digestibility and litter size of nulliparous Does. *Asian Journal of Animal and veterinary Advances,* 3(3): 155-161.

Iyeghe-Erakpotobor, G.T., Aliyu, R. and Uguru, J. (2006). Evaluation of concentrate, grass and legumes combinations on performance and nutrient digestibility of grower rabbits under tropical conditions. *African Journal of Biotechnology*, 4(20):2004-2006

Iyeghe-Erakpotobor, G.T., Balogun R.O., Abdulmalik, M.F. and Adeyinka, I.A. (2001). Influence of Breed and Environmental factors on litter parameters of rabbits raised in a semi-humid Environment *Nigerian Journal of Animal Production*, 28 (1):14-19

Iyeghe-Erakpotobor, G.T., Osuhor, C.U., and Olugbemi, T.S. (2005). Performance of weaner rabbits fed graded levels of soybean Cheese waste/maize offal diet and Bracharia grass hay. In: Proceedings 30th Annual conference, *Nig. Soc. For Animal production (NSAP),* Pp 239-241

Iyeghe-Erakpotobor, G.T., Oyedipe, E.O., Eduvie, L.O., Ogwu, A. and Olurunju, A.S. (2002). Effect of doe physiological state on nutrient digestibility of rabbits. *Proc. 7th Ann. conf. Anim. Sci. Ass. of Nig. (ASAN)* Pp 21-23

Iyeghe-Erakpotobor, G.T., Otchere, E. O., Tegbe, T. S. B., Jegede, J. O. and Abeke, F. O. (2002). A review of some Agro-industrial by-products in the nutrition of pigs. *Journal of Animal Production Research*, 18 (1&2): 31 – 46.

Iyeghe-Erakpotobor, G.T., Oyedipe, E.O, Eduvie, L.O and Ogwu U. (2005). Effect of rebreeding interval on reproductive performance and body weight changes of does during pregnancy *Nigerian Journal of Animal production, 32 (1) :142-152.*

Iyeghe-Erakpotobor, G.T., Oyedipe, E.O., Eduvie, L.O. and Ogwu, U. (2007). Nutrient digestibility of rabbit does in different stages of reproductive cycle under tropical conditions. *Journal of Animal Physiology and Animal nutrition.* 91:74-82

Iyeghe-Erakpotobor, G.T., Sekoni, A.A. and Esievo, L.O. (2009). Nutrient intake and digestibility of rabbit does fed varying levels of concentrate and lablab during pregnancy. *Nigerian Journal of Animal Production*, 36(2): 275-287.

Iyeghe-Erakpotobor G.T., Olorunju,S.A.S and Emmanuel, O. O. (2005). Effect of protein level and flushing method on the reproductive performance of rabbits. *Animal Science Journal* 76:209-215

John B. Hall, 2010. Nutritional influences on reproduction: Energy and protein. *Applied Reproductive strategies conference proceedings. August 5th & 6th,2010 Nashville. T.N.M.S.A, Pp 220-239*

Johnson, L.T., Noll,S., Reuteria, A., Shurson, J., (2003). Feeding by-products high in concentration of fibre to non-ruminants. Presented at the third National Symbosium on Alternative feeds for livestock and poultry held in Kensas city Mo, November (2003) 26 Pp. http://www.grogue.com.

Kexian, y. (2000). Commercial leaf meal production. Stylo international. September 2000. CSIRO, ACIAR. 4PP.

Knap, P.W. (2000). Variation in maintenance requirements in growing pigs in relation to body composition. In: Van Milgen, J. and Noblet, J. (2003). Partitioning of energy intake to heat, protein and fat in growing pigs. *Journal of Animal Science 81CE. Suppl* (2): E86 – E93.

Kumar, D., Singh, U., Bhatt, R.S. and Risam, K.S. (2005) Reproductive efficiency of female German Angora Rabbits under Indian Sub-temperate climatic condition. *World Rabbit Science*, 113-122

Lanyasunya, T.P., Musa, H.H., Yang Z. P., Mekki, D.M., and Mukisira, E.A. (2005). Effect of poor Nutrition on reproduction of Dairy stock on smallholder farms in the Tropics, *Pakistan Journal of Nutrition* 4 (2): 117-122.

Lebas, F. (1989). Nutrient requirement of various categories of rabbits: Piva, G. and Wiseman, J. (eds) *Proceedings of the first International Feed Production Conference.* Piacenza. Pp 297-332

Lukefahr, S.D. (2009). Role of organic rabbit farming for poverty alleviation, MEKARN M.Sc, 2008 – 10, mini project pp. 1 – 11.

Lukefahr, S.D. (1985). A note on an estimate of the world's domestic rabbit population. *Journal of Applied Rabbit Research, 8:157.*

Mailafia, S., Onakpa, M.M. and Owoleke O.E.(2010). Problems and Prospects of rabbut production in Nigeria – AReview. *Bayero Journal of Pure and Applied Sciences*, 3(2): 20 - 25

Mannetje, L. and Lones, R.M. (1992). Plant Resources of South – East Asia. NO. 4 Forage, Bogor, Indonesia.

Mateos, G.G. and de Blas, C. (1998). Minerals, Vitamins and Additives, In: C. de Blas and J. Wiesman (Eds)The nutrition of the rabbit. CABI publishing. Pp 145-175

Mcdonald, P., Edwards, R.A., Greenhalgh, J.F.D. and Morgan, C.A. (1995). Animal nutrition 5th Edition, Longman Publishers, London. U.K. Pp 606

Meteorological Unit, Institude of Agricultural Research (IAR) (2011).

Moriwoto, M. (2009). General Physiology of Rabbit. In: Rabbit Biotechnology Houdebine, L. and Fan, J. (Editors). *Springer Science + Business Media B. V*. Pp 27- 35

Moreki, J. C. (2007). Commercial rabbit production. Agrinews Magazine, 38(10): 2 – 12.

Murphy, A. M. and Colucci, P.E. (1999). A tropical forage solution to poor quality ruminant diets. A review of *Lablab purpureas*, *Live stock Research for Rural Development*, 11 (2). Htt://www,cipaviorg,co/Irrd/Irrd 11/2/colu.htm.

Murphy, A. M., Colucci, P.E. and Padilla, M.R. (1999). Analysis of the growth and nutritional characteristics of *lablab purpureus*. *Livestock Research for Rural Development*. Htt://www,cipaviorg,co/Irrd/Irrd 11/2/colu.htm

Noblet, J. (2007). Net energy evaluation of feeds and determination of net energy requirement for pigs. *Revista brasileira de especial, Pp 277-284.*

National Research Council (N.R.C), (1977). Nutrition of domestic animals. Nutritional requirement of rabbits, 2nd ed. National Academy of Science. Washington D.C. In: Obinne, J.I., Mmereole, F.U.C. (2010) Effects of different dietary crude protein and energy levels on production performance, carcass characteristics and organ weights of rabbits raised under the humid environment of Nigeria. *AGRICULTURA TROPICA ET SUBTROPICA*, Vol. 43(4):285-290

Odetola, O.M., Adetola, O.O., Ijadunola, T.I., Adedeji, O.Y and Adu, O.A. 2012. Utilization of moringa (*Moringa oleifera*) leaves meal as a replacement for soya bean meal in rabbit's diets. *Scholarly Journal of Agricultural Science*, 2: 309-313

Odunsi, A.A., Ige, O.A., Sodeinde, F.G., Akinlade, J.A. and Afon, O.A. (2006). Growth and carcass yield of Finisher broiler chickens fed lablab leaf meal. *Nigerian Journal of Animal Production*, 33(2):203-208

Ogundipe, S.O., Oni, O.O., and Sekoni A.A. (1992). Revamping poultry production management and feeding. *NAPRI Publication*, Pp 49-51.

Ojewola, G.S., Ukachukwu, S.N. and Abasiekong, S.F. (1999). Performance of growing rabbits fed sole concentrate forage diet. *Journal of Sustainable Agriculture and Environment*, Pp 51-55

Omage,J.J., Agubosi, O.C.P., Bawa, G.S. and Onimisi, P.A. (2009). Evaluation of the nutritive value of quality protein maize on the growth performance and carcass characteristics of weaner rabbits. *Pakistan Journal of Nutrition*, 8(2):106-111

Omole, T.A. (1982). The effect of level of dietary protein on growth and reproductive performance in rabbits, *Journal of Applied Rabbit research*, Pp 5:83-88

Omole, T. A., Ajasin, F.O., Owokun, J.A., and Tiamiyu, A. K. (2007). Rabbit Farming, Back to Agric, Series 7. MAC – B Ventures (Publishers), Ibadan Nigeria.

Omole, T.A. and Onwudike, O.O. (1983). Effect of palm oil, the use of cassava peel meal by rabbits. *Tropical Animal Production*, Pp 27-32

Omole, T.A. and Sonaiya, E.B. (1981). The effects of protein source and methionine supplementation of cassava peels utilization by growing rabbits. Nutrition International, 23 (4): 720 – 737.

Onuekwus, O. C., and Okezie, C.A., (2007). Youth's Adoptation of improved Rabbitry Technology in Umauahia south L.G.A of Abia state, *Journal of Applied Science*, 2 (1) 65 – 69.

Onwudike, O.C. (1995). Use of the legume tree crops *Gliricidia sepium* and *Leucaena leucocephala* as green feeds for growing rabbits. *Animal Feed Science Technology,* 51:153-163

Onifade, A. A., Abu, A., Obiyan, R. I., Abenikande, O. T. F (1999). Rabbit production in Nigeria. Some aspects of current status and promotional strategies. *World Rabbit Science,* 7 (2) 51 - 58

Orunmuyi, M., Adeyinka, I. A., Ojo, O. A. and Adeyinka, F. A. (2006). Genetic parameters estimates for pre-weaning litter traits in rabbits. *Pakistan Journal of Biological Science*, 9: 2009 – 2911.

Oseni, S.O., Ajayi, B.A., Komolate S.O., Siyanbola, O., Ishola, M., and Madamidoki, G., (2008). Small holder Rabbit production in south western Nigeria. Current status, emerging issues and ways forward. *9th world Rabbit congress. Verona, Italy, Pp 1597 -1601.*

Otaru, M.S., Alawa, J.P., Bale, O.O. and Lakpini, C.A.M. (1998). Growth response of red Sokoto Bucks to lablab (Lablab purpureus) supplementation. In: O.O. Oduguwa, A.O. Fanimo and O.A. Osinowo (Eds). *Proceeding of the silver Anniversary conference of the Nigerian society for Animal Production and the Inauguration conference of the West African society for Animal Production* (WASAP), held at Gateway Hotel, Abeokuta, Nigeria, Pp 7-8

Owen, O. J. and Amakiri, A. O. (2010). The potentials and challenges of rabbitary in Nigeria: A review . *Journal of Environmental Issues and Agricultural Developing countries,* 2 (2&3): 22 – 27.

Parigi Bini, R., Xiccato, G., (1998). Energy metabolism and requirement. In: C. de Blas., J. Wiseman (eds). The Nutrition of the rabbit. CABI Publishing. Wallingford. Oxon, Uk. Pp 103-131.

Parigi Bini, R., Xiccato, G., Gnetto, M., Dalla Zotte, A., (1992). Energy and protein utilization and partition in rabbit does concurrently pregnant and lactating. *Animal Production*, 55:155 -162

Partridge, G.G. (1989). Nutrition of farmed rabbits, *Proceedings of Nutrition Society, 48: 95-101*

Partridge, G.G. and Allan, S.J., (1982). The effect of different intake of crude protein on nitrogen utilization in the pregnant lactating rabbits. *Animal Production, 35. 145 – 155*

Partridge, G. G., Daniels, Y. and Fordyce, R. A. (1986). The effects of energy intake during pregnancy in doe rabbits on pub birth weight, milk output and maternal body composition *Journal Agricultural Sciences, Cambridge, 107: 697 – 708.*

Pond, W. G., Church, D .C and Pond, K. R. (1995). Basic Animal Nutrition and Feeding, 4th edition, John Willey and Sons Publication, New York U. S. A Pp. 495 – 504.

Pond, W. G., Ven, J. T. and Varel, V. H.(1985). Effect of level and source of dietary fibre in gestation on reproductive performances and nutrient digestibility in gilts. *Nurition Reproduction International*, 32: 505 – 514.

Raharjo,Y. C., Cheeke, P. R., Patton, N. M. and Supriyati, K. (1986). Evaluation of tropical forages and by- products feeds for rabbit production. 1 Nutrient digestibility and effect of heat treatment. *Journal of Animal Science*. 9, 56 – 66.

Rao, D. R., Chen, C. P., Sunki, C. R. and Johnson, N. M. (1987).Effects of weaning on slaughter ages on rabbit meat production. *Journal of Animal Science*,46:573 – 577.

Rashwan, A. A., Szendro, Z. S., Matics, Z. S., Szalai, A., Biro-Nemeth, E., Szendro, E. and Nagy, I. (2003). Effects of the time of insemination and the litter size on the gestation length of rabbits. *World Rabbit Science*, 11: 75 - 85

Rick F. (2004). *Nutrition and reproduction interactions*. Proc. Applied Reproductive strategies in Beef cattle. North Platte, Nebraska U S A. Pp 58 - 83

Robinson, J.J., (1990). Nutrition in the reproduction of farm animals. *Nutrition Research.* A Review, 3:253 – 276.

Rommers, M. J., Meijerhof, R., Noordhuizen, J. P. M., and Kemp, B. (2004). The effect of level of feeding in early gestation on reproductive success in young rabbit does. *Animal Reproduction science*, 81:135-1581

River – Torres, V., Noblet, J., Dubois, S. and van milgen, J. (2009). Energy partitioning in male growing turkeys. *Poultry Science*, 89:530 – 538

Safwat, A. M., Sarmiento – Franco, L. and Santos – Ricalde, R. H.(2014). Rabbit production using Resources as Feedstuffs in the tropics. *Tropical and Subtropical Agroecosystem*, 17: 161 - 171

Sanford, J.C., (1986). The Domestic Rabbit. In: Iyeghe–Erakpotobor G.T., Oyedipe, E.O., Eduvie, L.O., and Ogwu, D. (2006) Nutrient digestibility of rabbit does in different stages of reproductive cycle under tropical conditions. *Journal of Animal physiology and Animal Nutrition 91: 74-82.*

SAS, 1987: SAS/STAST. Guide for personal computers. Version 6.ed. SAS Institute Cary, NC. Pp 697 – 978.

Schiere, J. B. (2004). Agrodok 20 Backyard rabbit farming in the tropics (4th edition). Agromisa Foundation, Wageningen, the Netherlands, Pp 71.

Sell, R. (1993). Alternative Agricultural Series No 6 North Dakota, State University Extension Services. Pp 1-4

Soenke M., Jacob A. and Ronald O. B. (2005). Using Net Energy for Diet formulation. Potential for the Canadian pig industry. *Advances in pork production* 16: 119 – 129

Soyebo, K.O., (2006). Constraints against wide spread of rabbit keeping among Households in Osun and Oyo state. Supplication for family Economic Empowerment. *Journal of Applicd sciences Research 2 (12). 1244 – 1242.*

Toschi, I., Cesari, V., Rapitti, L., Bava, L., Grilli, G., and Castrovilli, C., (2004). *Energy Utilization and Partitioning of Nullliparous Rabbit Does in the Last Third of pregnancy*. *Proc. 8th World Rabbit Congress*, Puebia Mexico, Pp 100 2 – 1007.

Toschi, I., Cesari, V., Grilli, G., and Castrovilli, C., (2005). *Effect of Intake Level and Diet Composition on Digestibility in Nulliparous Pregnant Rabbits Does*. ITAL. *Journal of Animal Science*. 4: Suppl.2, 529-531

United States Department of Agriculture (USDA) (1972): Selecting and Raising Rabbits, Agricultural Information Bulletin No. 358. In: Mailafia, S., Onakpa, M.M. and Owoleke O.E.(2010). Problems and Prospects of rabbut production in Nigeria – AReview. *Bayero Journal of Pure and Applied Sciences*, 3(2): 20 - 25

Van Dijik, L. (2003). *Rabbit production guidelines for the Malawi Prison Service*. Penal Reform International. Lilongwe, Malawi.

Van Millen, J., and Noblet, J. (2003). Partitioning of energy intake to heat protein, and fat in growing pigs. *Journal of Animal Science, 81 (E.Suppl . 2): E 86 – E93*

Villamide, M. J., Maertens, L., de Blas, C., and Perez, J.M. (1998). *Feed Evaluation*. In: de Blas, C. and Wiseman, J. (eds) (1998). The Nutrition of the Rabbit. CABI Publishing Pp. 89 -101

Villamide, M.J. and Fraga, M.J. (1998) Prediction of the digestible crude protein and protein digestibility of feed ingredients for rabbits from chemical analysis, In: Iyeghe – Erakpotobor G. T. and Adeyinka, I.A. (2008). Effect of Flushing on body weight changes. Nutrient digestibility and litter size of Nulliparous does. *Asian journal of Animal and veterinary Advances 3 (3):155 – 161.*

Walack – Jamiak, M., Raj, J. S. and Fandrejewaki, H. (1986). *Protein and Energy balance in pregnant gilts*. In: Speer, V.C. (1990). Partitioning nitrogen and Amino acids for pregnancy and lactation in Swine. A review. *Animal Science, 68:553 -561*.

Xiccato, G. (1996). Nutrition of lactating does. In: Xiccato. G., and Trocino, A. (Eds) (2010) Feed and energy intake in rabbits and consequences on farm Global efficiency. *The 6th International Conference on Rabbit Production in Hot Climate*, 2010. Assiut, Egypt, Pp 1-16

Xiccato, G. and Trocina, A. (2010). Feed and energy intake in rabbits and consequences on farm Global efficiency. *The 6th International Conference On Rabbit production in Hot Climate*, Assiut, Egypt, Pp 1-16

Xiccato, G. Bernardini, M., Castellini, C., Dalle Zotte, A., Queaque, P. I. and Trocino, A. (1999). Effect of post weaning feeding on performance and energy balance of female rabbit of different physiological states, *Journal of Animal science*, 77: 416-426

Xiccato, G., parigi Bini, R., Dalle zotte, A., Carazzolo, A. and Cossu, M.E. (1995). Effect of dietary energy level, addition of fat and physiological state on performance and energy balance of lactating and pregnant rabbit does. *Animal Science 61. 387 – 398*