GROWTH PERFORMANCE OF RED SOKOTO BUCKS FED DRIED AND ENSILED *Leptadenia hastata (Yadiya)* FORAGE IN A TOTAL MIXED RATION IN NORTHERN GUINEA SAVANNAH OF NIGERIA

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN ANIMAL SCIENCE

DEPARTMENT OF ANIMAL SCIENCE

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DECLARATION

I declare that the work in the dissertation entitled **GROWTH PERFORMANCE OF RED SOKOTO BUCKS FED DRIED AND ENSILED *Leptadenia hastata* (*Yadiya)* FORAGE IN TOTAL MIXED RATION IN NORTHERN GUINEA SAVANNAH OF NIGERIA** has been carried out by me in the Department of Animal Science under the supervision of Dr. H.Y Adamu and Dr. M.R. Hassan. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was presented for another degree or diploma at any tertiary institution.

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NAME OF STUDENT **SIGNATURE** **DATE**

CERTIFICATION

This dissertation entitled **"GROWTH PERFORMANCE OF RED SOKOTO BUCKS FED DRIED AND ENSILED *Leptadenia hastata (Yadiya)* FORAGE IN TOTAL MIXED RATION IN NORTHERN GUINEA SAVANNAH OF NIGERIA"** by **MUHAMMAD BUHARI KUDU** meets the requirement governing the award of the degree of master of science of Ahmadu Bello University, Zaria Nigeria and it is approved for contribution to scientific knowledge and literary presentation.

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DEDICATION

This work is dedicated to my Parents Alhaji Muhammad Kudu Gwarji, Hajiya Rahmatu Muhammad and My wife Amina Muhammad (Kamilah) for their immeasurable support and prayers.

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ABSTRACT

The study was conducted to evaluate the growth performance of Red Sokoto Buck fed dried or ensiled *Leptadenia hastata* forage in a Total Mixed Ration at the Department of Animal Science Teaching and Research Farm Ahmadu Bello University, Zaria. A total of 16 Red Sokoto bucks weighing between 12-15±0.5, kg were used for the experiment. The study consisted of four treatments with four animals in each treatment in a Completely Randomized Design (CRD).Treatment I served as the control diet with no *L. hastata* forage, treatment II contained dried *L. hastata* forage, treatment III contained Ensiled *L. hastata* and treatment IV contained a combination of dried and ensiled *L. hastata* (50:50) all in a Total Mixed Ration. The animals were fed 3% of their body weights daily and water was provided *ad-libitum* for a period of ninety (90) days for growth performance, nutrient digestibility, nitrogen balance, heamatological parameters, serum parameters, lipid profile and economic analysis. Results of the growth performance showed that there were significant differences ($P<0.05$) in total weight gain, average daily weight gain, total feed intake, average daily feed intake and feed conversion ratio. However, final weights were not significantly different ($P>0.05$) across the dietary treatments. The digestibility coefficients of diet containing ensiled *L. hastata* had significantly ($P<0.05$) higher dry matter (66.17%), crude protein (83.67%), crude fibre (68.57%), ash (80.77%), ether extract (80.97%) and nitrogen free extract (72.57%) digestibility compared to other treatments. Results of nitrogen balance showed there were significant differences ($P<0.05$) in all the measured parameters across the dietary treatments. Nitrogen intake was higher for bucks fed Ensiled *L. hastata* diet and least for those fed combination (50:50) of dried and Ensiled *L. hastata*. Results of haematological parameters showed there were significant ($P<0.05$) differences in packed cell volume (PCV%), haemoglobin (hbmg/dl), red blood cells ($RBCx10^{12}/L$), white blood cells ($WBCx10^{9}/L$), neutrophils (%), while lymphocytes(%), eosinophil(%), monocyte(%), basophils(%) and mean corpuscular volume(MCV fl) were not different ($P>0.05$) across the treatments. Lipid profile result showed there were significant differences ($P<0.05$) in all the measured parameters across the dietary treatments. High density lipoprotein (HDL) was significantly ($P<0.05$) higher in Red Sokoto bucks fed dried *L. hastata*. Low density lipoprotein (LDL) and tryglycerides were significantly ($P<0.05$) higher in Red Sokoto Bucks fed dried, ensiled and mixtures of *L.hastata*. Lowest cost/Kg gain and higher return on investment was observed in animals fed diet containing ensiled *L. hastata*. It was therefore concluded that *L. hastata* forage had effect on the growth performance, nutrient digestibility, nitrogen balance, haematological parameters and lipid profile of Red Sokoto Bucks. It was also observed that addition of *L. hastata* forage in diets of Red Sokoto bucks is cost effective

CHAPTER ONE

1.0 INTRODUCTION

Small ruminants form an integral part of the livestock economy in Nigeria. The arid and semi arid areas are home to over 80% of small ruminants and their sustenance is reducing due to dependence on natural pastures (Kosgey *et al*., 2008). They support 46-58% of pastoral households and play a significant role in the food chain and overall livelihoods of rural households, where they are largely the property of women and their children (Lebbie, 2004). There is a seasonal variation in availability of natural pasture; pasture tends to be more succulent, highly nutritious and more abundant in the rainy season as opposed to dry season where they become fibrous, scarce and devoid of most essential nutrients such as protein, energy, minerals and vitamins which are required for increased rumen microbial fermentation that will result in the production of volatile fatty acids and consequently performance of host animal in the area of maintenance, production and reproduction (Sowande, 2004; Lamidi, 2009).

Wild plants play an important role in the diet of most rural dwellers in Nigeria. These plants tend to be drought resistant and are gathered both in times of plenty as well as times of need. Throughout the year, the plants play an important role in supplying nutrients and calories especially during the dry season when cultivated vegetables are scarce. (Freiberger *et al*, 1998). *Leptadenia hastata* called 'yadiya' in Hausa language is a drought resistant uncultivated forage belonging to the family Asclepiadaceae, The leaves are abundant and fresh all season (Aliero *et al*., 2001). Fresh leaves of *Leptadenia hastata* (Decne) contain 10.86% crude protein, 4.7% crude fibre, 8.18% Ether extracts and energy value of 226KJ (54Kcal) (Leung *et al.* 1968 and Hassan *et al.*, 2007) The dried leaves contain 8.79% crude protein, 38.37% crude fibre, 1.39% ether

extracts (Inuwa 2013). Like any other forage in the tropics, *Leptadenia hastata* contain some metabolite including tannin, saponins, glucosides and alkaloid (Hassan *et al.,* 2007 and Inuwa 2013). Drying has been used traditionally as a method of preserving leafy vegetables in Nigeria and other developing countries. In Nigeria one of such plants vegetables is of *Leptadenia hastata.* (Hassan *et al.,* 2007). Forages preserved through fermentation are used to provide feed for ruminant animals. Ensiled feedstuff totaled 132 million tonnes in the US (NASS 2007). Ensiling is one of the methods of forage conservation practiced in livestock production systems, although it is not a common practice among the livestock producers in Nigeria (Kallah 1997). Fermentation or ensiling has been reported as a viable option for preservation of surplus forage during the growing season when yield and nutritional values are optimal. Silage can be used at any period of the season when it is required, more especially during the period of scarcity (Khanderker and Uddin, 2013) Increasing trend of intensification of livestock production in Nigeria suggest the need for development of feed conservation strategies which allows for stuck - piling fodders at the time of abundance for use at the time of its shortage period (dry season). This will redistribute the feed supply over the year to meet the requirement of livestock resources. (Muhammad *et al.,* 2009) According to Oyawoye *et al.* (1998) and Ewuola *et al.* (2004) Haematological and biochemical indices are influenced by the quantity and quality of feed as well as the level of toxins or metabolites present in the feed. Drying and fermenting have proven to be effective in reducing these metabolites in plants. Wiktorsson (2002) reported that fermentation contributes to some extent in reducing deleterious effect forage leaves by up to 70%.

1.1 Justification of the Study

The problem of dry season feed and feeding has been recognized as a limiting factor to a successful ruminant production enterprise in Nigeria due to poor nourishment of the animals during the dry season which eventually results to drop in animal performance in terms of growth, work, maintenance, production and reproduction (Darrag, 1995).

Feed costs about 60-70% of cost of livestock production (Akinmutimi *et al.,* 2001). This necessitates searching for cheap and readily available feed source. Legume browse plants such as *Leptadenia hastata* are novel feed materials that can be used to augment feed scarcity during off season. *Leptadenia hastata* leaf has complementary nutrient composition that could be harnessed in the reduction of feed cost in ruminant feeding. They are rich in crude protein (10.86%), low in crude fibre (4.7%), ether extracts (8.18%) and energy value of 226KJ (54Kcal), (Leung *et al.* 1968 and Hassan *et al.* 2007). However, the utilization of these browse materials is often limited by the presence of anti-nutrients. Anti-nutrient are polyphenolic compounds that interfere with the use of nutrients by the animals leading to growth retardation and other deleterious effects on the animal. To neuter the negative effects of these compounds there is therefore the need for processing. Processing reduces the level of anti-nutrients in these plants to a level that is tolerable by the animal, thus guaranteeing nutrient utilization for optimum growth and production. Generally, processing of forage materials improve the quality a great deal and also aids in it utilization by animals. (Shinelis *et al.,* 2013). This justifies the need to process *Leptadenia hastata* forage using drying and fermentation methods.

1.2 Objectives of the Study

- ✓ To evaluate performance, nutrient digestibility of Red Sokoto Bucks fed dried or Ensiled *Leptadenia hastata* forage.
- ✓ To evaluate the profile of major blood, serum and lipid constituents of RSB fed dried or Ensiled *L. hastate.*
- ✓ To evaluate the cost effectiveness of feeding dried or Ensiled *Leptadenia hastata* forage in Total Mixed Ration to Red Sokoto Bucks.

1.3 Hypotheses

Ho_1: Feeding dried or Ensiled *Leptadenia hastata* forage in a Total Mixed Ration has no effect on growth performance, nutrient digestibility, nitrogen balance, haematological parameters and lipid profile in Red Sokoto Bucks.

H_{A_1}: Feeding dried or Ensiled *Leptadenia hastata* forage in Total Mixed Ration has effect on growth performance, nutrient digestibility, nitrogen balance, haematological parameters and lipid profile in Red Sokoto Bucks.

Ho_2: Feeding dried or Ensiled *Leptadenia hastata* forage in Total Mixed Ration is not cost effective.

H_{A_2}: Feeding dried or Ensiled *Leptadenia hastata* forage in Total Mixed Ration is cost effective.

CHAPTER TWO

2.0 REVIEW OF LITERATURE

2.1 Small Ruminant Production in Nigeria

2.1.1 Population of Small Ruminants

The world total number of goats and sheep were estimated to be 861.9 and 1078.2 million, respectively, i.e. there is about one goat to approximately 1.25 sheep in the world (FAOSTAT, 2008). The largest number of goats and sheep was observed in Asia, representing about 59.7% goats and 42% sheep. Africa, with 33.8% goats and 26.7% sheep was the second largest producer of small ruminants. Nigeria was fifth of the ten leading countries of the world in small ruminant production with a population of 53.8 million goats and 33.9 million sheep (FAOSTAT, 2008).Sheep andgoats represent about63.7% of total grazing domestic animals in Nigeria (Gefu, 2002).

2.1.2 Breeds and Distribution of Small Ruminant in Nigeria

2.1.3 Balami

According to Blench (1999), Balami is the largest bodied native sheep in Nigeria. It is confined to the semi-arid north, but it is favoured as a stall-fed breed by Muslims throughout the Nigerian Middle Belt (Blench, 1999). It is white and hairy with pendulous ears and along thin tail; rams have a throat ruff and are horned but ewes are normally polled. Another feature that makes the Balami distinctly recognisable is its large bulbous nose that distinguishes it from the Yankasa. Balami is a widespread breed in the northern region of the country (Buvanendran and Adu, 1990). It has good potential as a meat producer. Balami is fast growing and attains a weaning

weight of 18kg in 12 weeks. The weight of mature males ranges from 45 to 60kg while that of female between 35 and 40kg. The milk yield per lactation ranges between 28 and 33kg in 70days (Adu and Ngere, 1979).

2.1.4 Uda

The Uda is slightly smaller-bodied than the Balami, although their size ranges overlap. It is easily recognised by a distinctive coat colour pattern; entirely brown or black forequarters and white behind (Oni, 2002). It is a widespread breed in the northern region of the country. It is dominant in North Western Nigeria with its crosses found in the North East and Central Nigeria (Oni, 2002).The rams have large wide and spiral horns, which are usually absent in the ewes. The breed appears to thrive in hot, dry environment and suffers from poor survival outside this ecological zone; it is particularly adapted to extensive grazing and is renowned for its trekking abilities. Mature weights range from 35 - 45kg for ewes and 45 – 55kg for rams. Milk yield per lactation lies between 32 and 36kg for an average actation length of 91 days (Adu and Ngere, 1979).

2.1.5 Yankasa

The Yankasa is a meat breed of sheep found in the North and North Central Nigeria. It is a white bodied sheep with black patches around the eyes and sometimes on the feet. The muzzle and ears are usually black too. Rams have curved horns and a hairy white mane, while ewes are polled (Mason,1996).Yankasa sheep have been recorded in all parts of Nigeria, though the populations attenuate towards the northern border and the sea-coast (Aganga *et al.,* 1988). It is the most numerous and most widely distributed of the Nigerian breeds of Sheep and is found throughout the Guinea and Sudan Savannah zones (Osinowo *et al.,* 1985; Wamagi *et al.,* 2013).Mature

females could weigh 25 to 40kg while male weighs between 35 and 50kg. The milk yield (kg) per lactation is between 30 and 56kg and has a lactation length of 91 days.

2.1.6 West African Dwarf Sheep (WAD)

The West African Dwarf is a small-bodied, compact breed which may be all white, black, brown, or spotted black or brown on a white coat. Its variation in colour and patchy distribution make it difficult to distinguish clearly from the Yankasa (Charray *et al.*,1992).The West African Dwarf is the predominant breed of the humid tropics from Southern West Africa through Central Africa(Mason,1988). In Nigeria, The WAD sheep is common to Southern region of the country (Wamagi *et al.,* 2013). The breed is relatively smaller and lighter. The rams have a well-developed throat ruff and are horned. The horns are wide at the base, curve backwards, outwards and then forwards again, with a maximum of one and a half coils (Wilson, 1991*)*.They weigh between 25 to 35kg (Charray *et al.*,1992). The females are usually polled, but may have slender short horns. Mature ewes weigh between 20 to 30kg.They can be bred at the age of 7 to 8 months. They tend to have a short lambing interval. The prolificacy of adult ewes is low to moderate ranging from 1.15 to 1.50 lambs per lambing. At less than 100 g per day under good feed conditions, their growth rate is low and lamb mortality is high (Mason, 1988). This breed is also trypano tolerant (Charray *et al.,* 1992).

2.1.7 West African Dwarf Goat (WAD)

West African Dwarf (WAD) goat is common to Southern Nigeria (Wilson 1991).This breed is markedly stunted and has a typical height at withers 30 to 50 cm. Adult males weigh 20 to 25 kg and females 18 to 22 kg. Both sexes have horns, which curve outwards and backwards in males. Males have beards, and manes. The neck is relatively long the chest is broad and the back

straight. The legs are short and the udder is small but usually well-shaped. Most types have short stiff hair, and the colour varies; dark brown with black points is probably the most common, but black, red, white, pied and multi-coloured goats also occur (Wilson, 1991). West African Dwarf goats are capable of breeding at twelve to eighteen months. Multiple births are very common with twins being normal and triplets frequent. The kidding interval averages about 220 days. Growth rate and milk yield of this breed is very low; it is kept for meat production. The breed is well adapted to humid environment and very resistant to trypanosomosis (Ozung *et al.,* 2011; Chiejina *et al.,* 2015).

2.1.8 Sahelian Goat

The Sahelian or Desert goat is found along the northern border of Nigeria, particularly in Borno. This goat is believed by the Hausa/Fulanis who are the original custodian of the breed to have originally come from the dry lands of Niger (Otoikhian, 2012). However, some literatures have traced its origin to Switzerland but came into Nigeria via Niger and Chad Republic (Moruppa and Ngere, 1986). It is a dual purpose breed kept for meat and dairy products. The Sahelian goats have the ability to breed out of season and are excellent range animals because of their long limbs. In addition, they are usually characterised as being very hardy, able to survive and thrive under adverse agro climatic conditions with only limited management input (Ngere *et al.,* 1984., Morupa and Ngere, 1986). In Nigeria, this goat is generally the breed preferred by pastoralists (Mason, 1988).

2.1.9 Red Sokoto Goats

The Red Sokoto, Kano Brown or Maradi goats are found in Nigeria and Niger (Ozung *et al.,* 2011). Within the indigenous breeds of goats kept for meat production in Nigeria, Red Sokoto

goat is the most numerous and most widely distributed throughout the various ecological zones, particularly Guinea and Sudan savannah vegetation belt (Ibrahim *et al.,* 2014). It measure between 55 – 60cm height at withers with an average mature live weight of 25kg (Otoikhian, 2012). Red Sokoto is a large, fast growing, early - maturing meat breed (Ebozoje, 1992). It is a small fine goat famous for its skin (Ozung *et al.,* 2011). The skin of Red Sokoto is known for its superior quality and the premium it commands in the world market (Otoikhian, 2012).Red Sokoto was the source of "Morocco leather" known in Europe from the medieval period onwards (Blench, 1999). This breed is a good dairy animal which produces a daily milk yield of 0.5 to 1.5kg and 100 days of lactation (Gall, 1996).

2.2.0 Small Ruminant Production System in Nigeria

2.2.1 Pastoral System

Small ruminants in Nigeria are managed under pastoral, agro-pastoral and peri-urban systems. Pastoralism is defined to mean a situation whereby people herd animals to sustain their livelihoods (Bhasin, 2011). Pastoralists are mainly livestock producers who do not grow crops and therefore depend on the sales of live animals and dairy products to buy grains, other food items and other necessities (Aregheore, 2009). Pastoral agriculture is an integral part of rural economy as livestock serve as a source of cash to the family thereby preventing social depression which arises as a result of lack of financial resources. Grazing livestock remains an important asset to livelihoods, especially for people of dry region (Dick *et al.*, 2010). According to Blench (1999), most pastoralists may move very long distances every year. It is a popular assumption that they wander from place to place without any logic; in general they have set migration routes and often long-standing arrangements with farmers to make use of their crop residues. It is only

when there is drought, a failure of the pasture or the spread of diseases that they diverge from their existing patterns.

2.2.2 Agro-pastoral system

This is mixture of crop- livestock system of pastoral farming (Sanni *et al.,* 2004; Ahmed and Egwu, 2014).According to Aregheore (2009), the system is made up of semi-settled pastoralists and they are found in many parts of Northern Nigeria. They cultivate areas sufficient to feed their families from their own cereal production. They hold land rights, use their own or hired labour to cultivate land and grow crops such as yams and cassava in addition to the staple cereals such as sorghum, millet and maize. Sheep and goats are efficiently reared on marginal lands and are good users of crop residues (Fakoya, 2002; Sanni *et al.,* 2004). As such, they provide the only practical means of using vast areas of natural grasslands in regions, where crop production is almost impracticable (Ngatezie, 1989; Rege, 2001). In the system, the average herd of livestock is small compared to other pastoral systems, because they no longer rely solely on livestock and the finite grazing area around their environs that can be reached in a day will limit herd size. Most agro-pastoralists have preferences for particular breeds (Blench, 1999; Aregheore, 2009). The agro-pastoral farmers utilize extensive and semi-intensive management systems (Ajala and Gefu, 2003; Mbilu, 2007).

2.2.3 Peri-urban and modern ruminant livestock husbandry

According to Aregheore (2009), this system could be referred to as the commercial or intensive production system. Wealthy urban businessmen, wealthy Fulani and government officials practise this system. These types of farms which were found only on the periphery of major towns in northern and central Nigeria are also found today in the south of the country. The rich

individuals who own these farms capitalize on the potential of animals as investment, source of milk and meat for their family and also a status symbol. In this system, a farmer may decide to have only cattle or cattle with small ruminants inclusive. Trained personnel are hired and expected routine management practices carried out in most modern ranching operations are also seen in these farmers. In this type of intensive production system the use of crop residues andagricultural by-products are effectively and economically combined with grazing (Blench, 1999; Aregheore, 2009).

2.3.0 The significance of goats to National livestock economy

The contribution of the livestock sector to the agricultural gross domestic product in Nigeria is 49% (Amadou *et al.,* 2012). The importance of goats in Nigerian livestock economy can be attributed to its value for meat, milk and leather, primary use being for meat production. In Nigeria, livestock provides about 36.5% of total protein intake (NISER/CBN, 1991). Goats contribute about 24% of Nigerian meat supply (Oni, 2002). Goat meat has low saturated fatty acids and cholesterol compared to other red meats (Devendra, 1988).A diet rich in non-saturated fatty acids is correlated with a reduced risk of stroke and coronary diseases. Hence, the American Heart Association reported that molecular structure of goat meat is different and as a result goat meat is more easily digested (Jamal, 2007). In the rural areas, the value of goat is far greater and it is usually appreciated, being often the most-readily available source of meat.

In addition, goat milk with its special attributes is very valuable to the rural populace. The uniqueness of goat milk, yoghurt and cheese in human nutrition has several aspects. Goat milk can be used for the treatment of direct or indirect cow milk allergy (Grezesiak, 1989). Goat milk has predominantly smaller fat globules compare to cow’s milk and it is more easily digested

(Fevrier *et al*., 1993).The essential amino acids of goat milk are slightly in excess of infant requirement (Ochepo and Momoh, 2010). Goat milk has higher medicinal value, high vitamin B content and high digestibility, which makes it helpful in relieving stress and constipation (James *et al.,* 2005).Hence, goat milk is a valuable alternative not just for babies, but also for adults and especially nursing mothers (Baldo, 1984; Host *et al*., 1988).

Goat skin although is consumed as meat in some parts of the country, is very useful by product with a significant export trade; the skin of the Red Sokoto breed for example is known for its superior quality and the premium it commands in the world market (Otoikhian, 2012). 'Emergency cash source' has been reported as the major motivating factor for ruminant production as it serves as 'savings account' for their keepers (Adesehinwa, 2004). The contributions of goats to the people and economies of Nigeria is very much underestimated, basically because their production is considered as small in scale, and goat products seldom enter a formal marketing system. For these reasons, goats are accorded a low status and given a low priority in national development in most African countries.

2.4.0 Nutrient Requirement of Goats

2.4.1 Energy requirement

Meeting nutrient requirements of any class of livestock is essential for effective and efficient performance. Many factors affect the nutritional requirements of small ruminants: maintenance, growth, pregnancy, lactation, fiber production, activity and Environment (Martinez Marin *et al.,* 2012). Goats require water, energy, protein, vitamins, and minerals to sustain life, produce and reproduce. Energy is supplied in the ration through hay and concentrates mix (Alemu, 2010). As a general rule of thumb, sheep and goats will consume 2 to 4 percent of their body weight on a

dry matter basis in feed. The exact percentage varies according to the size (weight) of the animal, with smaller animals needing a higher intake (percentage-wise) to maintain their weight. Dry matter intake needed to meet the energy requirements is determined by the physiological stage and depends on the energy density of the diet (Martinez *et al.*, 2012). Dry matter intake is limited by the capacity of the digestive system and is determined by the size of the abdominal cavity, also it depends on the volume of the diet, which can be related to its neutral detergent fibre (NDF) content (Williams *et al.*,1989). Daily dry matter intake of young goats at ages of 90, 240 and 350 days old has been reported by Sulton *et al* (2000) to be 0.4, 0.7 and 0.9 kg respectively for long hay. While for chopped hay, it was 0.8, 1.3, and 1.4 respectively. Hence, animals will take more feed if its volume is decreased.

Understanding energy requirements for goats is important to the rational design of animal production systems so as to provide balanced diets that precisely meet the needs of the animals (Medeiros *et al.*, 2014). A still widely used publication on nutrient requirements of goats was published by the US National Research Council (NRC, 1981). Maintenance requirements increase as the level of the animals' activity increases. For example, a sheep or goat that has to travel a farther distance for feed and water will have a higher maintenance requirement than animals in a feed lot. Environmental conditions also affect maintenance requirements. In cold and severe weather, sheep and goats require more feed to maintain body heat. The ME content of the feedstuff is calculated from the total digestible nutrients (TDN) content using the relationship: 1kg TDN = 18.37 MJ DE = 15.06 MJ ME. The TDN content is calculated from regression equations or digestible coefficient applicable to crude protein (CP), crude fibre (CF), crude fat and nitrogen free extractives. The minimum and maximum TDN for mature Does is 53 and 66% respectively. While for growing kids it varies respectively from 67 and 86% (NRC,

2007). Maintenance requirement of goat according to NRC (2007) is 4.44 MJ ME/day. Dry matter intake of growing goats reaches a physiological limit when the metabolizable energy (ME) content of the diet is about 12.55MJ/kg DM. Lu and Potchoiba (1990) supplied three complete pelleted diets, which had increasing levels of ME (10.29, 11.59, and 12.76 MJ/kg DM), to goats between 4 and 8 months old, and they observed that DMI decreased none linearly with increasing ME concentration: the intake decreased by 124g/d when dietary ME content increased from 10.29 to 11.59 MJ/kg DM; but increasing dietary ME content from 11.59 to 12.76 MJ/kg, decreased the intake by 326g/d.

The energy ingested by animals during their growing period is an important factor of their growth capacity. The NRC (1981) indicated an energy requirement for weight gain to be equal to 30.3KJ ME/g gain. Lu *et al.* (1987) reported that the growth requirement of Alpine and Nubian young goats within 4 – 8 months of age was equal to 37.7, 59 and 57.4 KJME/g gain, respectively, for animals fed diets with 12.8, 11.6 and 10.3 MJ ME/kg dry matter.

2.4.2 Protein requirement

Protein is the most expensive feed ingredient for livestock, and a clear understanding of the protein requirements of animals can be valuable for reducing cost and ensuring farm profitability (Dengand Zhang, 2015). Animals require a considerable amount of protein because their bodies and products (meat, milk) are composed of high levels of protein. The minimum protein requirements for ruminants range from 10-12% (ARC, 1985).The most recent protein evaluation systems for goats are INRA (2007) and NRC (2007). INRA (2007) expresses the protein supply and requirements as protein truly digested in the small intestine.

The results obtained by Negesse *et al.* (2001) in post weaned goat kids show that inadequate or excessive inclusion of CP in the diet results in inefficient use of nitrogen intake. In that respect, both INRA (2007) and NRC (2007) took into account the negative effect of inadequate available nitrogen in relation to energy on ruminal digestion. NRC (2007) recommended that the relationship of protein digested in the small intestine (DIP) and TDN (DIP: TDN) should be higher than 0.09 for adequate use of nitrogen intake. This recommendation is based on the works of Prieto *et al.*(2000) and Soto-Navarro *et al.*(2004). Prieto *et al.* (2000) observed satisfactory ADG of whether goats between 4 and 12 months old offered a 70% concentrate diet with 14% CP and a DIP: TDN ratio equal to 0.115. In yearling wether goats offered a maize based diet, Soto-Navarro *et al.*(2003) found that a 9-10% CP content and a DIP:TDN ratio equal to 0.073 was enough to maximize microbial protein synthesis, though organic matter digestibility increased when the CP content and the DIP:TDN ratio was 11.5% and 0.104 or 13.5% and 0.114. Soto-Navarro *et al.*(2004) observed satisfactory ADG of wether goats between 7 and 14 months old offered a 70% concentrate diet with 13% CP and a DIP: TDN ratio equal to 0.09.

2.4.3 Mineral requirement

Many minerals are required by small ruminants. The most important are, calcium, and phosphorus. The maximum content of Ca and P in the diet recommended by NRC (2005) is 1.5 and 0.6% DM, respectively. The requirements of Ca and P are interrelated, but the tolerable limits of the Ca:P ratio are large. ARC (1980) and NRC (1981) recommended a minimum limit of 1:1 and 1.2:1, respectively, while the maximum recommended limit is 7:1 (ARC, 1980, NRC, 1980). Liesegang and Risteli (2005) found no differences in bone characteristics of 8-month old goats fed diets with adequate levels of P and Ca : P ratios of 1.5:1 and 4:1. Moreover, Mejia-

Haro *et al.*(2001) found no differences in the apparent absorption and retention of P in 6-month old lambs fed a diet slightly deficient in P and Ca : P ratios of 2.5:1.5, 6:1 and 9:1.

However, Boxebeld *et al.* (1983) observed in 6-month old lambs fed semi purified diets that the negative effects of a P marginal deficiency (decreased phosphatemia and DMI) got worse when Ca was supplied to get a Ca: P ratio equal to 9.1:1. Also, Zahari *et al.* (1990) observed in wether lambs grown from 25 to 50 kg BW that a Ca: P ratio of 3.6:1 had a negative effect on intake and growth rate when P was supplied at 0.75 times its requirement. All these references suggest that the proposed Ca: P ratio limits are acceptable if the minimum requirement of the companion mineral is met. In that respect, studies with 3-month old lambs have shown no negative effects when the diet supplies adequate P but Ca is in excess (Ca:Pratio equal to 5.4:1; Rajaratne *et al.*,1990), or when the diet supplies adequate Ca but P is in excess (Ca:P ratioequal to 0.5:1; Wan Zahari *et al.*,1994).The ratio of calcium to phosphorus should be kept around 2:1 to prevent urinary calculi.

2.4.4 Source of Nitrogen for Rumen Metabolism

In ruminant nutrition, leguminous forages and their grains are mainly used as protein supplements (Cutrignelli *et al.,* 2011). The proteins of legume grain are highly degradable in the rumen and digestible in the intestine. Protein rich leguminous forages are not widely grown in many areas grazed by ruminants, and vegetable protein supplements are usually expensive or unavailable (Cutrignelli *et al.,* 2011). However, ruminants can utilize all nitrogen compounds unlike non-ruminants which can digest only real proteins and use only them in their body (Burgstaller, 1983).Feeding grass, fodder and concentrates of low nutritive value does not always meet the nutritional needs of ruminants; hence they should be supplemented with suitable

alternative feed resources. One of such alternative feed resources is the use of non-protein nitrogen (NPN) compounds (Yilkal and Negassie, 2015). Non-protein nitrogen (NPN) is a term used in animal nutrition to refer collectively to components such as urea, biuret, uric acid and a number of other ammonia compounds which are not proteins but can be converted into proteins by microbes in the ruminant stomach (Yilkal and Negassie, 2015). A portion of nitrogen in feeds for ruminants may be provided in the form of simple nitrogen compounds (NPN) that are degraded in the rumen to release ammonia (NH_3), which is used by rumen microorganisms to produce amino acids (Nadeem *et al*., 2014). Sources of NPN for ruminants include Urea, Biuret, Poultry litter, ammonia hydroxide (Yilkal and Negassie, 2015) and urea-N recycled back to the rumen via saliva (Reynolds and Kristensen, 2008).

2.5.0 Origin and geographical distribution of *L. hastata* Forage

Leptadenia hastata, commonly known as "Yadiya" in Hausa language is an edible non-domesticated herbaceous vegetable that is widely distributed in Tropical Africa; from Mauritania and Senegal eastwards to Cameroun, Ethiopia, Northern Kenya and to Uganda. It is however cultivated in Ethiopia, (Thomas 2012).

2.5.1 General Description of *Leptadenia hastata*

2.5.2 Classification of *Leptadenia hastata*

Kingdom	plantae
Class	Magnoliopsida
Order	Gentiananae
Family	Apocynacae
Genus	Leptadenia
Specie	hastata

Other names: Akamongot, Avara (Common name), Ya*d*iya, (Hausa).

Leptadenia hastata (*L. hastata*) is a perennial liana species of the Apocynaceae family that includes the subfamily Asclepediaceae, (Meve and Liede, 2004). The genus *Leptadenia* R. Brown comprises 4 species: *L. arborea* (Forssk.) Schweinf., *L. madagascariensis* Decne., *L. hastata* (Pers.) Decne. and *L. pyrotechnica* (Forssk.) Decne. *L. arborea* is a slender liana of scrub vegetation, distributed from West Africa to Arabia in Sahelian areas (Sanogo *et al.*, 2011). It provides excellent forage for all livestock and is recognized to have medicinal properties (El-Hassan *et al.*, 2003). *L. pyrotechnica* is an erect leafless shrub which grows on sand dunes and is widespread from Senegal to India. The latex and seeds of this shrub are of medicinal value and young shoots are used as vegetable (Endress *et al.*, 2007). *L. madagascariensis* is an endemic liana from Madagascar dry forests, where its mature leaves serve as fodder for lemurs and also used for medicine purposes

Asclepiadaceae plants are widely used in traditional medicine and have been reported to be rich in steroidal glycosides, cardenolides, flavonoids, triterpenes and polyoxypregnane derivatives, (Bazzaz and Haririzadeh 2003).

Leptadenia hastata is an important emergent local food of Africa with the ability to grow under harsh environmental conditions, (Sena *et al.*,1998). Many studies have revealed the potential of *L. hastata* for different uses (Freigberger *et al*., 1998). It is worth to be noticed that hormone-like activities of *L. hastata* have been reported in response to the administration of its extracts with regard to the weight of reproductive organs, spermatogenesis and testosterone levels (Bayala *et al.,* 2011).

2.5.3 Chemical component of *L. hastata:*

L. hastata is characterized by significant quantities of a variety of essential nutrients (Friegberger *et al.,* 1998). Justifying its important role as nutriment Fatty acids, vitamin E, carotenoids, selected minerals and amino acids have been also determined in the leaves of *L. hastata,* particularly rich in lutein and beta-carotene (Bayala *et al*., 2011). So far, it is distinguished by the presence of terpenoids and saponins since the phytochemical data are rather limited. There is only a small number of studies related to the isolation and identification of secondary metabolites from *L. hastata*.

2.5.4 Medicinal uses of *Leptadenia hastata*

In veterinary medicine, *L. hastata* is used to treat horse's colic. In addition, antibacterial and antimicrobial effects of *L. hastata* have been reported (Aliero *et al*., 2009). Safety studies revealed no acute toxicity from *L. hastata* water extract suggesting that use of the plant is relatively safe (Tamboura *et al*., 2005).

L. hastata is well known to be a good source of triterpenes. Triterpenes are a huge class of chemical compounds produced by arrangement of squalene epoxide in a chair-chair-chair-boat arrangement followed by condensation. As cholesterol does in animal cell membranes, free triterpenes can stabilize phospholipid bilayers in plant cell membranes. One triterpene which has gained wide attention of medical professionals, pharmaceutical marketers and researchers all around the world, is Lupeol. Lupeol was isolated from the latex of *L. hastata* for tests on anti-inflammatory activities (Nikiema *et al*., 2001).

2.5.5 Traditional medicinal uses

Various parts or constituents of *L. hastata* have been described for the application in traditional medicinal applications. The latex is applied on wounds and put in the nose against headache. Decoctions and macerations of roots and leaves are applied both, alone or in combination with other plants against abdominal complaints such as constipation, urethral discharge, gonorrhoea, stomachache and diarrhea (Aliero *et al.,* 2001). An extract of boiled leaves and stem is drunk regularly to treat dyspepsia and hemorrhoids. Ethno botanical information from traditional medical practitioners in northern Nigeria revealed that *L. hastata* aqueous extracts are used for the treatment of diabetes mellitus (Bello *et al.,* 2011).

The plant is used in herbal medicine against milk drying, sexual impotence, trypanosomosis and acute rhinopharyngitis (Neuwinger 1996). The leaves are often chewed by shepherds against polydipsia and mouth dryness to treat nausea. Three soup spoons full of a decoction are taken which is prepared from two handfuls of fresh leaves and boiling in about 500 ml of water until the fluid is reduced to half (Olivier 1986).

In Mali, traditional healers treat onchocerciasis with *L. hastata* leaves decoction and *Erythrina senegalensis* bark (Togola *et al.*, 2008). The roots are taken against scabies in Chad and In Nigeria, the leaves of *L. hastata* are boiled and the liquor is taken for treating gonorrhea. "Hausa tribe in Northern Nigeria uses this liquor to cure stomach-ache in children (Aliero *et al.*, 2001). Also in Nigeria, local healers use the plant for hypertension, catarrh and skin diseases (Danbatta and Aliyu 2011). The sap or the root in decoction is used for ophthalmia in Senegal. In association with other plants, it is used in Senegal for suckling babies with green diarrhoea, Senegalese healers also use the *L. hastata* for prostate and rheumatism complaints (Mathieu and Meissa 2007).The bark of *L. hastata* plant is used as an anti-inflammatory and antitumor drug in Senegalese folk medicine (Adjanohoun, 1989).

2.5.6 Nutritive Value of *Leptadenia hastata*

Leptadenia hastata called 'yadiya' in Hausa language is drought resistant uncultivated forage belonging to the family Asclepiadaceae; the leaves are more abundant and fresh all season (Aliero *et al*. 2001). Fresh leaves of *L. hastata* contain 10.86% crude protein, 4.7% crude fibre, 8.18% Ether extracts and energy value of 226KJ (54Kcal) (Leung *et al*., 1968 and Hassan *et al.*, 2007) The dried leaves contain 8.79% crude protein, 38.37% crude fibre, 1.39% ether extracts (Inuwa 2013). *L. hastata* is a good source of calcium. A concentration of 94,325.00 mg/kg magnesium was found in the leaves of *L. hastata*. The concentration of zinc determined in the leaves of *L. hastata* was found to be 53.00 mg/kg which plays an essential role in polynucleotide transcription and translation as well as in the process of genetic expression (WHO/FAO 2001).

The high level of iron in the leaves of *Leptadenia hastata* shows that it could help in boosting blood level in anaemic conditions ((NRC 1989). The value of copper determined (12.80 mg/kg) was found to be higher than the recommended dietary allowance (RDA) value (1.50-3.00 mg) for

male adults (Lintas 1992). Copper is important in diet since it is a very powerful pre-oxidant and catalyses the oxidation of unsaturated fats and oils as well as ascorbic acid.

2.5.7 Factors Influencing Nutritional Quality of *Leptadenia hastata*

Like any other forage in the tropics, *Leptadenia hastata* contains some secondary plant metabolites including tannin, saponins, glucosides, and alkaloids (Hassan *et al.,* 2007 and Inuwa, 2013). *L. hastata* has shown to contain trypsin inhibitors.

Antinutrients are characterised or engineered to meddle with the assimilation of supplements

2.6.0 Effects of Anti Nutritional Factors in Animal Nutrition

The potential uses of tree leaves as supplements to ruminants is often limited by the presence of anti-nutritional factors that might affect the availability of nutrients, palatability and feed intake (Reed *et al*. 1990; Reed, 1995; Bonsi *et al*. 1994; Norton, 1994; Kiatho, 1997, Salem *et al*. 1999). However, the effect of anti-nutritional factors depends on the digestive process of the animal (Kumar, 1992). Common anti-nutritional factors which have been implicated in limiting the utilization of shrub and tree forages include non-protein amino acids (mimosine and indospecine), glycosides (cyanogens and saponins) and polyphenolic compounds tannins and lignins (Kumar, 1992).

The ANFs may be regarded as a class of compounds, which are generally not lethal but reduce animal productivity and may cause toxicity during periods of scarcity or confinement when the feed rich in these substances is consumed by animals in large quantities (Cheeke and Shull, 1985).

The ANFs which have been implicated in limiting the utilization of shrub and tree forages include non-protein amino acids, glycosides, phytohemagglutinins, polyphenolics, alkaloids, triterpenes and oxalic acid (Prasad *et al.*,2013).

2.6.1 Tannins

Among the polyphenolic compounds, tannins have received most attention in ruminant nutrition. Tannins are divided into hydrolysable tannins and proanthocyanidins (condensed tannins). Hydrolysable tannins are more susceptible to enzymic and non-enzymic hydrolysis than condensed tannins. Hagerman and Robbins (1993) found that hydrolysed tannins did not affect the nutrient digestibility in ruminants. However, the microbial and acid-hydrolysis of hydrolysed tannis in the gut produced metabolites that had antimicrobial activity and toxicity in the liver (Cheeke, 1998). In any case, values ran from 3.8-5.9mg/g in the cotyledons (Elias, Fernandez and Bressani, 1979). Much of the nutritional and toxicological effects of tannins depend on the ability of condensed tannin to complex proteins (Hagerman and Butler, 1981) and carbohydrate (Reed, 1995). The tannin- protein complexes are stable over the pH range 3·5–7 and dissociate at pH < 3 and > 8·5 (Mangan, 1988). The tannin–protein complex decreases the fermentation (degradability) of forage proteins (Robbins *et al*. 1987; Bonsi *et al*. 1994) in the rumen, thereby decreasing rumen NH_3 concentration and increasing the amount of plant bypass protein available for abomasal and intestinal digestion. This phenomenon can sometimes lead to inefficient mammalian enzyme digestion of the protein in the small intestine when the complex fails to dissociate (Reed, 1995). Tannins may therefore have either a beneficial or detrimental effect.

2.6.2 Phytic acid

Phytic corrosive is available in many plant frameworks, comprising around 1 to 5% by weight of numerous grains and vegetables. Worry about its essence in sustenance emerges from proof that it diminishes the bioavailability of numerous basic minerals by associating with multivalent cations or potentially proteins to frame buildings that might be insoluble or generally inaccessible under physiologic conditions (Munir *et al.,* 1988). Phytic corrosive substance can be decreased through dousing or different types of preparing (Real food media, 2009).

2.6.3 Saponin

Saponins are glycosides that are generally considered as anti-nutritional factors. Since dietary saponins are poorly absorbed, their biological effects occur in the digestive tract (Cheeke, 1996). The anti-nutritional effects differ depending on the digestive process of the ingesting animal. In ruminants, saponins are differentially toxic to rumen protozoa. The differential toxicity may be explained by the presence of cholesterol in eukaryotic membranes but not in prokaryotic cells (Kilta *et al*. 1996). Saponins are degraded in batch cultures of rumen fluid *in vitro* (Makkar and Becker, 1997), although apparently the resultant sapogenins are more resistant to degradation (Wang *et al*. 1998). Sapogenins do not have the anti-protozoal property of the parent saponins (Teferdegne *et al*. 1998). Metabolites produced by rumen microbial metabolism of steroidal saponins were implicated as a cause of secondary photosensitization in sheep (Miles *et al*. 1991). Saponins are made out of a lipid-dissolvable aglycone that comprises of either a sterol or all the more normally a triterpenoid structure connected to water-solvent sugar deposits that vary in their sort and sum. The real wellsprings of dietary Saponins are vegetables, and numerous kinds of Saponins can be available in a similar bean (Messina, 1999). Saponins are ineffectively consumed. They can slaughter or restrain malignancy cells without executing typical cells (Rao,

1996). Most Saponins shape insoluble buildings with 3-ß-hydroxysteroids and are known to collaborate with and frame huge, blended micelles with bile acids and cholesterol (Mali , Marbin and dela Castra, 1985).

2.6.4 Trypsin inhibitors

Trypsin inhibitors when ingested by a man in huge amount upset the stomach related process and may prompt bother some physiological responses (Booth *et al.,* 1960). They exist together with against α-amylases and are found for the most part in the external layer of the cotyledon of vegetables. Trypsin inhibitors from beans meddle with protein processing and in a few types of creatures do cause pancreatic growth and upgrade synthetically prompted pancreatic tumors (Grant, 1989). In any case, warm treating dry beans for the most part lessen the trypsin inhibitor content by 80 - 90% (Duarte-Rayas, 1992). Other preparing strategies like absorbing water through draining, maturation, and germination have been appeared to likewise diminish trypsin inhibitors (Nnam, 1997)

2.6.5 Oxalate

Oxalate happens broadly in the plant kingdom; models of nourishments containing oxalates are dark pepper, parsley, poppy seed, amaranth, spinach, chard, beets, cocoa, chocolate, most nuts, most berries, fish tail palms, New Zealand spinach (*Tetragonia tetragonioides*) and beans. Over abundance utilization of oxalates may result in kidney infection or even passing because of oxalate harming, (Hitchcock 1976). Oxalic corrosive can initiate poisonous and in addition

hostile to nutritive impacts. To people, it very well may be intensely lethal. Nonetheless, it would require huge dosages of 4 to 5g to prompt any poisonous impact.

2.7.0 Methods of Alleviating Anti Nutritional Factors

Some plants and other legumes have been known to contain some anti-nutrients which interfere with digestive processes and prevent efficient utilization of their nutrients. Some of these are protease inhibitors, heamagglutinin, lectins, saponins and flatulence factors (Osabor *et al*., 2009). However, they could be eliminated or reduced by some processes such as soaking, dehulling, germination and fermentation (Cheuham, 1986).

2.7.1 Fermentation

Forages preserved through fermentation are used to provide feed for ruminant animals (Goeser 2015). Fresh forage crops such as maize, grasses, legumes, wheat and lucerne can be preserved by ensiling. In many countries ensiled forages are highly valued as animal feed. In European countries such as The Netherlands, Germany and Denmark more than 90% of the forages locally produced are stored as silage. Even in countries with generally good weather conditions for hay Ensiled feedstuff totaled 132 million tonnes in the US (Philips *et al*., 2017).making such as France and Italy approximately 50% of the forages are ensiled (Wilkinson *et al.,* 1996). It is essential to have a good microbial fermentation process to produce high quality silage. A good fermentation process is not only dependent on the type and quality of the forage crop, but also on the harvesting and ensiling technique. (stefanie *et al* 2000) The aim in ensiling feedstuffs is to yield a homolactic or heterolactic anaerobic fermentation. Fermenting microorganisms grow, metabolizing water-soluble carbohydrates into organic fermentation acids (Weinberg and Muck, 1996). Lactic, acetic, butyric, and propionic acid are major acids produced during ensiling. The dissociation constants (Nelson and Cox, 2003) are 3.86 for lactic acid, 4.76 for acetic acid, 4.82

for butyric acid, and 4.87 for propionic acid. A lower dissociation constant signifies stronger acid; hence, lactic acid is a stronger acid and a primary factor for decreased ensiled-forage (silage) pH. Weinberg and Muck (1996) characterized fermentation into 4 stages: (1) aerobic, (2) fermentation, (3) stable, and (4) feed out. After ending the aerobic phase (stage1), anaerobic microbial growth and fermentation acids increase (stage 2) until forage pH decreases to the point that microbial activity slows. Approximate pH ranges at silage stability are 3.5 to 4.5 for corn- and grass-based silages and 4.0 to 5.0 for legumes. At this point the forage is effectively preserved (stage 3) until feedstuffs are again exposed to oxygen (stage 4). Forage DM losses can take place at each of these 4 stages, but the focus of this research is to determine whether losses can be characterized for stages 1, 2, and 3. Stage 4 losses can also be substantial but relate to aerobic microbial growth, spoilage, and subjective silage disposal by farm owners due to spoilage.

2.7.2 Drying

Drying like other methods of conservation reduces digestibility and intake, related to the time the herbage is exposed to leaching and other losses in the field. These can be reduced by barn drying and high temperature drying of herbage, and the technology is well developed but most hay is still field cured, (Doymaz, 2007).

Drying has been used traditionally as a method of preserving leafy vegetables in Nigeria and other developing countries. In Nigeria one of such plants vegetables is of *Leptadenia hastata.* (Hassan *et al* 2007). Naturally drying of mown herbage by the sun and wind is still the commonest way of conserving fodder, natural grass and crop residues. Auxiliary artificial drying

is used occasionally in some of the more highly mechanized systems. Hay is the small scale producer's best conserved fodder since in all but humid climate it can be made with little equipment or costs other than labour. Hay can be made by simple equipment and once correctly cured, it is easy to transport and store and can be fed with little or no wastage. Since hay is appropriate conserved forage for small scale farmers and pastoralist with limited resources, it should be encourage where climatic and economic conditions are suitable. Hay is often marketed as cash crop, usually baled (Bogale and Yami 2008).

2.7.3 Germination/sprouting

By definition, Germination is a process that incorporates events beginning with the absorption of water by the mature dry seed and ending with the protrusion of the radicle or more generally of a portion of the embryo through the envelopes of the seed Job *et al*., (2012)

Sprouting is well-known technique for high fodder yield, year round production and least water consumption (Fazaeli *et al.,* 2012). Sprouts fodder production requires only about 2-3% of that water used under field conditions to produce the same amount of fodder (Kumar, 2010). Germination is often used to improve the concentration and bioavailability of nutrients in foods Samia *et al*., (2007) Sprouting activates enzymes that change the starch, protein, and lipids of the grain into simpler forms, for example, starch changes to sugars and as well increasing the percent crude protein (Tudor *et al.,* 2003). Germinated guar gum seed, for 36hours, removed, sun dried and ground to pass 0.22mm screen study, observed that germination reduces polyphenol of bean (Kataria, *et al.,* 1989). Also, bean lectin in the cytoplasm of cotyledon and embryo were found to disappear during germination. Germination of *Mucuna pruriens* for 24hours and 48hours were also effective in the reduction of various anti nutrients, although, this reduction appeared to be more pronounced in prolonged period of germination (72hours) (Samantray *et al.,* 1989), also

sprouting treatments were efficient in reducing anti-nutritional factors while increasing enzyme activities and maintaining mineral content. Sprouting or germination has been reported to improve vitamins and protein quality of some cereals and legumes with reduction in anti-nutritional factors, (Asiedu *et al.,* 1992). In contrary, Oloyo (2004) found that germination of pigeon pea seed for 3 days caused an increment in tannin content, and also, Ahmed *et al.,* (2006) reported an increase in tannin content during germination of guar grains. The increment in tannin content may be attributed to solubulization of tannin and soluble tannin migrates from seed coat to the core of the seed. However, sprouting facilitates reduction in anti-nutritional compounds and increase enzymatic activities in minor millets (Jood *et al.*, 2006).

2.7.4 Soaking

Report shows that soaking of cowpea seed for different period of time significantly reduces polyphenol content of seed. Also, report shows that soaking of guar gum seeds, reduced tannin content (Ahmed *et al*., 2006). Soaking is essential in the processing of pigeon pea as it improve digestibility of the product by blocking the active site of protease inhibitors and leaching out of trypsin inhibitor factor, thus inhibiting activity of anti-nutritional factor.

Soaking also remove about 1/3 of soyabeans oligosaccharides, some of which are responsible for the production of intestinal gas. Soaking significantly reduced the content of tannin alone in *Vigna aconitifolia,* both total free phenolics and tannin were markedly reduced in *Vigna sinesis* (Vijayakumari *et al.,* 1998). An insignificant loss of raffinose was noticed when seed (Molina) were subjected to soaking (Vijayakumari, *et al.,* 1997). Also, report from Vijaykumari, *et al.* (1996) indicated that loss of phytic acid was found to be higher in distilled water soaking compared to salt water soaking in kernel germplasina. Decrease in anti-nutritional factors during

soaking treatment might be attributed to the leaching of polyphenols in soaking water; in addition to leaching increased emzymatic hydrolysis might have facilitated the reduction of total phenol and tannin in soak treatment (Bishnol *et al.,* 1994). Soaking alone causes a significant decrease in anti-nutrients, as the anti-nutrients are leached into the soak water. Soaking for 24 hours at roon temperature removed 66% of trypsin (protease) inhibitor activity in mungbean, 93% in lintel, 59% in chick pea and 100% in broad bean (Al-baker *et al.,* 1982).

2.8.0 Total Mixed Ration (TMR) and Feeding Management

Total Mixed Rations are designed as a homogeneous mixture to help minimize the selective consumption of individual feed components by ruminants (Stojanovic *et al.,* 2012).

Feeding a TMR ideally results in rumen bacteria encountering the same mixture of ingredients and nutrients in the rumen throughout the day, a consistency that helps improve fermentation (Amaral-*phillips et al.,* 2001). Forages and concentrates are usually fed separately to ruminants; however, in the recent times complete diet feeding is advocated.The objective of complete rations is to provide a blend of all the feed ingredients including roughages without giving any choice to the animal for selection of specific ingredient (Khan *et al.,* 2010).In this feeding system, all feed ingredients inclusive of roughages are proportioned, processed and mixed into a uniform blend. The product is fed as a sole source of nutrients, (Devasena and Rama 2014).

The TMR system involves the feeding of an intimate mixture of dietary ingredients *ad libitum* (Owen and Miller, 1971). This could increase the possibility of meeting nutritional requirements, facilitate management, allowing full mechanization and, taking into account that goat are selective feeders, more flexibility for inclusion of a wide range of alternative feeds

(Coppock *et al.,* 1981; Owen, 1984)

Cows have been shown to sort preferentially for the grain component of a TMR, leaving the longer forage components. This behavior results in an increase in the fibre content of the remaining feed, with the greatest effect thought to occur when frequency of feed delivery is low. Sorting against long fibre particles was associated with lower rumen pH and increasing the risk of subacute ruminal acidosis (SARA), especially at cows with high risk for acidosis (cows in early lactation). Sorting of a TMR can also reduce the nutritive value of the TMR remaining in the feed bunk, particularly in the later hours past the time of feed delivery (Leonardi and Armentano, 2003). Despite providing feed as a TMR, extensive diet selection (sorting) of a TMR can still occur.

Longer particles are typically higher in NDF concentration than the TMR, therefore, refusal of long particles can reduce total NDF intake. Sorting can be signified by disparities between NDF concentrations in the diet and the refusals (Stojanović *et al.* 2012). Sorting of the TMR can reduce the quality of the feed, particularly in the later hours past the time of feed delivery. This may be detrimental to animals that do not have access to feed at the time when it is delivered. In such cases, these animals may not be able to maintain adequate nutrient intake to maintain high levels of production. Minimizing sorting of the TMR by animals is very important, with a goal of the top screen of the Pen state particle separator (PSPS) not changing more than 5% units over the 24 hour feeding period. If excessive sorting occurs, ration conditioners such as water, liquid molasses, and wet by-products can be effective in reducing the amount of sorting that occurs.

2.8.1 Advantage of Total Mixed Ration

The feeding value of crop residues can be increased by incorporating them into TMR by fortifying them with required nutrients (Sharma *et al.*, 2010). All forages grains, protein

supplements, minerals and vitamins are thoroughly mixed. Therefore, animals do very little sorting for individual ration ingredients. Completely blended feeds, coupled with grouping the animals, permits greater flexibility in feeding exact amounts of nutrients (energy, protein, etc.) to more nearly nourish animal for their particular stage of production. Grain mixtures can be liberally fed to grouped high producers without over feeding (Schroeder 1997).

TMR feeding has been the most significant feature of dairy cattle feeding systems in the developed countries. The merits and demerits of this system have been summed up by Coppock et al. (1981). TMR comprising 45 % cotton straw, 47 % mixed grass hay or 35 % sunflower straw maintained milk production of 6-8 litres with normal fat content compared to conventional or individual feeding system (Reddy and Reddy, 1983). The merit of TMR is related to stable rumen environment for optimum rumen fermentation, minimal fermentation losses, minimal fluctuation in the release of ammonia and stabilization of acetate to propionate ratio, which favours normal fat synthesis and enhancement of low grade roughages (Sharma and Singhal, 1988).

2.8.2 Formulation of TMR for sheep and goat

Ram lamb rearing which is gaining importance in the recent years is best suited to feed lambs with TMR based on tree leaves, legume crop residues or hays and concentrate in the ration of 50:50 or 60:40 (R:C). In lambs fed TMR, an average daily gain (ADG) of 100-150g, finishing body weight of about 25-30 kg at 6-9 months was reported. Several least cost rations based on TMR have been developed for economic production in sheep and goats (Kishore 2017).

2.8.3 Cost economics in animals fed TMR

In the recent years TMR feeding is becoming increasingly popular. This system supports equal or even higher milk production in case of high yielding animals compared to conventional system with lower labour and feed costs. Further, TMR proved to be a best feed particularly in the ram lamb rearing maintained under intensive system. Several workers reported Decreased cost of feeding was reported in lactating Murrah Buffaloes fed TMR per kg 6 % fat corrected milk (FCM). The improvement in net benefit over feed cost was about 24 % due to feeding of complete ration over conventional system of feeding (Raja Kishore *et al.,* 2013). The reports corroborated with the findings in lactating cross bred cows (Khan *et al.,* 2010) fed TMR. Similarly, Chopade *et al.* (2010), Suresha *et al*. (2009) and Afzal *et al*. (2008) reported decreased cost of feed per kg live weight gain in kids, goats and sheep, respectively.

2.8.4 Forage fibre characteristics and level in TMR

Several studies have shown that fibrous crop residues can be successfully used as a sole roughage source in the preparation of TMR for optimum growth and milk production (Reddy, 1988).The pattern of VFA production in the rumen and the animal performance is highly influenced by the characteristics and level of forage in TMR. Chewing activity dictates the rate and amount of saliva production which in turn is influenced by the source of roughage (Okine *et al*, 1997).

It is observed that different forage sources with different NDF concentrations altered the nutrient supply and resulted in changes in milk composition. But the roughage source with different NDF concentrations had no effect on milk yield because the energy output from various substrates was similar among the sources of forage (Khorasani *et al*., 1993). Several scientists made an attempt

to develop TMR using sunflower heads, lucerne hay (Mohan *et al.*, 1997), corn gluten feed (Bernard *et al.*, 1991), cotton seed hulls/stalks and sorghum straw (Reddy and Reddy, 1999), wheat straw (Singhal and Mudgal, 1980) etc. and reported the suitability of the crop residues as a source of roughage and improved nutrient utilization. The results opined that agro-industrial by-products used in the TMR preparation can be enriched by adding urea for effective utilization. Further, the inclusion of ammoniated wheat/jowar/bajra straw to the extent of 60% in TMR reported to be more economical in the diet of the buffaloes.

2.8.5 Particle size of roughage in TMR

Particle size reduction in forages results decreased chewing activity and depression in milk fat even the animals receives adequate NDF (Grant *et al.*, 1990). Milk fat depression is a consequence of lowered forage to concentrate ratio in the diet or restricting the amount of forage fibre (Woodford *et al*., 1986).

The minimum recommended NDF is 25-28 %, of which 75% should be supplied by forage. The extent to which particle size needs to be reduced for improving intake, for increasing density of feed, higher growth and maintaining milk fat level at the minimum processing costs are the important factors to be considered in processing TMR. Several studies reported variations in the particle size i.e. 12 mm sieve (1740 μ size) in sheep for cottonseed hulls (Reddy, 1990), 8 mm sieve in case of crossbred bulls for maize cobs (Murali *et al*, 1989) etc. The paddy straw ground by 8 mm sieve was optimum to be incorporated in TMR and reduced the cost of feeding compared to when ground at 12 mm and 16 mm sieves. Insufficient particle size decreases the ruminal acetate to propionate ratio and the pH, which in turn lowers milk fat percentage. Reduced particle size increases dry matter intake, decreases digestibility and retention time of

solids in the rumen (Martz and Belyea, 1986; Uden, 1987). This results in an increase in the fractional turnover rate of the ruminal dry matter and increased dry matter intake. Smaller forage particle spend less time in the rumen, giving little scope for microbial digestion resulting in decreased fibre digestibility.

2.9.0 Serum Biochemistry and Haematology in Farm Animals

Serum bio-chemical and haematological references constitute important panels in the diagnosis, prognosis and treatment of livestock diseases via the investigations of myriads of parameters influencing blood and serum biochemical indices among which are total blood glucose (TBG), total protein (TP), urea, creatinine, albumin, uric acid, globulin, aspartate amino transferase, alanine amino transferase, alkaline phosphatase, cholesterol e.t.c (Yokus *et al.,* 2006).

The parameters influencing the haematology and serum bio-chemistry of various livestock animals are typically under two broad categories i.e genetic and non-genetic parameters. Genetic parameters include the breed and genotype of the animal while the non-genetic parameters include the age, sex, management system, medication, health status and environmental factors such as nutrition, hormone and climate. Haematological values of farm animals are also influenced by geographical location, season, climate, day length, time of day, life habit of species, nutritional status, physiological status of individual animal and other non-genetic factors (Afolabi *et al.,* 2010). Laboratory blood tests would be a vital tool to help detect any deviation from normal state of wellbeing of animals (Etim *et al,.* 2014). Hence, it is important to establish standard values for the various blood parameters based on age aforementioned genetic and non-genetic parameters (Ogunbajo *et al.,* 2009).

Hematological status changes in livestock can be used to detect metabolic disorders, diseases, structural damage to organ, and stress (Kubkomawa *et al*., 2015; Iheidioha *et al*., 2012).

Hematologic examination may help monitoring livestock metabolism conditions (Lager and Jordan, 2012), which can then determine the physiological and livestock health conditions.

2.9.1 Serum and Haematological Components and their Functions in Farm Animals

Blood which is a vital special circulatory tissue is composed of cells suspended in a fluid intercellular substance (plasma) with the major function of maintaining homeostasis (Grau *et al*., 2013). Haematologcal components, which consist of red blood cells, white blood cells or leucocytes, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular are valuable in monitoring feed toxicity especially with feed constitute that affect the blood as well as the health status of farm animal (Oyawoye and Ogunkunle, 2004).

2.9.2 Red blood cells

Red blood cells (erythrocytes) serve as a carrier of haemaglobin. It is haemoglobin that reacts with oxygen carried in the blood to foam oxyhaemoglobin during respiration (Johntson and Morris, 1996; Chineke *et al*., 2006). According to Grau *el al* (2013) RBC is involved in the transport of oxygen and carbon dioxide in the body. Thus, a reduced RBC count implies a reduction in the level of oxygen that would be carried to the tissues as well the level of carbon dioxide returned to the lungs (Ugwene, 2011; Soetan *et al* ., 2013; Isaac *et al*., 2013). Red blood cells or erythrocytes are relatively large microscopic cells without nuclei. In this latter trait, they are similar to the primititive prokaryotic cells of bacteria. Red cells normally make up 40-50% of the total blood volume (Ghergariu *el al*., 1984). The red cell are produced continuously in our bone marrow form stem cells at a rate of about 2-3 million cells per second. Hemoglobin is the gas transplanting protein molecule that makes up 95% of a red cells which has about

270,000,000 hemoglobin molecules. The red colour of blood is primarily due to oxygenated red cells (Koubkova *et al*., 2000).

2.9.3 White Blood cell

The major functions of the White Blood Cell (WBC) and its differentials are to fight infections, defend the body phagocytocis against invasion by foreign organisms and to produce or at least transport and distribute antibodies in immune response. Thus, animals with low white blood cells are exposed to high risk of disease infection, while those with high counts are capable of generating antibodies in the process of phagocytocis and have high degree of resistance to diseases (Soetan *et al.,* 2013) and enhance adaptability to local environmental and disease prevalent conditions (Kabir *et al .,* 2011; Okun;o;a *et al* 2012., Iwiji and Herbert, 2012; Isaac *et al .*, 2013). White cells or leukocytes exist in variable numbers and types but make up very well parts of bloods volume normally only about 1% in healthy animals. Leukocytes are not limited to bloods. They occur elsewhere in the body as well, most notably in the spleen, liver and lymph glands (Gutienez-De lar *et al.,* 1971). Most are produced in our bone marrow from the same kind of stem cells that produce red blood cells (called lymphocytes) are the first responders for the immune system (Oduye and Fasanmi, 1971). They seek out, identify to alien protein on bacteria, virus and fungi so that they can be removed. Other white cells also have the function of getting rid of dead or dying blood as well as foreign matter such as rust. White blood cells usually last 18-36 hours before they are removed, though some types live as much as a year. The description of white cells presented here is a simplification. There are actually many special sub-types of them that participate in different ways in their immune responses (Doornenbal *et al.,* 1988).

2.9.4 Packed Cell Volune (PCV)

Packed cell volume (PCV) is involved in the transport of oxygen and absorbed nutrients. Increased PCV shows a better transportation and thus result in an increase primary and secondary polycythemia. PVC which is also known as haematocrit (Ht or Hct) or erythrocyte volume fraction (EVF) is the percentage (%) of red blood cell in blood (Purves *et al.,* 2003). According to Isaac *et al*. (2013) it is normally about 45% for male animal and 40% for female animal. It is considered an integral part of a person's complete blood count results, along with hemoglobin concentration, white blood cell count and platelets count, in mammals, hemotocrit is independent of body size. The PCV rise when the number of red blood cells increase or when the blood volume is reduced, as in dehydration. The PCV falls to less than normal, indicating anaemia, when the blood of an animal decrease its production of red blood cells or increases its destruction of red blood cells (Dargie and Allonby, 1975). PCV value for red sokoto goat is 25.7±3.1% (Tanbuwal *et al.,* 2002).

2.9.5 Blood platelets

Blood platelets, or thrombocytes, are cell fragment without nuclei that work with blood clotting chemicals at the site of wounds. They do this by adhering to the walls of blood vessels, thereby plugging the rupture in the vascular wall. They also can release coagulating chemicals which cause clots to form in the blood that can narrowe blood vessels. Thirteen different blood clotting factors, in addition to platelets, need to interact for clotting to occur. They do so in a cascading manner, one factor triggering another (Kumar *et at.,* 2000). Recent research has shown that platelets help fight infections by proteins that kill invading bacteria and some other microorganisms. In addition, plates stimulate the immune system. Individual platelets are about

1/3 the size of the cells. They have a lifespan of 9-10 days. Like the red and white blood cells. Platelets are produced in bone marrow from stem cells.

2.9.6 Haemoglobin

Haemoglobin is the iron-containing oxygen-transport metalloprotein in the red blood cells of all vertebrates (Maton *et al.,* 1993) with the exception of the fish family, channichthyldae (Sidell and Brien, 2006) as well as tissues of invertebrates. Haemoglobin has the physiological function of transporting oxygen to tissues of the animal for oxidation of ingested food so as to release energy for the other body function aswell as transport carbon dioxide out of the body of animals (Ugwuene, 2011; Omiyale *et al.,* 2013; Isaac *et al.,* 2013). In mammals, the protein makes up about 97% of the red blood cells dry content, and around 35% of the total content (including water). The molecule also carries the important regulatory molecule nitic oxide bound to a globin protein thiol group, releasing it at the same time oxygen (Oduye and Adedevoh, 1976). Tambuwal (2002) found hemoglobin content in Red Sokoto goat to be 4.4±1.6g/dl. According to Peter *et al*. (2011), previous report stated that PCV, haemoglobin and mean corpuscular haemoglobin are major indices for evaluating circulatory erythrocytes, and are significant in the diagnosis of anaemia and also serve as useful indices of the bone marrow capacity to produce red blood cells as in mammals (Awodi *et al*., 2005; Chineke *et al.,* 2006). Furthermore, Chineke *et al*. (2006) posited that high PCV reading indicated either an increase in number of Red Blood Cells (RBCs) or reduction in circulating plasma volume. Mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration indicate blood level condition. A low level is an indication of anaemia (Aster, 2004).

2.9.7 Lymphocyte

The lymphocyte is an agranular cell with very clear cytoplasm which stains pale blue. Its nucleus is very large for the size of the cell and strains dark purple. (Notice that the nucleus almost fills the cell leaving a very thin rim of cytoplasm) this cell is much smaller than the three granulocytes (which are all about the same size) these cells play an important role in our immune response (Olusanya *et al.,* 1976). The T-lymphocytes act against virus infected cells and tumor cells. The B-lymphocytes produce antibodies. This is the second most numerous leukocytes, accounting for 25-35% of the cells counted in a differential WBC count. When the number of these cells exceeds the normal amount, one would suspect infectious mononucleosis or a chronic infection, in goat, like other ruminants there are more lymphocytes than neutrophils in circulation. (Olusanya *et al.,* 1976).

2.9.8 Neutrophil

These granulocytes have very tiny light staining granules (the granules are very difficult to see). The nucleus is frequently multi lobed with each lobe connected by thin strands of nuclear materials. These cells are capable of phagocytising foreign cells, toxins and viruses. When taking a differential WBC count of normal blood, this type of cell would be the most numerous. Normally, neutrophils account for 50-70% of all leukocytes. If the count exceeds this amount, this cause is usually due to an acute infection such as appendicitis, smallpox or rheumatic fever. If the count is count is considerably less, it may be due to a viral infection such as influenza, hepatitis, or rubella (Benjamin, 1978; Schalm *et al.,* 1975). Tambuwal (2002) found Neutrophil count in red Sokoto goats to be 36.4±2.5%.

2.9.9 Normal haematological values for various species of farm animals

Haematological values could serve as baseline information for comparison in conditions of nutrient deficiency, physiology and health status of farm animals (Daramola *et al.*, 2005). According to Research Animal Resources [RAR] (2009) (see table 2.1) the value below are subjectivity average from a variety of sources. There is a great range of values. This may be accounted for by varation in age, sex, breed or strain, sampling techniques, and testing methodology. As such, the range limit are not firm boundaries and should only be used as guidelines.

Table 2.1: Reference values of Haematology for Farm Animals.

Parameters	Swine	Sheep/Goat	Cow	Rabbit	Guinea Pig
PVC (%)	32 – 50	24 – 45	24 - 48	30 – 50	37 – 48
Hb (g/dl)	10 – 16	8 – 16	8 – 15	10 – 15	11 – 15
MCV (fl)	50 – 68	23 – 48	40 – 60	78 – 95	67 – 77
MCH (pg)	17 – 23	8 – 12	11 – 17	-	-
MCHC (g/dl)	30 – 36	31 – 38	30 – 36	27 – 37	30 – 34
WBC	7 – 20	4 – 12	4 – 12	4.5 – 11	5 – 8.9
Lymphocyte	40 – 60	40 – 70	40 – 70	40 – 80	39 - 72
Monocyte	2 – 10	0 – 6	1 – 6	1 – 4	2 – 6
Eosinophils	0 – 10	0 – 10	0 – 4	0 – 4	0 – 5
Basophils	0 – 2	0 – 3	0 – 2	1 – 7	0 – 3

Source: Research Animal Resources [RAR] (2009)

CHAPTER THREE

3.0 Materials and Method

3.1 Experimental Site

The study was conducted in the Small Ruminant Unit of the Department of Animal Science Teaching and Research Farm, Ahmadu Bello University, Samaru, Zaria. it located is within the Northern Guinea Savannah Zone of Nigeria, latitude 11° 09' 01.78" N and longitude 7° 39' 14.79"E at an altitude of 671m above sea level. The climate is characterized by well-defined dry and wet seasons with a mean annual rainfall ranging from 700 – 1400mm. the maximum tempreture varies from 26-32^{0}C depending on the season while the relative humidity during the dry and wet season 21 and 72% respectively (IAR,2018).

3.2 Ethical Approval

Ethical approval was obtained from Ahmadu Bello University Committee on Animal Use and Care (ABUCAUC) for care and handling of the animals.

3.3 Sourcing of *Leptadenia hastata* forage and other Feed Ingredients

The experimental feed material (*Leptadenia hastata*) was sourced from Ahmadu Bello University Farm, Zaria, where it is very much available. Other feed ingredients were purchased from Labar and Rebson Feed Mills respectively.

3.3.2 Drying of *L. hastata*

Leptadenia hastata forage after harvesting was shade dried by spreading in a single layer on a wide spread polyethylene sheet in a well ventilated environment and turned at regular interval to

avoid moulds until the forage was satisfactorily turned into hay. The drying period lasted for 7 days.

3.3.3 Fermentation process

Ten PICS (Purdue Improved Cowpea Storage) bags were provided and stacked with about 100kg each of wilted *Leptadenia hastata* forage. *L. hastata* forage was harvested and wilted to bring down the DM content to about 30 – 35%. The fodder was then chopped into smaller pieces about 2 – 3cm using hammer mill before filling it into the PICS bags. The fodder was pressed layer by layer of 30 – 45cm. this was done to get rid of the forage trapped air during filling. Filling and pressing was done as quickly as possible. After filling and pressing, the bags were tied and sealed properly to allow proper anaerobic fermentation. The fermentation period lasted for 3 weeks which is the optimum period for ensiling.

3.4 Experimental Diets

Diet I which is the control diet comprised of rice husk, cotton seed cake, maize offal, bone meal and salt with CP content of 16.89%. Diet II contained 20% dried *L. hastata* hay forage with CP content of 15.45. Diet III with CP content 15.00 had 20% ensiled *L. hastata* forage included while Diet IV had a combination (50-50) of Hay and ensiled *L. hastata* forage included in the diet at 20% all in a Total Mixed Ration. M.E (MJ/kgDM) ranged from 12.030 -12.037 across the diets. Water was provided *ad-libitum*.

Table 3.1: Ingredient composition of experimental diet

Ingredients (%)	**Composition (%)**			
	0	**Dry**	**Ensiled**	**Dry/Ensiled**
		20%	**20%**	**20%**
Rice Husk	30	30	30	30
CSC	34.40	30.79	28.23	29.52
Leptadenia hastate	0	20	20	20
Maize Offal	34.10	17.71	20.27	19
Bone meal	1.00	1.00	1.00	1.00
Salt	0.5	0.5	0.5	0.5
Total	100	100	100	100
Calculated Analysis				
Crude Protein	14.00	14.00	14.00	14.00
ME/Kcal	2115.76	2140.17	2341.46	2240.67

3.5 Experimental Animals, Design and Management

The experimental animals were bought from Anchau livestock market, Kubau Local Government Area, Kaduna state. A total of 16 growing Red Sokoto bucks with an average initial weight of 10 to 12±0.5kg were used for the experiment. The animals were balanced for weights and randomly divided into four groups with four animals (replicates) in each group in a Completely Randomized Design. The experimental animals were housed in an individual pen and treated against endo and ecto parasite using 1ml/10 kg BW of Albendazole and 1ml/10 kg BW of Ivermectin injection, respectively before commencement of the experiment. The animals were placed on experimental diets and allowed for 14 days adjustment period before commencement of the experiment. The animals prior to the experiment were weighed using spring balance for three consecutive times and average value recorded. The animals were fed the experimental diet at 3% of their live weight daily. Leftovers were recorded the following morning. Water was also provided *ad libitum.* The animals were weighed every forth night to ascertain the change in live weight and their rations were adjusted accordingly. The growth trial period lasted for 12 weeks.

3.6 Digestibility Study

At the end of the growth trial, three (3) animals were selected from each treatment and housed in an individual metabolism crates for fecal and urine collection. The animals were allowed 14 days adjustment period before commencing the digestibility trial which lasted for 7 days. The animals were fed 3% of their body weight daily. Daily feed intake was measured during the collection period. Total faecal output were collected daily in the morning, weighed and mixed thoroughly, 10% of sub samples were taken and oven dried at 60°C for dry matter determination (DM). This was later bulked for laboratory analysis. Results obtained from proximate analysis were used to calculate apparent nutrient digestibility. Total urine output of individual animal was collected

daily into a plastic container containing 100mls of 0.1N H_2S0_4 to prevent nitrogen loss by volatilization placed under the metabolic crates. The collected urine was strained through a layer of glass wool to remove detached hair fragments and other solid contaminants. Ten percent (10%) aliquot of total urine output was taken from each animal and stored in a refrigerator and later analyzed for nitrogen determination (Osuji *et al.*1993).

The digestibility of nutrient was calculated as:

$$\text{Digestibility of nutrient} = \frac{\text{Nutrient intake (g/d) –faeccal nurients (g/d)}}{\text{Nutrient intake (g/d)}} \text{ x } 100\%$$

Nitrogen Balance was calculated using:

N-balance (g/d) = Intake N (g/d) – faecal N (g/d) – urine N (g/d) MAFF (1983).

3.7 Proximate Analysis

Samples of experimental diets, faecal and urine were taken to the Biochemical Laboratory of the Department of Animal Science. ABU, Zaria. for proximate analysis as described by AOAC (2001). The analysis was done to obtain the nutrient composition (Dry matter, Crude protein, Ether extract, Crude fibre, Ash and Nitrogen free extract). The CP was determined by Kjedahl procedure, Ether extract was determined by subjecting the samples to petroleum ether extraction at 60 – 80°C using Soxlhlet extraction apparatus. Dry matter was determined by oven drying the samples at 100°C over a period of 24 hours.

3.8 Blood Sampling Procedure.

At the end of the experiment, 10mls of blood samples were taken from the jugular veins of the animals using hypodermic needles into sterilized bottles, one containing EDTA and the other without EDTA to the clinical Pathology Laboratory, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria. For Serum, Haematology and lipid profile studies. The samples were analyzed for packed cell volume (PCV), haemoglobin (Hb) count, red blood cell (RBC), white blood cell (WBC), lymphocytes and neutrophils. The serum biochemical parameters determined were blood urea nitrogen, glucose, globulin, albumin, creatinine and cholesterol. Lipid profile parameters determined were HDL, LDL, Tryglycerides and cholesterol.

3.9 Economic Analysis

The prevailing market prices of the various feed ingredients were used to compute the cost and cost of feed consumed within the feeding trial period. The economic benefit analysis was calculated in Nigerian naira based on the method of Anigbogu (2003), where the cost of feed ingredients (w/kg) was used to calculate the cost/kg of diet.

Where the:

$$\text{Cost/kg of feed} = \frac{\text{Total cost of production 100kg of feed}}{100}$$

Cost of total feed consumed = Total feed intake x Cost per kg of feed.

Cost/kg weight gain = Cost per kg of feed x Efficiency of feed utilization

Cost of production = Cost of inputs (Cost of feed consumed + Cost of goat)

Gross profit = Price/kg goat x Final weight of Goat

Profit = Gross profit - Cost of production.

$$\text{Return on Investment} = \frac{\text{Profit Net income}}{\text{cost of production}} \frac{100}{1}$$

3.9 Statistical Analysis

Data collected at the end of the experiment were analyzed using one way ANOVA procedure of statistical analysis system (SAS 2002). Differences among treatment means were compared using Duncan Multiple Range Test.

$Y_{ijk} = u + P_i + e_{ij}$

Where;

Y_{ij} = Dependent Variable (Observation)

u = overall mean

P_i = effect of the i^{th} Treatment evaluated (1, 2, 3).

e_{ij} = random error

CHAPTER FOUR

4.0: RESULTS

4.1: Chemical composition and Anti Nutritional Factors of Dried and Ensiled *Leptadenia hastata* Forage

The Chemical composition of dried and Ensiled *Leptadenia hastata* forege is presented in Table 4.1. The results showed that the DM content ranged from 58.94- 66.30%. The CP and CF ranged from 17.13-18.06% and 14.50-14.65% respectively. While the EE ranged from 1.03-1.10%. The ash content of the hay (13.20) is almost similar to that of the silage (13.06). The NFE is higher (54.28) in ensiled *L. hastata* when compared to (52.99) of hay. The NDF and ADF ranges were 10.63 to 15.63 and 24.13 to 33.46, respectively. The result of Anti Nutritional Factors (ANFs) present in *Leptadenia hastata* forage showed that the ranges of values of Tannin, oxalate and phytate in the experimental material were 1.03-1.10, 4.70-5.30 and 0.59-0.60 respectively which were very low and this invariably implies minimal interference in feed digestion and absorption

Table 4.1: Chemical composition and Anti Nutritional Factors of Hay and Ensiled *Leptadenia hastata* Forage

Ingredients (%)	***Leptadenia hastate***	
	Hay	**Silage**
Dry Matter	66.30	58.94
Crude Protein	18.06	17.13
Crude Fibre	14.65	14.50
Ether Extract	1.10	1.03
Ash	13.20	13.06
Nitrogen Free Extract	52.99	54.28
Acid Detergent Fibre	15.63	10.63
Neutral Detergent Fibre	33.46	24.13
Anti – Nutritional Factors		
Saponin	0.01	0.01
Tannin	1.10	1.03
Phytate	0.59	0.60
Oxalate	5.30	4.70

4.2: Chemical composition of Experimental diet

The chemical composition (%) of experimental diets fed to Red Sokoto bucks is presented in Table 4.2. The DM content varied from 60.23 to 70.11% across the treatments, with the ensiled *L.hastata* having the highest value. The organic matter was also highest in ensiled *L.hastata* while it was lowest in the hay. The crude protein content of 16.89%, 15.45%, 14.94% and 15.38% were recorded for control, dried, Ensiled and a mixture of dry and Ensiled *Leptadenia hastata* forage inclusion in the diets. The CF values ranged from 12.64 to 13.34% with the control diet having the highest value of crude fibre. Ash content ranged from 12.39 to 13.02%. The ADF and NDF ranged from 9.63 to 15.63% and 25.91 to 25.15%, respectively.

Table 4.2: Chemical composition of Experimental diet

Ingredients (%)	Control	Hay	Ensiled	H+E
Dry Matter	60.81	59.68	70.11	60.23
Organic matter	48.42	46.87	57.09	47.58
Crude Protein	16.89	15.45	15.00	15.38
Crude Fibre	13.34	12.93	12.64	13.09
Ether Extract	0.95	1.04	1.01	1.00
Ash	12.39	12.81	13.02	12.65
NFE	56.43	57.77	58.38	57.88
ADF	9.63	12.64	10.60	15.63
NDF	23.80	23.64	23.85	25.15
ME(Kcal/Kg/DM)	2874.75	2874.03	2873.79	2873.32

NFE = Nitrogen Free Extractives, ADF = Acid Detergent Fibre, NDF = Neutral Detergent Fibre H+E =Hay and Ensiled. ME(MJ/Kg/DM) = 11.78 +0.0064CP +(0.00065 EE)2 – 0.118A (Alderman 1985).

4.3 Growth performance of Hay and Ensiled *Leptadenia hastata* forage fed Red Sokoto Bucks

The growth performance of red Sokoto bucks fed hay and ensiled *Leptadenia hastata* forage is presented in Table 4.3. The result showed that there were significant differences ($P<0.05$) in Total weight gain, Average daily weight gain, Average daily feed intake, Total feed intake, Average daily feed intake and feed conversion ratio. However, initial and final weights were not significantly different ($P>0.05$) across the dietary treatments. Control and ensiled diets were comparable ($p>0.05$) in TWG, ADWG, and FCR yet superior ($p<0.05$) to hay and hay + silage mixed rations.

Table 4.3: Growth performance of Hay and Ensiled *Leptadenia hastata* forage fed Red Sokoto Bucks

Parameters	Control	Hay	Ensiled	H+E	SEM
Initial weight (kg)	11.88	11.88	11.75	12.38	0.95
Final weight (kg)	14.93	13.33	14.50	13.43	1.25
TWG (kg)	3.05^{a}	1.45^{b}	2.75^{a}	1.05^{b}	0.41
ADWG (g)	50.83^{a}	24.17^{b}	45.83^{a}	17.50^{c}	3.11
TFI (kg)	19.29^{a}	17.84^{ab}	18.99^{a}	14.72^{b}	1.82
ADFI (g)	344.50^{a}	318.50^{ab}	339.00^{a}	262.75^{b}	32.22
FCR	6.52^{a}	13.75^{b}	7.47^{a}	14.11^{b}	1.66

^{abc}Means with the same superscripts along the rows are not significantly different ($p>0.05$), SEM: standard error of means,TWG: Total weigh gain,ADWG: Average daily weight gain,TFI: Total feed intake, ADFI:Average daily feed intake, FCR: Feed conversion ratio. H+E: hay and ensiled

4.4 Nutrient digestibility of Hay and Ensiled *Leptadenia hastata* forage fed Red Sokoto Bucks

Table 4.4 shows the nutrient digestibility of diet containing hay and ensiled *L. hastata* forage or their mixtures fed to Red Sokoto bucks. The result showed that there were significant ($P<0.05$) differences in all the measured parameters except for neutral detergent fibre digestibility. Red Sokoto bucks fed Ensiled *Leptadenia hastata* had significantly ($P<0.05$) higher dry matter (66.17%), crude protein (83.67%), crude fibre (68.57%), ash (80.77%), ether extract (80.97%) and nitrogen free extract (72.57%) digestibility coefficients. In general, animals fed diets containing *Leptadenia hastata* forage had better digestibility values when compared with the control diet.

Table 4.4: Nutrient digestibility of Hay and Ensiled *Leptadenia hastata* forage fed Red Sokoto Bucks

Parameters (%)	Control	Hay	Ensiled	H+E	SEM
Dry matter	37.03[b]	42.97[b]	66.17[a]	61.20[a]	8.22
Crude protein	74.20[b]	77.57[ab]	83.67[a]	82.20[a]	3.70
Crude fibre	46.57[b]	54.63[ab]	68.57[a]	66.77[a]	7.27
Ash	65.47[c]	69.43[bc]	80.77[a]	75.70[ab]	4.83
Ether extract	62.73[c]	71.83[b]	80.97[a]	79.77[ab]	4.17
Nitrogen free extract	51.00[b]	56.80[b]	72.57[a]	71.80[a]	6.47
Acid detergent fibre	64.71[b]	80.24[a]	68.63[ab]	74.73[ab]	7.28
Neutral detergent fibre	69.30	76.04	65.70	70.47	8.74

[abc]Means with the same superscripts along the rows are not significantly different (P>0.05), SEM: standard error of means. H+E: hay and ensiled.

4.5: Nitrogen balance in Red Sokoto Bucks fed diet containing Hay and Ensiled *Leptadenia hastata* Forage.

The nitrogen balance of Red Sokoto bucks fed *Leptadenia hastata* forage in dry and Ensiled forms or their mixtures is presented in Table 4.5, The result showed that there were significant differences ($P<0.05$) in all the measured parameters across the dietary treatments. Nitrogen intake was higher for bucks fed diet containing ensiled *L. hastata* forage and least in those fed diet containing mixtures of hay and ensiled *L. hastata* forage. Faecal nitrogen and total nitrogen output was highest in animals fed the control diet and lowest in the animals fed diet containing mixtures of hay and ensiled *L. hastata*. The Nitrogen retained and %Nitrogen intake ranged from 4.21 to 7.54 and 66.72 to 74.79, respectively.

Table 4.5: Nitrogen balance in Red Sokoto Bucks fed diet containing Hay and Ensiled *Leptadenia hastata* Forage.

Parameters (g/d)	Control	Hay	Ensiled	H+E	SEM
Nitrogen intake	10.27[a]	9.07[a]	9.93[a]	6.27[b]	1.07
Faecal N	2.91[a]	2.29[b]	1.99[bc]	1.70[c]	0.18
Urinary N	0.33[a]	0.24[b]	0.41[a]	0.36[a]	0.04
Total N output	3.25[a]	2.52[b]	2.40[b]	2.07[b]	0.18
N-Retained	7.02[a]	6.55[a]	7.54[a]	4.21[b]	1.15
%Nitrogen Intake	67.26	69.90	74.79	66.72	4.78

[abc]Means with the same superscripts along the rows are not significantly different (P>0.05), SEM: standard error of means, H+E=Hay and Ensiled.

4.6 Haematology in Red Sokoto Bucks Fed Hay or Ensiled *Leptadenia hastata* forage

The haematological profile of Red Sokoto bucks fed diets containing hay and ensiled *L. hastata* is presented in Table 4.8. The result shows that there were significant ($P<0.05$) differences in packed cell volume (PCV), haemoglobin (Hb), Red blood cells (RBC), White blood cells (WBC), Neutrophils, while Lymphocytes, Eosinophil, Monocyte, Basophils and Mean Corpuscular Volume were not different ($P>0.05$) across the treatments. Diets with ensiled *L.hastata* had higher values of PCV, Hb and RBC. Similarly mixed rations of hay and silage resulted in significantly ($p<0.05$) higher WBC and Neutrophil concentrations.

Table 4.6: Haematology in Red Sokoto Bucks Fed Hay and Ensiled *Leptadenia hastata* forage

Parameters	Control	Hay	Ensiled	H+E	SEM	Ref. Value
PCV (%)	20.6^{b}	22.8^{b}	32.57^{a}	32.3^{a}	0.40*	21-35
Haemoglobin (mg/dl)	7.70^{ab}	7.05^{bc}	8.25^{a}	6.75^{c}	0.39*	7-15
RBC ($\times 10^{12}$/L)	0.56^{a}	0.32^{b}	0.53^{a}	0.46^{ab}	0.08*	7.15
WBC ($\times 10^{9}$/L)	15.10^{b}	18.75^{b}	15.95^{b}	22.00^{a}	1.81*	6.8-20.1
Neutrophil (%)	24.95^{b}	30.60^{ab}	31.20^{ab}	38.80^{a}	4.69*	17-52
Lymphocytes (%)	58.65	52.80	52.50	45.65	7.36	47-82
Eosinophil (%)	5.50	5.25	5.90	5.60	1.11	1-7
Monocyte (%)	10.50	10.60	10.10	9.55	0.93	0-10
Basophils (%)	0.40	0.75	0.30	0.40	0.24	0-3
MCV (fl)	47.80	47.45	47.45	47.50	0.35	28-48

[abc]Means with the same superscripts along the rows are not significantly different ($p>0.05$), SEM: standard error of means, PCV: Pack cell volume, MCV: Mean corpuscular volume. RBC : Red blood cell, WBC: White blood cell. H+E= Hay and Ensiled.

4.7 Serum biochemistry of Red Sokoto Bucks fed Hay and Ensiled *Leptadenia hastata* Forage

The serum biochemical indices in Red Sokoto bucks fed diet containing hay and ensiled *Leptadenia hastata* forage is presented in Table 4.7. The result showed that there were significant ($P<0.05$) differences in albumin, glucose, creatinine and urea concentrations while total protein and globulin concentrations were not different ($P>0.05$). Albumin and Glucose concentrations ranged from 2.53 to 2.86 and 40.37 to 46.48, respectively. Creatinine and urea concentrations were also ranged from 0.58 to 0.87 and 2.70 to 3.07, respectively. Ensilage improved the concentration of glucose. Also mixed ration influenced the concentration of creatinine and urea.

Table 4.7: Serum biochemistry of Red Sokoto Bucks fed Hay and Ensiled *Leptadenia hastata* forage

Parameters	Control	Hay	Ensiled	H+E	SEM	Ref Value
T. Protein (g/dL)	10.74	10.46	11.55	11.37	0.74	6.2-7.9
Albumin (g/dL)	2.86[a]	2.53[b]	2.85[ab]	2.66[ab]	0.10*	2.9-4.3
Globulin (g/dL)	7.88	8.02	8.70	8.71	0.81	2.7-4.1
Glucose (Mmol/l)	46.48[a]	46.42[a]	45.88[a]	40.37[b]	2.41*	50-75
Creatinine (Mmol/l)	0.80[a]	0.62[b]	0.58[b]	0.87[a]	0.04*	1.0-1.8
Urea (Mmol/l)	2.70[b]	3.07[a]	2.74[b]	3.07[a]	0.16*	3.6-7.1

[abc]Means with the same superscripts along the rows are not significantly different (p>0.05), SEM: standard error of means, H+E: Hay and Ensiled

4.8 Lipid Profile of Red Sokoto Bucks fed Hay and Ensiled *Leptadenia hastata* Forage

The lipid profile of Red Sokoto bucks fed diet containing dried or Ensiled *L. hastata* forage is presented in Table 4.8. The result showed that there were significant differences ($P<0.05$) in all the measured parameters across the dietary treatments. High density lipoprotein (HDL) was significantly ($P<0.05$) higher in Red Sokoto bucks fed ensiled *Leptadenia hastata*. Low density lipoprotein (LDL) and tryglycerides were significantly ($P<0.05$) higher in Red Sokoto bucks fed diet containing dried, Ensiled and mixtures of *Leptadenia hastata* forage.

Table 4.8: Lipid profile of Red Sokoto Bucks fed Hay and Ensiled *Leptadenia hastata* Forage

Parameters	Control	Hay	Ensiled	H+E	SEM
HDL (mg/dl)	47.01^{ab}	47.14^{ab}	49.32^{a}	41.88^{b}	2.86*
LDL (mg/dl)	38.70^{b}	45.16^{a}	45.13^{a}	39.90^{ab}	2.98*
Triglycerides (mg/dl)	73.70^{b}	76.80^{b}	105.48^{a}	110.43^{a}	9.64*
Cholesterol (mg/dl)	99.04^{c}	107.65^{b}	115.55^{a}	103.86^{bc}	3.18*

^{abc}Means with the same superscripts along the rows are not significantly different ($p>0.05$), SEM: standard error of means, HDL: High Density Lipoprotein, LDL: Low Density Lipoprotein, H+E; Hay and Ensiled

4.9 Economic evaluation of Red Sokoto Bucks fed Hay and Ensiled *Leptadenia hastata* Forage in a Total Mixed Ration.

Table 4.9 showed the economic evaluation of feeding Red Sokoto Bucks diets containing hay, ensiled and mixture of hay and ensiled *L. hastata* forage. The total cost of feed was highest (₦1218.05) in the control diet and lowest (₦ 679.77) in the diet containing mixture of hay and ensiled *L. hastata.* The value of gain ranged from ₦13325 to ₦14925 with the control and diet containing ensiled *L.hastata* being the highest and diet containing dried *L.hastata* being the lowest. The cost/kg gain values ranged from ₦342.86 to ₦651.68 with diet containing mixture of hay and ensiled *L.hastata* being the highest, while diet containing ensiled *L.hastata* being the lowest. The Net benefit was however higher in control and ensiled diets; ranging from ₦12496.56 to ₦13706.10. The Return on investment of feed were ₦3624.46, ₦3886.42, ₦4227.13 and ₦2060.0 for control diet, hay, ensiled, and diets containing mixture of hay and ensiled *L.hastata* forage, respectively,

Table 4.9: Economic evaluation of Red Sokoto Bucks fed Hay and Ensiled *Leptadenia hastata* forage in a Total Mixed Ration.

Parameters	Control	Hay	Silage	H+E
Final weight (kg)	14.93	13.42	14.5	13.43
Total wt gain (kg)	3.05	1.45	2.75	1.05
Daily wt gain (kg)	0.05	0.03	0.05	0.02
Value of gain (₦)	14930	13420	14500	13430
Total feed Intake (kg)	19.30	17.84	19.0	14.72
Cost/kg of feed(₦)	63.15	46.43	45.92	46.18
TCoFC (₦)	1218.05	828.44	871.83	679.77
Cost/kg gain (₦ /kg)	411.93	638.47	342.86	651.68
Net benefit (₦)	13706.10	12496.56	13628.16	12745.45
ROI of Feed (₦)	3624.46	3886.42	4227.13	2060

TCoFC= Total Cost of Feed Consumed, ROI= Return on Investment of feed.

CHAPTER FIVE

5.0 DISCUSSION

5.1 Chemical composition and Anti nutritional Factors of *Leptadenia hastata*

The CP contents observed in this study were higher than values reported by (Wafar *et al*. 2014 and Inuwa 2013). The crude fibre observed in this study is also higher than values reported by Wafer *et al* (2014). The Ether Extracts recorded were however lower than the values 8.34-9.07% reported by Hassan *et al*. (2007). The variation could be attributed to the age of harvesting, climatic conditions, edaphic factors as well as methods of processing and analysis (Fuglie 1990 and Ojewole *et al.* 2005).

Most tropical browse species and forage legumes used as animal feed contain substantial amounts of phenolic compounds, mainly tannins, as well as other secondary compounds (Makkar, 2003).Tannin, oxalate and phytate observed in the experimental diet 1.03-1.10, 4.70-5.30 and 0.59-0.60 respectively were very low which invariably implies minimal interference in feed digestion and absorption. This is in tandem with the work done by Aliero *et al*., (2009) & Bello *et al*., (2011). These values are low compared to values reported in other vegetables e.g. Pigeon pea has oxalate content of 310.50mg/100g, Oloyo, (2002). Oladele *et al., (*2009), reported 21.42mg/100g phytate and 1.12mg/100g oxalate content in tiger nuts. Eka, (1977), reported that phytate and oxalate levels in traditional foods of the Northern Nigeria were below toxic level, which is in line with the values gotten from *L.hastata.* Tannins have been reported to have other positive effects in ruminant digestion besides increasing protein supply; they reduce enteric methane production in ruminants (Makkar 2003; Tavendale *et al.*, 2005; Carulla *et al.*, 2005); promote high digestibility of nutrients (Yisehak *et al.*, 2014); shift short-chain fatty acid (SCFA) production in favour of propionate production. Tannins (on the negative side) can reduce DM

and OM digestibility (Hess *et al.*, 2006; Abdalla *et al.*, 2007; Animut *et al.*, 2008; Tiemann *et al.*, 2008) decrease the number of cellulolytic bacteria (McSweeny *et al.,* 2001), reduce fibre digestibility (Lamy *et al.*, 2011) thereby limit the extent of rumen fementation and are resistant to enzymatic digestion (Goel and Makkar, 2012) thus can still maintain their protein and energy complexes post ruminally.

5.2 Chemical composition of Experimental diets

The crude protein contents of the experimental diets were all higher than the minimum (8) CP requirement for ruminal microbial activities in goats. The crude fibre content across all dietary treatment exceeded 12% minimum requirement needed to avoid high energy related problems as reported by Rashid, (2008). The nutrient detergent fibre (NDF) was far below 60.0 % suggested by Muia, (2000) as critical limit for efficient utilization of roughages. It was reported by Lu, (2005) that goats require adequate dietary fibre for normal rumen functions. The range of ADF in this experiment falls below 18% which is the optimum level of high dry matter intake in goats, it was also reported that DM intake in goat reached optimum high when fed a diet containing 18% ADF with 2.30 Mcal/kg ME, Lu (2005).

5.3: Growth performance of Red Sokoto Bucks fed dry or Ensiled *Leptadenia hastata* forage

The result of DMI was higher in animals fed diet containing ensiled *L.hastata* forage than diet II and diet IV but comparable with the control diet. The increase in DMI intake among bucks fed diet containing ensiled *L. hastata* forage may imply that ensiling improved the palatability of the

forage in quality, taste, aroma or colour. The range of daily DMI values were however lower than values reported by Sulton., *et al* (2000) for goats.

Total weight gain and average weight gain were significantly ($P<0.05$) higher in bucks fed diet containing ensiled *L. hastata* and control. Higher weight gain obtained for bucks fed diet containing ensiled *L. hastata* forage indicates that fermentation improves the utilization of the plant material. Forages preserved through fermentation (ensiling) according to Goeser (2015) are used to provide feed for ruminant animals and they offer comparative advantage of increased weight gain. This may also be as a result of chemical composition of the ensiled *L. hastata* which had lowered the cell wall content and high amount of fermentable carbohydrate and energy which had increased the digestibility of the diet and consequent higher utilization. According to the report of Okoruwa *et al.,* (2012) which states that fermentation process of high fibre diets had taken longer compared to low fibre diets by the rumen microorganisms. Feed conversion ratio (FCR) value of the experimental animals significantly ($P<0.05$) decreased across the dietary treatments but later increased with animals fed diet containing dried *L hastata* and diet with mixture of dried and Ensiled. *L. Hastata*. Animals on diet of mixture of dried and Ensiled *L. Hastata* recorded the highest FCR value (14.11) while the lowest values (6.52 and 7.47) were observed in those on control diet and those on diet containing ensiled *L. hastata*. The FCR value obtained in animals fed diet containing ensiled *L. hastata* is similar the value reported by Babeker *et al*., (2015) who fed graded levels of *Moringer olifera* leaf as a supplement to goats. The lowest FCR values obtained were indication that the feed were better utilized when compared with other dietary treatments. This was in consonance with the report of Doma (1999) who reported that the lower the feed conversion ratio (FCR) of a diet the better the diet. The result also revealed the higher ability of the animals with low FCR to convert the feed consumed

to weight gain. The higher growth rates of the animals on diet containing Ensiled *L. hastata* in this study could be ascribed to their efficient utilization of feed and therefore reflecting lower feed conversion ratio (FCR).

5.4 Nutrient digestibility of Hay and Ensiled *Leptadenia hastata* Forage fed Red Sokoto Bucks

The high DM digestibility values observed in animals fed diet containing *L. hastata* may be due to addition of Protein quality which must have provided adequate nitrogen as stated by Quala *et al.* (2011) that the activities of rumen microbes is improved by nitrogen in diet leading to high digestibility. The CP, CF, Ash and NFE digestibility were highest in animals fed diet containing ensiled *L.hastata* forage, this may imply that fermentation process aids in weakening the cell wall of the forage material before ingestion by animals there by giving it a better rate of digestibility ahead of other diets, this agrees with the report of Olivierra *et al*., (2016) which states that silage quality affects intake and digestibility. The CF digestibility values obtained in this study were however lower than values reported by Olorunnisomo and Ososanya. (2002). who fed cowpea husk and Sorghum Brewer's grain as supplement to West African Dwarf Goats.

5.5 Nitrogen balance of Red Sokoto Bucks fed dry or Ensiled *Leptadenia hastata* forage

The improved protein utilization and retention in this study is in agreement with the report of Osakwe (2004) which stated that forages with low concentration of condensed tannins could improve the efficiency of N-digestion. The values of N-retained indicated that all the bucks were in positive nitrogen balance. The positive N balance values obtained for buck fed Ensiled signified that anti-nutrient contents of the diets did not depress utilization and that the diets were adequate in their supply of nitrogen. Munza *et al.* (2017) stated that superior nitrogen absorbed

and retained in Red Sokoto Bucks fed sorghum hay/concentrate mixture as compared to those fed sole sorghum hay might be due to the efficient utilization of nitrogen. The nitrogen retention and absorbed as percentage intake were 66.72-74.79%. This was higher than 47.98% reported by Yashim *et al.* (2014), but lower than 95.84% and within 74.24% reported by Wada *et al.* (2016) and Ishiaku (2016), respectively. The result of this study revealed that feeding Red Sokoto bucks with *Leptadenia hastata* was adequate to meet their nutritional requirement.

5.6: Haematology of Red Sokoto Bucks fed dry or Ensiled *Leptadenia hastata* forage

Haematological constituents are a reflection of animal responsiveness to their internal and external environments (Isikwenu *et al*., 2012), hence these constituents are important in diagnosing the functional status of an exposed animal to suspected toxicant.

PCV concentration is higher in bucks fed diet containing ensiled *L. hastata* forage and diet containing its mixtures. Increased PCV shows a better transportation and thus result in an increased primary and secondary polycythemia (Purves *et al.*, 2003).

The Haemoglobin content obtained (6.75 to 8.25 g/dl) was within the normal ranges of (8.0 to 15.0 g/dl) reported for normal blood functions by Blood, Studdert, and Gay (2007) The Hb values showed that the experimental diets were adequate for the nutritional requirements, and the test diets did not pose any danger to the animals.

Red blood cell is involved in the transport of oxygen and carbon dioxide in the body. Thus, a reduced red blood cell count implies a reduction in the level of oxygen that would be carried to the tissues as well the level of carbon dioxide returned to the lungs (Ugwene, 2011; Soetan *et al*., 2013; Isaac *et al*., 2013). RBC values observed in this study showed the animals were in good plain of nutrition. The obtained RBC, Hb and PCV values in this study were similar to the values

obtained by Okoruwa *et al.,* (2013), for West African Dwarf bucks fed *pannisetum purpureum* and *unripe plantain* peels.

Animals with low white blood cells are exposed to high risk of disease infection, while those with high counts are capable of generating antibodies in the process of phagocytocis and have high degree of resistance to diseases (Soetan *et al.,* 2013) and enhance adaptability to local environmental and disease prevalent conditions (Kabir *et al .,* 2011). Processing method had a significant ($P<0.05$) influence on haemogloblin concentration of Red Sokoto bucks fed diet containing *Leptadenia hastata* forage. According to Peter *et al*. (2011),

The WBC plays a prominent role in disease resistance especially with respect to the generation of antibodies. WBC was significantly ($P < 0.05$) highest in bucks fed diet containing mixtures of hay and ensiled *L. hastate.* The WBC counts were higher than values reported by Scott *et al.,* (2006) for sheep but within the level reported for WAD goats (Daramola *et al.*, 2005). This implies that goats on the diets remained clinically healthy as indicated by researchers (Konlan, Karikari, & Ansah, 2012) and that the animals will be able to fight against any foreign body in the circulatory system.

5.7: Serum biochemistry of Red Sokoto Bucks fed dry or Ensiled *Leptadenia hastata* forage

Total protein in the blood indicates protein metabolism, since serum protein and albumin syntheses are related to the amount of available protein in the diet. Anti Nutritional Factors could also inhibit protein metabolism as reported for sphingolipid synthesis or protein absorption, which may cause poor protein absorption and utilization from the gastro-intestinal tract of the animals (Iyayi, 1998 and Esonu *et al*., 2001). The Total protein observed were high and well

within the normal range across the treatment, which indicates that animals were all in good plain of nutrition.

Albumin concentration was lower in Red Sokoto bucks fed diet containing dried *Leptadenia hastata* (2.53 g/dl) and highest in bucks fed the control diet (2.86 g/dl) and those fed diet containing ensiled *Leptadenia hastata* (2.85 g/dl), they are however within the normal range. Higher glucose concentrations ($P<0.05$) were observed in bucks fed control diet and those fed with dried and Ensiled *Leptadenia hastata*. According to Mayes (1996) a continuous supply of glucose is necessary as a source of energy especially for the nervous system and erythrocyte. This implies that, the glucose level of bucks fed diet containing mixtures of dried and Ensiled *Leptadenia hastata* forage was inadequate or not properly utilized.

Creatinine and urea are nitrogenous end products of metabolism. Urea is the primary metabolite derived from dietary protein and tissue protein turnover. Creatinine is the product of muscle catabolism, Hosten, (1990). RSB fed the mixture of hay and ensiled *L.hastata* had higher creatinine and urea concentrations when compared to other diets, they are however all within the normal ranges for a normal functioning of kidney.

5.8: Lipid profile of Red Sokoto Bucks fed dry or Ensiled *Leptadenia hastata* forage

Some factors that can affect cholesterol, HDL, LDL and triglyceride levels in blood serum of goat are breed of goats, age, sex, nutrition, health status, disease, goat farm management, environment and biosecurity. HDL (high-density lipoprotein), or "good" cholesterol, absorbs cholesterol and carries it back to the liver. The liver then flushes it from the body. High levels of HDL cholesterol can lower the risk for heart disease and stroke. Animals fed diet containing ensiled *L. hastata* had significantly ($p<0.05$) higher HDL when compared to other diets, this

could be as a result of fermentation process involved the diet preparation. LDL (low-density lipoprotein), sometimes called “bad” cholesterol, makes up most of the body’s cholesterol. High levels of LDL cholesterol raise the risk for heart disease and stroke. Diets containing dried and ensiled *L.hastata* had higher values when compared to others they are however all within the normal range. Herinda *et al.,* (2019)

Feeding of *Leptadenia hastata* in dried or Ensiled forms or their mixtures increases the cholesterol content in Red Sokoto bucks. Cholesterol is a group of fats that is vital to cell membranes, nerve fibre and bile salts and it is a necessary precursor for the sex hormone (Alabi *et al*, 2017).

The observed cholesterol values were between 99.04 – 115.55 mg/dl. Although observed values were lower than values reported by oluche *et al* (2018), for red sokoto bucks fed diets containing varying levels of yam peel meal with *Ficus polita* as basal diets but they were within the normal range of 64.60-136.40 mg/dl reported by Plum (1999) for healthy goats. Cholesterol levels of 180 mg/dl and below is safe in ruminants and may not result to arteriosclerosis MC Donald *et al* (1995). This showed that diets containing the *leptadenia hastata* did not unduly elevate the cholesterol levels to cause hepatic damage. Abnormally high cholesterol is not desirable as continual deposition of cholesterol may lead to narrowing of the coronary arteries resulting to cases of cardiac arrest and heart failure Alabi (2012).

5.9: Economic evaluation of Red Sokoto Goat fed dry and Ensiled *Leptadenia hastata* forage in a total mixed ration.

The value of gain is highest in animals fed control diet; however it is comparable to the animals fed diet containing ensiled *L. hastata*. The Total cost of feed consumed was lowest in animals

fed diet containing mixtures of dried and ensiled *L. hastata* but had the highest cost/kg gain. Supplementation of diet III with ensiled *L.hastata* reduced cost/kg gain when compared to the control and other diets. This is in consonance with Nsidinanya *et al*. (2020) who observed that supplementing diet of Red Sokoto bucks with Malted Sorghum Sprout reduced their cost of production while showing appreciable weight gain in the animals. The Net benefit was observed highest in animals fed control diet followed by diet containing ensiled *L.hastata*. The return of investment was however highest in animals fed ensiled *L.hastata* when compared to the control and other diets. The highest profit recorded as noted in diet containing ensiled *L.hastata* forage could also be as a result of the high feed conversion ratios (FCR) of these bucks fed diets with the consequent higher weight gain.

CHAPTER SIX

6.0 SUMMARY CONCLUSION AND RECOMMENDATIONS

6.1 Summary

To bridge the gap of dry season feeds and feeding problem, there is a need to search for alternative feed materials that are cheap and can provide the needed nutrients for the animals. This research was conducted to evaluate the growth performance of red sokoto bucks fed dried or Ensiled *Leptademia hastata* forage in a Total Mixed Ration. Sixteen Red Sokoto Bucks were used for this experiment; they were divided into four treatments with four animals in each treatment in a completely randomized design. The animals were fed 3% of their BW daily and water was provided *ad-libitum*. The experiment lasted for a period of ninety (90) days which determined growth performance, apparent nutrient digestibility, nitrogen balance, heamatological parameters, serum parameters, lipid profile and economic analysis. Results of the growth performance showed that there were significant differences ($P<0.05$) in total weight gain, average daily weight gain, total feed intake, average daily feed intake and feed conversion ratio. The Apparent digestibility by Red Sokoto bucks fed diet containing Ensiled *Leptadenia hastata* had significantly ($P<0.05$) higher dry matter (66.17%), crude protein (83.67%), crude fibre (68.57%), ash (80.77%), ether extract (80.97%) and nitrogen free extract (72.57%) compared to

other treatments. Results of nitrogen balance showed there were significant differences ($P<0.05$) in all the measured parameters across the dietary treatments. Nitrogen intake was higher for bucks fed Ensiled *Leptadenia hastata* diet and least for those fed combination (50:50) of dried and Ensiled *Leptadenia hastata*. Results of haematological parameters showed there were significant ($P<0.05$) differences in packed cell volume (PCV%), haemoglobin (hbmg/dl), red blood cells ($RBCx10^{12}/L$), white blood cells ($WBCx10^{9}/L$), neutrophils (%), while lymphocytes(%), eosinophil(%), monocyte(%), basophils(%) and mean corpuscular volume(MCV fl) were not different ($P>0.05$) across the treatments. Lipid profile result showed there were significant differences ($P<0.05$) in all the measured parameters across the dietary treatments. High density lipoprotein (HDL) was significantly ($P<0.05$) higher in Red Sokoto bucks fed dried *Leptadenia hastata*. Low density lipoprotein (LDL) and tryglycerides were significantly ($P<0.05$) higher in Red Sokoto Bucks fed dried, Ensiled and mixtures of *Leptadenia hastata*. It was therefore concluded that *Leptadenia hastata* forage had effect on the growth performance, nutrient digestibility, nitrogen balance, haematological parameters and lipid profile of Red Sokoto Bucks. It was also observed that addition of *Leptadenia hastata* forage in diets of Red Sokoto bucks is cost effective.

6.2 Conclusion

The following conclusions were made from the results of this study:

- Inclusion of ensiled *Leptadenia hastata* forage in the diet of Red Sokoto bucks improved their growth performance, nutrient digestibility, haematological, serum and lipid profile.
- Diet containing ensiled *Leptadenia hastata* forage was more cost effective as it gave better value of gain, net benefit and return to investment.

6.3 Recommendations

The following recommendations are made from the results of this study:

1. Subsistence and commercial farmers could incorporate 20% of Ensiled *Leptadenia hastata* forage in the diets of Red Sokoto bucks for improved growth performance, nutrient digestibility, nitrogen retention, as well as lipid profile since *L. hastata* did not unduly elevate cholesterol levels, hence safe for human consumption.

2. At 20% inclusion levels of *Leptadenia hastata* forage, there was an improved value of gain and decreased total cost of feed consumed by Red Sokoto Buck, hence could be supplemented in their diet to reduce feed cost.

3. Further research should be conducted on the incorporation of ensiled *Leptadenia hastata* forage in the diets of Red Sokoto bucks above 20% inclusion level.

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