DECLARATION

I OPAWOYE FUNMILAYO ALICE hereby declare that this project on the Replacement of soyabean meal with *leucaena leucocephala* (lam.) leaf meal on growth performance and nutrient digestibility of weaned rabbits is solely my own work carried out with the period of June and July, 2017. This work has not been submitted before in any institution. All use of previously published work are clearly cited with the contest and fully acknowledged in the references list.

Opawoye Funmilayo Alice

30th November, 2017

Date

CERTIFICATION

This is to certify that this project work was carried out by **OPAWOYE** FUNMILAYO ALICE with matriculation number ASC/12/0460 in the department of Animal Production and Health, Federal University Oye Ekiti.

14/12/17

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Date

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Date

DEDICATION

This project is dedicated to the gracious God. For His love amd provision upon my life throughout my period of study in the university. Also to my beloved parent Mr. and Mrs E.O. Opawoye I appreciate your support. If not for their help it would not have been easy.

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I give God all the glory and adoration for his love, care, support and provision. He is the one who gave me strength, knowledge and understanding to successfully complete my degree program, despite all the challenges I was able to skill through.

The success of this work is a collaborative effort of some personalities who has worked so hard to make it possible. My gratitude goes to Dr. Modupe Orunmuyi, the H.O.D. Dr. A.H. Ekeocha and Prof. A.A. Aganga. My profound gratitude goes to my major supervisor Dr. O.A. Abu for his invaluable assistance and contribution throughout the period of this project. The blessing of God will never stop in your life and family.

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ABSTRACT

Leucaena leucocephala was soaked for 48 hours and sun dried for 12hours it was then incorporated into feed for growing rabbits, the nutrient digestibility of *Leucaena leucocephala* (LLM) at 0 (control), 50 and 100% replacement of soybean was evaluated and the growth rate of weaned rabbits at different level of inclusion was compared. A total of 15 growing rabbits of different sexes and breeds with initial body weight range of 679±90.55 were randomly distributed into three experimental groups of five (5) rabbits each and they were housed in individual cages using completely randomized design (CRD). The initial body weight of the rabbits was recorded before the commencement of the experiment, all groups were treated equally for 49 days, daily feed intake and weekly weight gain was recorded during the whole experimental period. Total feces were collected daily, weighed individually for three days and the digestibility of each diet was determined. Data collected were subjected to analysis of variance. The result showed that the digestibility of dry matter (DM), crude fibre (CF), crude protein (CF), ether extract (EE), and ash were not significantly ($p>0.05$) influenced by the level of replacement of *Leucaena leucocephala* leaf meal (LLM) with soyabean meal (SBM) in rabbit diet. The cost of feed intake was significantly ($p>0.05$) different with T_3 having the lowest cost of total feed intake of 627.55 followed by T_2 having 650.66 and T_1 having the highest value of 660.53. There were no significant difference ($p>0.05$) in the growth performance of rabbit among the groups.

Keyword: Rabbit, *Leucaena leucocephala* leaf meal (LLM), Nutritent digestibility, Growth performance.

Word count: 262

CHAPTER ONE

1.0 INTRODUCTION

Production of livestock in Nigeria is centered on cattle, sheep, goat and poultry. These animals have not been able to meet the protein requirement of human from animal origin, this is due to a number of factors such as increased competition for basic raw materials, small land for grazing (especially for ruminants), poor government policies etc. all these factors resulted into high cost of the available quantities and inadequate supply. Effect to reduce the high cost of feeds and therefore the cost of product concentrated on using alternative and unconventional feed stuffs (Adeniji and Balogun, 2002). There is therefore the need to look for alternative protein feedstuff which could be readily available and serve as replacement for protein source in diets of animal. The best class of plant that can be used for this purpose is the legume. It has been reported that legumes are good source of protein to man and animals. Also, large animals (i.e. cattle) which are the main source of animal protein in Nigeria have high protein requirement which cannot easily be met. Therefore, increasing the production of micro livestock such as rabbit, grass cutter, snail etc. will help to address this problem.

Rabbit production can be an effective means of converting materials that are not consumed by humans, such as forages into high quality human food. Rabbits are alternative meat producer to meet increasing demand of human for animal protein. They are efficient converter of forage into good quality animal protein compare to other livestock. Rabbit possesses peculiar characteristics, the caecotrophy makes the animal to utilize high forage diet efficiently (up to 20% fibre in their ration). Moreover, the caecal microflora aids in digesting fibrious components in feed. (Karu *et al.,* 2015).

Soybean meal and fish meal have been widely used as conventional protein sources for livestock. However, the prices of these feed ingredients have been on the increase with instability in their supplies in the market. To solve this problem, finding locally available protein supplemental resources especially fodder trees and shrub legumes such as *Leucaena leucocephala* can be consider as protein source for livestock.

Leucaena leucocephala (LAM.) DE WIT commonly known as Subabul. Leucaena originated in the Yucatan Peninsula, Mexico, where their forage value was recognized over 400 years ago by Spanish conquistadores who carried leucaena forage and seed in their galleons to the Philippines to feed their cattle. From there, it has spread to most tropical and subtropical countries of the world where it is used in animal feed and human food, due to its success as forage of high nutritional value (Brewbaker *et al.*, 1985). *Leucaena leucocephala* is a legume fodder crop that provides high quality and palatable feed for animal consumption, it is often being described as the 'alfalfa of the tropics'. *Leucaena* is a free seeding, colonising plant, which has spread to a very wide range of sites, which are more or less frost-free, and has naturalized itself in many areas, some far outside the tropics. In east Africa, it will grow up to about 1,900 meters above sea level with slow growth as altitude increases.

Leucaena leucocephala have shown a high nutritional value and could adequately be fed to livestock in place of the conventional protein sources. *Leucaena leucocephala* has been identified to hold the potential to make contributions to rabbit nutrition with the possibility of reducing a total dependence on conventional protein sources (Adama and Adekojo, 2002). *Leucaena* contain some anti-nutritional factor such as mimosine, tannin, cyanogenic glycoside, oxalate, phytic acid these antinutritional factors limit the use of *Leucaena* as animal feed. Mimosine is a non-protein amino acid structurally similar to tyrosine. The adverse effect of these anti-nutrients can be reduce by different processing technique such as roasting, drying, soaking, fermenting, steaming, cooking wilting etc. The main symptoms of toxicity of these anti-nutritional factor in ruminants includes; poor growth, loss of hair and wool, swollen and raw coronets above the hooves, lameness, mouth and oesophageal lesions, depressed serum thyroxine level and goitre. Some of these symptoms may be due to mimosine and others to 3, 4 dihydroxypyridine which is a metabolite of mimosine in the rumen (Jones and Hegarty, 1984). Mimosine content in leucaena has been reported to cause weight loss, ill health, organ damage and hair loss to rabbits at a level above 7.5 – 20% inclusion when fresh or unprocessed *Leucaena leucocephala* is included in the diet (Fayemi *et al.*, 2011).

This project was therefore designed to evaluate the effect of *Leucaena* leaf meal using a combination of two processing techniques (soaking and sun drying) on rabbit growth and check the digestibility at different level of inclusion.

1.1 PROBLEM STATEMENT

Despite the many advantages of keeping rabbits for meat supply, rabbit keeping and consumption remains very low in Nigeria. Egbunike and Archibong (2000) reported that the problem of rabbit keeping is because of the competition between man and farm animals also some of the ingredients are not readily available in some part of Ekiti state (i.e. soyabean meal).

The use of non- conventional feedstuffs will go a long way in solving the high cost of feed ingredients bearing in mind the right processing methods of these alternative feedstuff, their level of inclusion in feed and free toxic deleterious or anti-nutritional factors that can reduce the performance of animals.

In solving this problem, this experiment replaced processed *Leucaena leucocephala* leaf meal (LLM) with soya bean meal (SBM) and checked the effect on growth of the rabbit and how they are able to digest the feed.

Most of the forages suitable for feeding rabbits are unavailable during the dry season but the *Leucaena* plant is one of the very few exceptions.

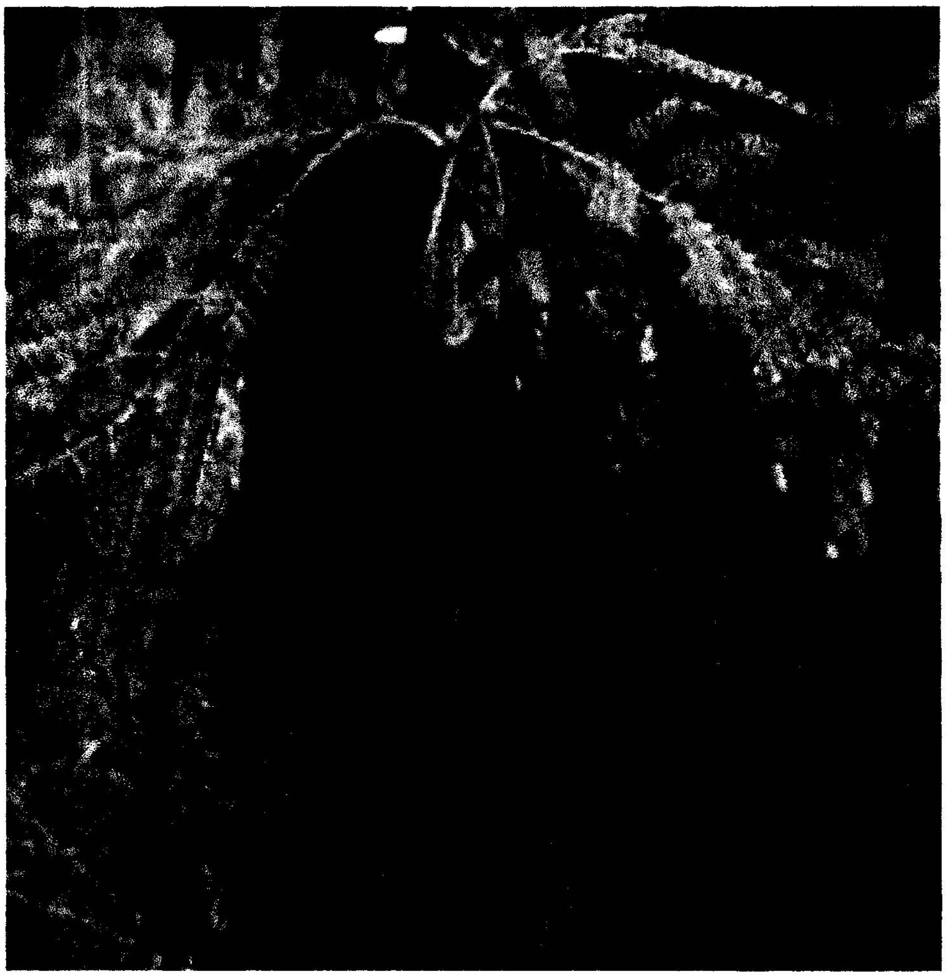

Figure 1: Image of *Leucaena leucocephala*

1.2 JUSTIFICATION

Leucaena leucocephala leaf meal will be used because it is the most available forage in dry season, it is evergreen also it has high protein content. The protein content of leucaena plant (seeds, pods, leaves) is comparable to conventional plant protein such as soyabean meal.

Soaking and drying will be adopted as detoxification method because soaking for 24hours eliminate 97% of mimosine in leucaena leaves, pod and seed (Soedarjo and Borthakur 1996). Drying Leaves of *Leucaena leucocephala* at 60°C for 24hours and soaking in water at room temperature for 72 hours reduce mimosine and tannin content. (Jones *et al.*, 2009)

1.3 OBJECTIVES

1.3. 1 BROAD OBJECTIVE

To assess the growth rate and nutrient digestibility of rabbit fed diets in which *Leucaena leucocephala* leaf meal replaced 0, 50 and 100% soybeans meal.

1.3.2 SPECIFIC OBJECTIVES

i. To monitor body weight on weekly basis
ii. To measure feed intake on daily basis
iii. To determine the crude protein, crude fibre, and dry matter

1.4 HYPOTHESIS

1.4.1 NULL HYPOTHESIS (Ho)

This state that there is no significant difference between growth rate and digestibility at different level of inclusion

H_O: T1=T2=T3

1.4.2 ALTERNATIVE HYPOTHESIS (Ha)

State that there is significant difference in growth rate and digestibility at different level of inclusion

H_A: T1 $\neq$ T2 $\neq$ T3

CHAPTER TWO

2.0 LITERATURE REVIEW

The rabbit (*Orytolagus cunniculus*) is an herbivore and classified as a hindgut fermenter, it is a good source of animal protein. They are highly selective when given forage (Bamikole *et al.*, 1999). Rabbits are considered as concentrate selectors because they naturally pick and choose food higher in energy density (Mayer, 2015).

2.1 ADVANTAGES OF RABBIT

The science and occupation of raising rabbits for food, can be regarded as a new breed of animal farming in Nigeria with its potentialities, opportunities and challenges. The potentialities of rabbit rearing are that the cooked meat has a high nutritional value with high protein (56%), low fat (9%), low in cholesterol, sodium and calories (8%) and contain 28% phosphorus, 13% iron, 16% zinc, 14% riboflavin, 6% thiamin, 35% B_{12} and 48% niacin – making it ideal meat for hypertensive patients (Damron, 2006). Also rabbitry requires comparatively low level of capital set up (Owen *et. al.*, 2010). Rabbit manure is high in Nitrogen and phosphorus and useful in improving soil fertility (Bolaji, 2005). Rabbit is prolific and has a short gestation period and generation interval, this makes it a choice for multiplication and serve as a short way of increasing animal protein intake (Egbo, Doma and Lacdacks, 2001; Ironkwe, 2004).

Low animal protein intake has been a major nutritional problem in Nigeria, especially for the low income earners (Amaefule and Obioha, 2005; Akinola, 2009). It is therefore necessary to develop different sources of animal protein that can be available at cheaper price.

2.2 ABOUT LEUCAENA LEUCOCEPHALA

Leucaena leucocephala is a legume fodder crop that grows in tropical and subtropical environments it provides high quality and palatable for animal consumption, often being described as the 'alfalfa of the tropics'. Leucaena performs best in tropical climates (hot, wet summers and mild winters) and effectively stops growing when the average day temperature falls below 15°C. Preferably, annual average rainfall needs to be above 600 mm (Jones, 2001). Leucaena is frost sensitive, however will re-grow from stored soil moisture in spring. Leucaena will grow in a wide range of soils but is most productive in fertile (high phosphorus and alkaline pH), deep (>1 m), well-drained soils (intolerant to waterlogging). Seedbed preparation, stored soil moisture and weed control are the keys to successful leucaena establishment. When cultivating, prepare the paddock as for any crop - cultivate to control weeds and prepare a seedbed, or use herbicides to control weeds. It is advisable to plant *Leucaena* when soil temperature is above 18°C, and with at least 60 cm of soil moisture. Plant the seed into wet soil sufficiently deep to stay wet for a week, but no deeper than 5 cm. Leucaena performs best in fertile soils with:

i. phosphorus above 20 mg/kg
ii. Sulphur above 5 mg/kg
iii. Good levels of calcium and trace elements, particularly zinc and potassium.

Leucaena is distinguished by its high protein contents, which range from 20 to 34% crude protein (CP) on dry matter basis; additionally they have an acceptable profile of essential amino acids, vitamins and minerals (Odetola *et al.*, 2012).

Leucaena seeds are ovoid in shape and have brown hulls and yellow kernels. The seeds were low in oil, 5.1 to 10.0% and rich in protein, 24.5 to 46% in DM basis (Chandrarekhar *et al.*, 1984). On autoclaving *in-vitro* digestibility of *Leucaena* seed kernel was increased from 25 to 89% (Seithi and Kulkarni, 1993). It was also expressed that *Leucaena* seeds contained high calcium levels (Kale, 1987), various vitamins such as thiamine, riboflavin, niacin, β-carotene and ascorbic acids were present in the hulled meal of *Leucaena* seeds, a traditional feed in Mexico (Prerz and Arellano, 1987) stated that *Leucaena* seed contained 95.56% OM, 27.10% CP, 44.22% NDF, 20.60% ADF, 16.49% cellulose, 23.52% hemicellulose and 4.23% lignin.

2.3 DIETARY NUTRIENT REQUIREMENT OF RABBIT

Rabbits feed by grazing on grass, forbs, and leafy weeds. Their diet contains large amounts of cellulose, which is hard to digest. Rabbits solve this problem via a form of hindgut fermentation. Information for rabbit owner, 2012 reported that the caecotrophic activity of the rabbit a behavior known as coprophagy enables it to digest their food further and extract sufficient nutrients.

The rabbit has a low utilization of the fibrous fraction due to the rapid passage of feed through the gastrointestinal tract (Gidenne, 2000). However through the caecotrophic activity, the digestibility of nutrients, especially protein, is incremented (Machado *et al.,* 2012).

2.4 COMPOSITION AND NUTRITIVE VALUE OF LEUCAENA

TABLE 1: CHEMICAL CONSTITUENTS OF *L. leucocephala*

CHEMICAL CONSTITUENTS (%)	LEAVES	SEEDS
Crude protein	25.90	46.00
Carbohydrate	40.00	45.00
Tannin	4.00	1.20
Mimosine	7.19	10.00
Total ash	11.00	3.79
Calcium	2.36	4.40
Phosphorus	0.23	0.19

SOURCE: Devi, 2011

The leucaena is considered as the most widely consumed legume due to its characteristics such as high supply protein, energy, calcium and sulfur, the latter with a possible potentiating effect on rumen microbial populations (Aregheore, 1999).

High intake of leucaena may have negative impact on the productive indicators of animals mainly as a result of:

1. Excess of nitrogen in the diet, which causes an imbalance in protein-energy ratio resulting in an inefficient microbial protein synthesis, and also high levels of ammonia in blood which can affect voluntary intake (Calsamiglia *et al.*, 2010).
2. Presence of secondary compounds, such as mimosine, which can induce toxicity or death in ruminants (Adejumo, 1991; Ghosh *et al.*, 2007a; Dalzell *et al.*, 2012), and condensed tannins that form protein-tannin complex, inhibit the activity of rumen microorganisms and results in changes in the ecology of the rumen.

These effects limit the degradation of nutrients and can cause a reduction in the production of volatile fatty acids (VFA) (Ramana *et al.*, 2000; Salem *et al.,* 2006; Galindo *et al.*,2009)

2.4.1 PROTEIN AND AMINO ACID COMPOSITION

The digestibility of the protein reaches 63% and digestibility of dry matter between 60 and 70% measured in vivo (Barros-Rodríguez *et. al.*, 2012). In this sense, the use of *Leucaena* as a protein supplement in livestock farming systems in tropical countries is widely accepted (Galindo *et al.*, 2009). In addition, it is a source of minerals such as sulfur, which can act as enhancer of rumen microbial populations (mainly cellulolytic fungi and bacteria) (Aregheore, 1999).

Leucaena has high protein content, the seed contain about 31.4 - 35.8% of protein in DM basis (Soedarjo and Borthakur 1996).

Among the various parts of the plant, seeds and immature leaves contain the highest amount of crude protein, and the stem and dry pods the lowest (Akbar *et al.*, 1985; Kale *et al.*, 1987; Hilal *et al.*, 1991; Yadau *et al.*, 1988). Leaf protein concentrate (LPC) was prepared from L. *leucocephala* leaf meal (LLM). The recovery of LPC was 7.6% and it contained 65.9% crude protein, compared with 29.2% in LLM. Ash content was 17.6%, and the levels of lysine, histidine, arginine, isoleucine, and leucine were 5.6%, 2.3%, 5.9%, 5.4%, and 11% on a dry matter basis, respectively. The LPC diet supported growth in rats but gave lower nutritive indexes than the control diet of soya bean and Guinea corn (Farinu *et al.*, 1992). Glutamic acid, aspartic acid, leucine, and isoleucine are the major amino acids in the plant (Hilal *et al.*, 1991).

TABLE 2. COMPARATIVE AMINO ACID CONTENT IN SOYA BEAN MEAL, FISH MEAL, ALFALFA AND SEEDS LEAVES AND PODS OF LEUCAENA

	Mg/g nitrogen					
				Leucaena		
Amino acid	**Soyabean meal**	**Fish meal**	**Alfalfa**	**Seeds**	**Leaves**	**Pods**
Cysteine	106	69	77	79	42-88	**21**
Aspartic acid	706	625	1	643	864	**432**
Methionine	88	175	96	94	88-100	**42**
Threonine	244	269	290	138	266	**133**
Serine	331	256	-	206	279	**139**
Glutamic acid	11.38	813	-	911	640	**320**
Poline	300	244	-	222	305	**152**
Glycine	275	400	-	285	278	**139**
Alanine	275	394	-	205	311	**155**
Valine	300	325	356	205	255-188	**127**
Isoleucine	294	256	290	148	244-653	**122**
Leucine	488	475	494	283	444	**222**
Tyrosine	2.38	-	2.32	162	208-263	**104**
Mimosine	0	0	0	763	343	**172**
Phenylalanine	319	256	307	197	250-294	**125**
Lysine	388	500	368	324	313-396	**157**
Histidine	181	-	139	158	112-135	**56**
Arginine	463	375	357	493	294-349	**147**

Source: Deguessa (1973), Hegerty Mohme (1978)

2.4.2 ENERGY COMPOSITION

Very limited data are available on the carbohydrates present in the leaves. According to Kale *et al.,* 1987, *Leucaena* seeds have a total carbohydrate content of approximately 35 to 45 %, with reducing sugars constituting 5.2%. Starch is absent from a number of the species (Sethi *et al.,* 1989), including L. *leucocephala*, although it was reportedly by Kale *et al.,* 1987 to be 1.3% in the seeds. The total oligosaccharide content of *L. leucocephala* is 3.5% to 3.6%, with sucrose 1.9% to 2.0%, raffinose 0.7% to 0.8%, and stachyose 0.7% to 0.8% (Kale *et al.,* 1987).

2.5 ANTI NUTRITIONAL FACTORS

2.5.1 MIMOSINE

Mimosine is a free amino-acid very often present in certain legumes which include *Leucaena leucocephala* and *L. glauca*, both considered as excellent sources of protein for animal feed. Its presence limits the use of the leaves and seeds in feed for mono-gastric animals. Mimosine affects thyroid function, leading to poor growth. Mimosine, a chemical present in *Leucaena leucocephala*, and its degradation product 3-hydroxy-4(1H)-pyridone (DHP) are both toxic when ingested by herbivores, and their inactivation or reduction would enhance the use of the plant as livestock fodder. Mimosine, although insoluble in distilled water, is soluble in ionic solutions. Mimosine has almost the same structure as tyrosine, therefore when consume by livestock it replaces tyrosine during metabolism result into absence of tyrosine.

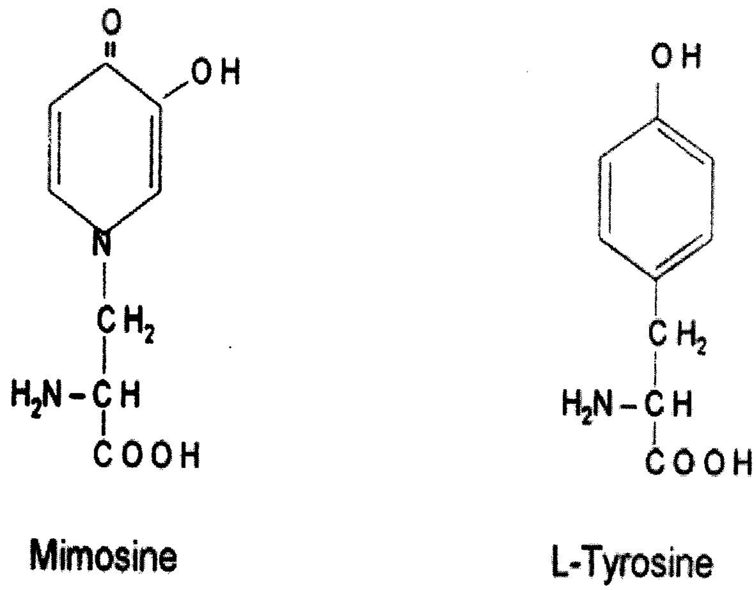

Figure 2: Chemical structures of mimosine and tyrosine

According to Sutikno 1991 and Kewalramani 2008, the values for mimosine differs among the species of *Leucaena*, being highest (5.4%) in L. *macrophylla* and lowest (1.2%) in L. *diversifolia* (Rushkin *et al.,* 2007). The value of mimosine differ widely among the various parts of L. *leucocephala* cultivars (Excobar *et al.,* 1988), as it did in the different plant parts, being 12.3% in the yellow cotyledon and 0.5% in the empty green pod. Mature seeds are twice as rich in mimosine as young seeds, 6.2% and 3.2%, respectively, but the reverse is true of the leaves, 2.6% versus 5.1%. (Yadav 1988). Deshmukh *et al.,* 1987 reported that the mimosine content also depends on the stage of plant growth, it is at the peak on the thirtieth day (7.1%) and decreases progressively by 45 days (6.0%) and 60 days (4.2%) of growth.

Plant breeders in Australia and Hawaii are developing low mimosine varieties of leucaena, which should improve the feeding value of this high protein plant (McNitt *et al.*, 2013).

2.5.2 EFFECT ON RUMINANT

Leucaena provides palatable digestible and nutritious forage for animals such as cattle, water buffaloes, goat, sheep, and other animals. The leucaena forage in ruminant nutrition is widely used due to its qualities such as high content of crude protein, which varies between 24 and 30%, depending on the variety and time of year (García et *al.*, 2008). An additional possible benefit from utilizing *Leucaena* in ruminant feeding are the effects arising from the secondary compounds it contains (for example, tannins). This compounds when consumed in moderate amounts generally have positive effects and do not reduce voluntary intake. The phenolic hydroxyl groups of tannins bind to the dietary protein in aqueous solution, leading to the formation of a complex with proteins, mainly, and to a lesser extent with metal ions, amino acids and polysaccharides, avoiding their degradation in the rumen, increasing the amount of bypass protein to the lower parts of the gastrointestinal tract (abomasum) and the amount of essential amino acids supply, resulting in higher animal production (Waghorn et *al.*, 1987). They can also be used as a natural anthelmintic agent for gastrointestinal nematodes (Torres-Acosta *et al.*, 2008; Alonso et *al.*, 2010). Additional, research with forage legumes, have suggested that condensed tannins may help to reduce rumen gas production (Monforte-Briceño *et al.*, 2005).

Under certain conditions, mimosine is readily conversed to another toxic compound, 3-hydroxy-4(1H) pyridone (DHP) (Hegarty *et al.*, 2005; Rushkin *et al.*, 2007). Although mimosine is directly toxic, DHP is only indirectly so, through its goitrogenic action. Thus, animals that break down mimosine to DHP can tolerate higher dietary levels of *Leucaena* than other animals, and animals that can degrade DHP even further can tolerate higher levels yet, perhaps diets consisting solely of *Leucaena* (Lowry, 1983).

Cattle feed

The *in vivo* digestibility of *Leucaena* forage is similar to that of other legumes and is estimated to be in the range of 50% to 70%. Mimosine tends to reduce the activity of cellulolytic bacteria, but in about a week the rumen bacteria adapt and digestion improves considerably.

Dried leucaena leaf-meal was found to be equivalent to cotton seed cake when it was used in the ration for fattening cattle (Thomas and Addy, 1977).

Rushkin, 1984 reported that dairy cattle produce well when fed *Leucaena*. Annual milk production of 5,000 to 9,700 L/ha was recorded in Australia, Hawaii, and Indonesia. In India, when cows and buffaloes were fed *L. leucocephala* foliage at 10% of their diets, their milk yield was 20% higher than that of the control group fed no *Leucaena*. (Ghatnekar, 1983).

According to Evans 1983, the symptoms of mimosine toxicity include decreased weight gain, cataract in young animals, infertility, goitre, and-the most striking feature loss of hair. Cattle fed completely on *Leucaena* may lose some of their coarse hairs but they will not die. However, newborn calves have shown signs of enlarged thyroids, which may result in death within a few days if their mothers have signs of toxicity (Kewalramani, 2008). Also, thyroxine levels were reported to be higher in the group fed an exclusive diet of *L. leucocephala* for 23 months from 10 months of age, compared with the control group. Mimosine itself is not goitrogenic, but its bacterial metabolite 3,4-dihydroxy pyridine (3,4-DHP) is (Hegarty, 2009). Mimosine is hydrolysed by the gut microflora of ruminants to 3,4-DHP (Hegarty, 2009).

According to Ter 1979, when ruminant is feed with *Leucaena* for more than 50% continuously for more than six months, it results in mimosine toxicity symptoms. Cattle can tolerate *L. leucocephala* intakes corresponding to 0.18 g mimosine/kg body weight without serious toxic symptoms (Szyszka 2008). Diets containing less than 1% mimosine on a dry matter basis have little adverse effect on thyroid function or feed intake, whereas above this level hypothyroidism and low feed intake may occur.

Rushkin, 2007 reported that cattle do not die from goitre resulting from feeding on *Leucaena* forage and that the effects are mostly reversible and can be seen soon after the feed is withdraw from the animals. Mimosine has no effect on the milk or meat of cattle feeding on the plant that can cause a health hazard to humans consuming these products.

Sheep and goats

According to Szyska, 2007 sheep can tolerate *L. leucocephala* intakes corresponding to only 0.14 g mimosine/kg body weight without serious toxic symptoms. High intakes by sheep, equivalent to a daily intake of 0.2 to 0.3 g mimosine/kg, cause remarkable shedding of fleece within 7 to 10 days. The zinc contents of blood and wool of lambs fed *L. leucocephala* foliage for 70 days were lower than the levels at the start of the experiment. It is established that sheep, like cattle, cannot detoxify mimosine after absorption. Instead, extensive degradation of mimosine to 2,3-DHP and 3,4-DHP takes place in the rumen (Evans, 1983).

Goats can tolerate *L. leucocephala* intakes corresponding to 0.18 g mimosine/kg, the same as for cattle, without serious toxic symptoms (Szyska, 2007). The goats were able to detoxify mimosine due to the degrading action of rumen micro-organisms. However, in another report, the body weight of goats fed only the plant decreased in six weeks due to lower intake and decreased digestibility of crude protein. Also, the concentration of inorganic phosphorus was significantly lower in the blood of these animals. (Girdhar *et al.*, 1991).

2.5.3 EFFECT ON NON-RUMINANT

Leucaena should not be a major protein source of the diet for non-ruminant animals. They generally do not tolerate a ration containing more than 5-10% leucaena (Sethi and Pushpa, 1995). There was no change in liveweight gain with up to 5% *Leucaena* included in the diet of chickens. At higher levels, toxicity symptoms appeared and there was a suggestion of reduced liveweight gain. There was no change in liveweight of pigs fed up to 10% in the diet (Liu Guodao1 *et al.*, 1994)

The LFM could be considered as an alternative resource to feed pigs, with daily weight gains and feed efficiencies similar to those obtained when feeding corn-soybean, and without risk to the animals ' health. However, it is important to carry out experiments where LFM is provided at all stages of the animal's growth, possibly including higher proportions of LFM in the diet to obtain a more comprehensive understanding (Espinoza *et al.*, 1995).

Rai 1992 reported that *Leucaena* up to 40% in camel rations depressed feed conversion efficiency but apparently did not have any adverse influence on palatability, growth performance, thyroid status, hair, and general health of camel calves.

Rats and mice

Akbar, 1984 and Rushkin, 1984 reported that mimosie toxicity in rats and mice causes reduction in hair growth, growth depression accompanied by appetite inhibition, retardation of functional organs such as ovaries, testes, and thyroid gland; necrosis or degeneration of the liver, kidneys, and cutis; cataract; reduced fertility and reproductive failure; goitre, attributed mainly to 3,4DHP; neurotoxic effects manifested as paralysis of the hind limbs, short lifespan and mortality.

2.6 PROCESSING OF LEUCAENA

A drastic reduction was reported in the contents of tannin, phytate, saponin, cyanogenic glycoside and trypsin inhibitor when feed ingredients were subjected to cooking and fermentation (Apata, 2003; Olaniyi, 2006; Fayemi *et al.*, 2011; Soetan, 2009 Jiya 2012). Many anti-nutritional factors are liable to heat therefore; heat treatment and simple washing with water will alleviate some anti-nutritional factors (Kumar, 1998).

Adekojo *et al.*, 2014 reported that processing techniques such as soaking, hot water treatment and fermentation apart from air drying were adequate in preventing any observed harmful effect when the diet contained 40% *Leucaena leucocephala*.

Heat treatment of *Leucaena* leaf meal and drying by exposure to sunlight and high temperatures cause considerable reductions in mimosine (Evans, 1983). Moist heat treatments such as cooking dipping leaves in hot water, and autoclaving leaves and seeds, reduce the content more than dry heat (Ter 1979). A virtually complete degradation of mimosine was reported in an aqueous slurry at pH 8.0 and 45°C in 10 minutes. Heating the intact leaf at 70°C resulted in 90% reduction of mimosine in 15 minutes (Tangeudjaja 1984).

Washing with water and soaking the leaves and seeds had a significant effect in lowering their mimosine contents (Padmavaly, 1987). Prolonged soaking (48 hours) in 30°C water was most effective in reducing virtually all the mimosine in the leaves (Wee, 1987).

0.05 N sodium acetate is one of the most effective reagents for extracting 95% mimosine. Studies carried out by treating *L. leucocephala* seeds with a number of reagents indicated that urea and sodium hydrogen carbonate completely removed mimosine (Tawata, 1988). The protein content of the mimosine-free seed mass was reduced to 80% of the original after treatment with urea, and 88% after treatment with sodium hydrogen carbonate solution (Hossain, 1991).

Hongo, 1988 reported that ensiling is an effective method for reducing mimosine content of *Leucaena* leaves. Mimosine in the *L. glauca* plant is removed by fermentation with lactic acid bacteria. The mimosine-removed silage is useful as a component of livestock feeds and human foods (Inafuku, 1992).

Apata, 2003, Olaniyi, 2006 and Soetan *et al.,* 2009 reported that there is a significant ($P<0.05$) reduction in the contents of tannin, phytate, saponin, cyanogenic glycoside and trypsin inhibitor when feed ingredients were subjected to cooking and fermentation, Kumar 1998 also reported that many anti-nutritional factors are liable to heat and that heat treatment and simple washing with water will alleviate some anti-nutritional factors.

2.7 DIGESTIBILITY OF *LEUCAENA* BY LIVESTOCK

The *in-vitro* digestibility of leucaena forage in cattle was similar to that of other legumes and was estimated to be in the range of 50 to 70% (TerMeulen *et al.*, 1979). The presence of mimosine tends to reduce the activity of cellulolytic bacteria for a week but the rumen bacteria were reported to adapt and digestion was improved considerably (Ruskin, 1977).

The lower feed and nutrients intake as well as apparent digestibility values recorded for rabbits fed LLM treatments was be attributed to the possible effect of the anti-nutritional compounds such as mimosine and tannins present in *L. leucocephala* (Simon, 2012), these compounds tend to decrease diet digestibility through their ability to bind with proteins and other nutrients, resulting in decreased diet intake (Al Mamary *et al.*, 2001).

Measuring digestibility is a way to evaluate the availability of nutrients. The *in vivo* digestibility of nutrients can be measured directly and indirectly; directly by precisely recording feed intake and fecal excretion of an animal subjected to dietary treatment in a given time period. The disadvantage of this method is the probable contamination of excreta and urine and the collection is not always accurate. The indirect way to measure the digestibility does not require quantifying consumption but a marker as fecal excretion could be added or included in the feed (Nieves *et al.*, 2008; Bovera *et al.*, 2012). The advantage of this method is that it saves labor, compared to the total collection method.

2.8 ABOUT SOYABEAN (*Glycine max*)

Soybean meal is the most important protein source used to feed farm animals (Oil World, 2015). Its feeding value is unsurpassed by any other plant protein source and it is the standard to which other protein sources are compared (Cromwell, 1999).

Soybean meal (SBM) is the by-product of the extraction of soybean oil. Different products are produced resulting from different processes which includes; solvent extraction, mechanical extraction and the third method combines extruding and expelling of soybean flakes, and neither uses solvent for oil extraction (Johnson *et al.*, 2004). Soybean meal is usually classified for marketing by its crude protein content. They two main categories of soybean meal are; "high-protein" soybean meal with 47-49% protein and 3% crude fiber, obtained from dehulled seeds, and the "conventional" soybean meal, with 43-44% protein, that contain the hulls. In solventextracted soybean meals, the oil content is typically lower than 2% while it exceeds 3% in mechanically-extracted meals (Cromwell, 2012).

Soyabean are very rich in nutritive components. soyabean has high protein content and contains a lot of fibre they are also rich in calcium, magnesium. The soy contains all the essential amino acids.

The protein and soyabean oil content account for 56% of dry soyabean by weight (36% protein and 20% fat). It consist of 30% carbohydrate, 9% water and 5% ash. Soybeans comprise approximately 8% seed coat or hull, 90% cotyledons and 2% hypocotyl axis or germ (corke *et al.,* 2004)

Soyabean meal (SBM) has advantages over most other oilseed meals because of its high digestible energy and protein. SBM is a particularly good source of both lysine and tryptophan. SBM is also an especially good source of lysine. When the digestible lysine concentration in SBM is compared to the required amount of lysine for chicks (per unit of protein), the amount of digestible lysine in SBM actually exceeds the requirement (Baker, 2000).

The antinutritional factor present that has adverse effects on nutrient digestibility in whole soybeans are trypsin inhibitors and phytate (Zhang & Laflamme, 1999). Phytate cannot be inactivated by heating, so mineral availability from soy-based diets must be addressed by other means (Zhang & Laflamme, 1999).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 EXPERIMENTAL SITE

The experiment was carried out in the Rabbit Unit of Federal University Oye Ekiti, Ikole Campus. GPS coordinates; latitude of 7^0 28^0N and longitude 4^0 34^0E.

3.2 EXPERIMENT MATERIALS

Fifteen rabbit of mixed sexes and breeds were obtained within Ado Ekiti, Ekiti State and Ibadan, Oyo State. The rabbits were 4-7weeks old with weight range of 600 to 800g. The rabbits were housed in a wire mesh cage and fed with concrete feeders and drinkers. *Leucaena* leaf meal was harvested within the school premises, soaked for 48hours and sun-dried for 12hours thereafter it was milled and incorporated into the experimental diets with other ingredients. Three diets were formulated at different level (0, 5 and 10%) using *Leucaena* to replace soya bean meal. The rabbits were given a week to adjust to the experimental diets.

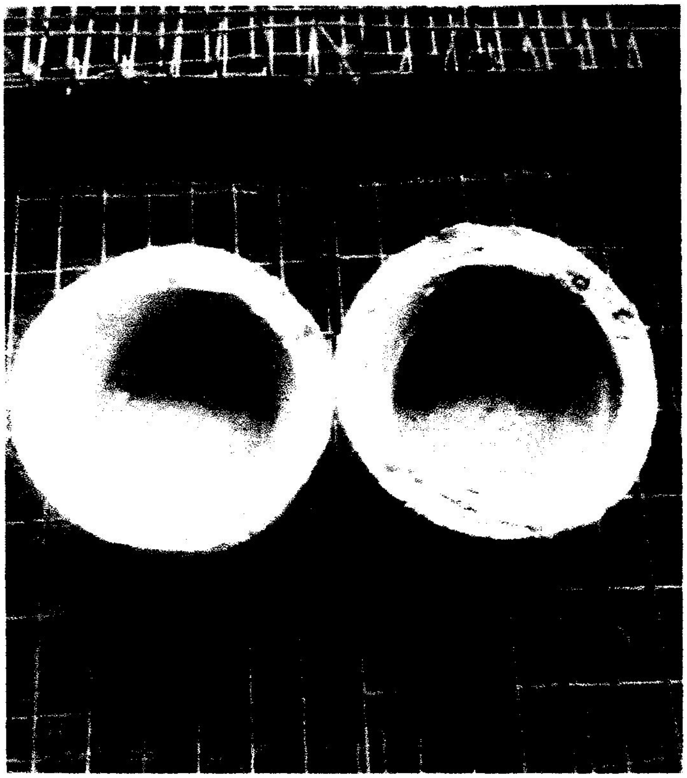

PLATE 1: IMAGE OF FEEDER AND DRINKER

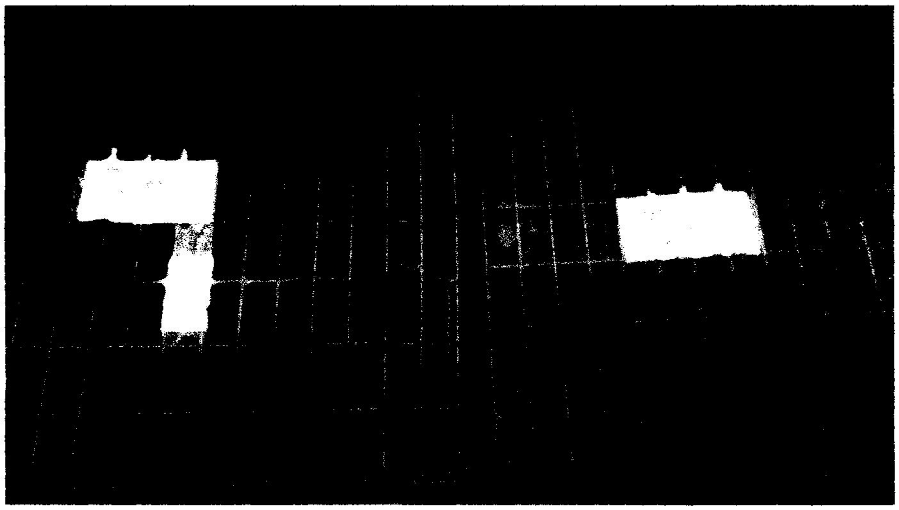

PLATE 2: IMAGE OF RABBIT HOUSE IN A WIRE MESH CAGE

3.3 EXPERIMENTAL PROCEDURE

The rabbits were randomly allocated into three treatments with five rabbits per treatment. A known quantity of the experimental diets was served twice daily at 7.00am and 4.00pm. Clean water was supplied *ad libitum* on daily basis.

The weight of each rabbit was taken before the commencement of the experiment and at weekly interval throughout the period of experiment.

The *Leucaena leucocephala* leaf was harvested into sack and moved into a drum filled with 12 buckets of fresh water, LLM was soaked for 48 hours and change in color of water from crystal clear to light reddish color was observed, the leaves were then sun dried for 12 hours after then it was milled and incorporated into the experimental diet at different level. The quantity of feed consumed by the rabbits was recorded on daily basis.

The animals were housed individually in a wire mesh cage which allow separation of feces and urine. Fecal samples were collected from three rabbit from each treatment, the feces were collected for three days as a collection period; the collection was done each morning before the next daily ration was provided. The samples (feces) were sun dried to prevent deterioration, thereafter the sample collected for different days were bulked together and taken to the laboratory for proximate analyses. The proximate composition of the experimental diets was analyzed in the laboratory. The digestibility of crude protein, crude fibre, ether extract and ash were determined. All results were subjected to statistical analysis using SAS The variation in means were separated using Tukey's honestly significant test

PLATE 3: FEEDING OF RABBIT

3.3.1 PERFORMANCE CHARACTERISTICS

The initial weights of rabbits were taken before the commencement of the experiment and were subsequently taken on a weekly basis. The daily feed intake was estimated by calculating the difference in the feed offered and the left over feeds. The weekly weight gain was estimated by deducing the previous weight from the final weight. Average daily feed intake and weight gained were calculated by diving the total feed intake and weight gained by the number of rabbits.

FEED CONVERSION RATIO

The feed conversion ratio was calculated from the weight gained and feed consumed by rabbits in each treatment. It was expressed with the formula;

$$\text{Feed conversion ratio} = \frac{\textit{Average feed intake per day}}{\textit{Body weight gain per day}}$$

3.3.2 DIGESTIBILITY

Fecal samples were collected for three days from three different rabbits in each treatments, the wet weight of the fecal samples were record, the samples from each rabbit were then bulked on the third day and taken to the laboratory, samples were oven dried at 105^0c until it attained a constant weight. The proximate analysis was determined. The proximate composition of the feed was also determined and apparent nutrient digestibility was calculated using the formula;

$$\text{APPARENT NUTRIENT DIGESTIBILITY} = \frac{intake - output}{intake} \; X\,100$$

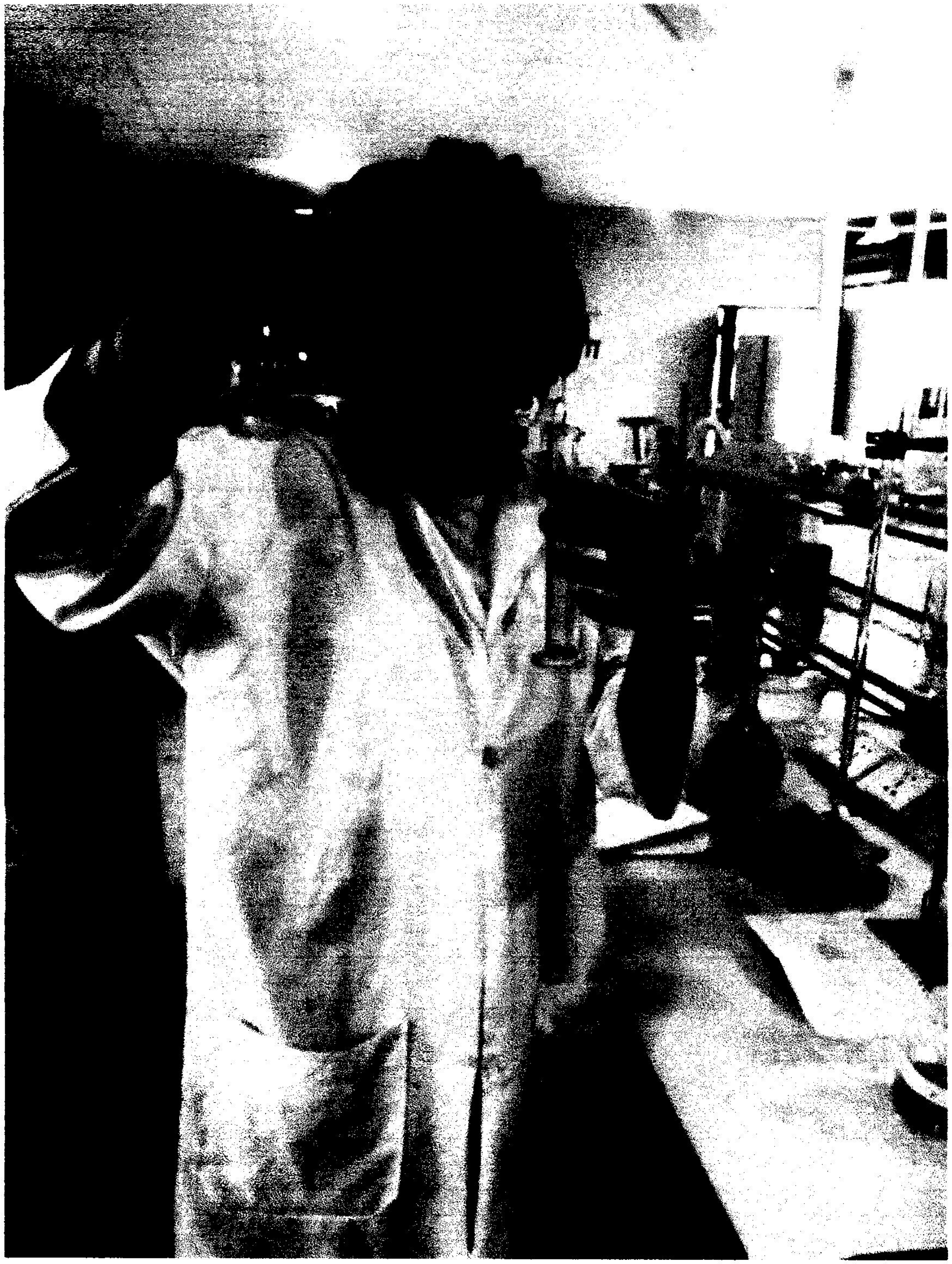

PLATE 4: IMAGE OF PROXIMATE ANALYSIS IN THE LABORATORY

TABLE 3: INGREDIENTS AND CHEMICAL COMPOSITION OF EXPERIMENT DIETS

	PERCENTAGE INCLUSION		
INGREDIENT	T_1 (0%)	T_2 (50%)	T_3 (100%)
Maize	20.00	20.00	20.00
Leucaena leaf	0.00	7.00	14.00
Soyabeans meal	14.00	7.00	0.00
Palm kernel cake	27.00	27.00	27.00
Wheat offal	28.25	28.25	28.25
Rice husk	7.00	7.00	7.00
Oyster shell	1.00	1.00	1.00
Premix	0.25	0.25	0.25
Dicalcium phosphate	2.00	2.00	2.00
Table salt	0.25	0.25	0.25
DL-Methionine	0.15	0.15	0.15
L-lysine	0.10	0.10	0.10
TOTAL	**100**	**100**	**100**
CALCULATED ANALYSIS			
Crude protein	17.62	16.45	15.27
Metabolisable energy	2278	2339	2400
Crude fibre	10.06	10.3	10.59
Ether extract	4.59	4.78	4.96
Calcium	0.9	0.92	0.95
Phosphorus	0.53	0.56	0.58
Lysine	0.39	0.39	0.4
Methionine	1.39	1.35	1.32
Total cost of feed	8987.58	8752.38	8517.18
PROXIMATE ANALYSIS			
Dry matter	85.64	87.79	86.86
Crude protein	16.55	16.5	16.01
Crude fibre	16.45	15.64	14.03
Ash	7.1	6.4	7.3
Ether extract	3.87	4.27	4.1

3.4 EXPERIMENTAL LAYOUT

CAGE ONE

T1R1	**T2R1**	**T3R1**	**T1R2**
T2R2	**T3R2**	**T1R3**	**T2R3**
T3R3	**T1R4**	**T2R4**	**T3R4**

CAGE TWO

T1R5	**T2R5**	**T3R5**

3.5 EXPERIMENTAL DESIGN

Completely randomize design (CRD) was used.

3.6 CHEMICAL ANALYSIS

Proximate analysis was carried out at Animal Science Laboratory in University of Ibadan. The composition of feed and fecal samples were determined using the standard A.O.A.C (2003) procedures to determine dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF) and ash content.

3.7 ANALYTIC METHOD

The digestibility was calculated using the formular;

$$\text{APPARENT NUTRIENT DIGESTIBILITY} = \frac{intake-output}{intake} X\ 100$$

All data were analyzed with using of SAS at 5% significant level and the mean were separated with the use of Tukey's honestly significant test

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

The results of the analysis for growth performance and digestibility were analyzed using SAS and the means were separated using Tukey's Studentized Range (HSD) Test.

4.1 GROWTH PERFORMANCE

The growth performance of the rabbits is presented in table 4. There was no significant difference (P<0.05) among the treatments for feed intake, initial body weight, final body weight, daily weight gains and feed conversion ratio. However, there were significant (P<0.05) difference between the cost of feed intake, treatment one (control; no *Leucaena*) having the highest cost of feed intake with mean of 660.53g followed by treatment two (50% replacement of soybeans with *Leucaena*) with mean of 598.30 and treatment three having the lowest cost of feed intake (100% replacement of soybeans with *Leucaena*) with mean of 523.73. This is in contrary to the work of Adekojo (2014) who fed rabbits with *Leucaena* using different processing techniques (air dried, soaking in fresh water for 36 hours and soaking in 60^{0}C water for 24 hours) and reported that the final body weight, average weight gain, average daily weight gain, average concentrate intake, average daily feed intake and feed conversion ratio were significantly (P<0.05) lower in rabbits fed air-dried *Leucaena leucocephala* leaf meal than other processing methods.

The non-significance difference observed in the parameters (daily weight gain, feed intake, final body weight) could be as a result of combined methods (soaking in fresh water and drying) that was used in processing the LLM before incorporating it into the diet.

The difference in cost of feed intake is due to high cost of soybeans meal resulting from increase in demand because of competition between human and other livestock.

TABLE 4: GROWTH PERFORMANCE OF RABBITS FED WITH *Leucaena leucocephala* LEAF MEAL AT DIFFERENT LEVELS OF REPLACEMENT WITH SOYABEAN MEAL

	TREATMENT				
PARAMETER	**0%**	**50%**	**100%**	**SEM**	**LOS**
Feed intake	6173.5	6244.67	6189.2	4.3	NS
Initial body weight	650.3	678.67	668	11.69	NS
Final body weight	1451.8	1398.3	1264.6	20.73	NS
Weight gain	801.5	719.67	596.6	10.96	NS
Feed conversion ratio	7.83	8.78	10.91	0.16	NS
Gain weight daily (g/rabbit)	16.36	14.69	12.18	0.22	NS
Feed intake (g/day/rabbit)	125.99	127.44	126.31	0.09	NS
Cost of total feed Intake (₦)	660.53[a]	650.66[a]	627.55[b]	0.44	*
Cost of weight gain/Kg (₦)	837.3	915.2	1106.7	16.8	NS

Means in the same row with different superscripts are significantly different at ($P<0.05$)

LOS= Level of significant at ($P<0.05$), NS= No significant difference, *=significant difference

SEM=Standard error of mean

Although there was no significant ($P<0.05$) difference in the body weight gain but the highest value was recorded in T_1 (801.5) and this is as a result of lower value of feed conversion ratio of T_1 compare with other treatments.

TABLE 6: NUTRIENT DIGESTIBILITY OF RABBIT FED WITH *LEUCAENA LEUCOCEPHALA* LEAF MEAL AT DIFFERENT LEVELS OF REPLACEMENT WITH SOYABEANS MEAL

	TREATMENTS				
NUTRIENT	**0%**	**50%**	**100%**	**SEM**	**LOS**
DRY MATTER	64.67	69.67	72.67	2.13	NS
CRUDE PROTEIN	76.00	85.33	88.33	1.83	NS
CRUDE FIBRE	51.67	54.33	56.67	3.76	NS
ETHR EXTRACT	77.67	82.00	82.00	1.81	NS
ASH	34.00	37.00	43.00	6.13	NS

SEM=standard error of mean

LOS= Level of significant at (P<0.05), NS= No significant difference, *=significant difference

4.3 NUTRIENT DIGESTIBILITY

4.3.1 DRY MATTER

The digestibility of proximate components of different diets shown in Table 6 revealed that there was no significant difference in the dry matter (DM) digestibility among the treatment. A means of 64.67, 69.67 and 72.67 forT_1, T_2 and T_3, respectively was observed. Although there are no significant difference in the DM digestibility, an increase was noticed in the coefficient of means with T_3 having the highest value. This is in contrary to the report of Manika *et al.*, (2016) who reported that mimosine in the leaves and especially in the stem of *Leucaena*, reduces the digestibility of dry matter and protein.

4.3.2 CRUDE PROTEIN

The digestibility of crude protein (CP) of the treatments were 76.00, 85.33 and 88.33 for T_1, T_2 and T_3 respectively. There was no significant difference in crude protein digestibility among the treatments as shown in Table 6 but the value of mean increases with an increase in percentage level of *Leucaena,* T_3 (100%) has the highest value with 88.33% followed by T_2 (50%) with 85.33% and the lowest value was recorded in T_3 (100%) with 76.00%, this may be associated to the report of Raharjo *et al.*, 1986 which stated that the digestibility of tropical legumes is general high. The result is in contrary to the report of Manika (2016) who reported that the digestibility of *Leucaena* at 15% level of inclusion is higher than that of 10 and the 10% is higher than the control diet.

The high value of crude protein digestibility in T_3 (100% replacement with LLM) could be as a result of drastic reduction in the mimosine content due to the processing techniques, this agrees with the report of D'Mello who reported that mimosine exerts its toxic action by blocking the metabolic pathways of aromatic amino acids and tryptophan.

4.3.3 CRUDE FIBRE

The digestibility of crude fiber was 51.67, 54.33 and 56.67 for treatment 0, 50% and 100%, respectively. It was observed from table 6 above that there were no significant differences among the treatments.

4.3.4 ETHER EXTRACT

The digestibility obtained for ether extract were 77.67, 82.00 and 82.00 for treatments (0, 50% and 100%) respectively. Significant similarities were recorded with ether extract for all dietary treatments

Different level of replacement had no significant (P>0.05) effect on the digestibility of ash, crude protein, crude fibre and ether extract. This agrees with the findings of Adekojo *et. al.*, 2014 who fed rabbit with different methods of processed *Leucaena leucocephala* leaf meal and reported that different methods of processing had no significant (P>0.05) effect on dry matter, ash and ether extract digestibility, although the crude protein content was significantly (P<0.05) affected by the processing methods. With T_1, (no *Leucaena leucocephala)* having highest value of 84.30% followed by hot water treated sample 82.81%, fermented 82.55%, fresh water treated sample 82.40% and air-dried *Leucaena leucocephala* leaf meal 72.53%.

The result observed in the digestibility of crude protein is in contrary to the work of Adekojo *et al.*, (2014) who reported reduction in digestibility of crude protein for rabbits fed with LLM with different processing technique with the control, (no *Leucaena leucocephala)* having highest value of 84.30% followed by hot water treated sample 82.81%, fermented 82.55%, fresh water treated sample 82.40% and air-dried *Leucaena leucocephala* leaf meal 72.53%.

CHAPTER FIVE

5.0 CONCLUSION

Based on the results of this research, it can be concluded that:

The similarity in digestibility of soyabean meal and *Leucaena leucocephala* by growing rabbit at 50% and 100% replacement levels could be as a result of the combination of two processing techniques (soaking and drying) used on LLM.

Since cost of feed intake for rabbits fed with soyabean is higher than those feed with *Leucaena* and there was no significant difference in digestibility and growth performance both at 50% and 100% replacement, total replacement of soyabean meal with *Leucaena leucocephala* will help farmers to reduce cost of production.

Since there was no difference in the daily weight gain of rabbits fed with soyabean and those fed with LLM it could be concluded that *Leucaena leucocephala* leaf meal can be efficiently utilized by rabbits up to 100% replacement with soybean without adverse effect on growth performance and digestibility when the leaf is subjected to soaking in fresh water for 48 hours and sun drying for 12hours.

5.1 RECOMMENDATIONS

i. The total replacement of soyabean meal (SBM) with *Leucaena leucocephala* leaf meal (LLM) in rabbit feed should be recommended for farmers in other to reduce the cost of production.

ii. The plantation of *Leucaena leucocephala* should be encourage so has to increase it availability.

iii. Research should be geared towards the development of species of *Leucaena* with less anti-nutritional content

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