EFFECT OF ENSILING EGGPLANT *(Solanum melongena L.)* FORAGE ON INTAKE AND NUTRIENT DIGESTIBILITY BY YANKASA RAMS

BY

Lilian Ijeoma OKEREKE
M.Sc/AGRIC/1083/2011-2012

DEPARTMENT OF ANIMAL SCIENCE,
FACULTY OF AGRICULTURE,
AHMADU BELLO UNIVERSITY, ZARIA,
NIGERIA.

JULY, 2015.

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A THESIS "SUBMITTED TO SCHOOL OF POSTGRADUATE STUDIES"AHMADU BELLO UNIVERSITY, ZARIA NIGERIA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR DEGREE OF MASTERS OF SCIENCE IN ANIMAL SCIENCE DEPARTMENT, AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA.

JULY, 2015.

DECLARATION

I declare that the work in this thesis titled **EFFECT OF ENSILING EGGPLANTS (*Solanum melongena L.*) FORAGE ON INTAKE AND NUTRIENT DIGESTIBILITY BY YANKASA RAMS''** was written by me in the Department of Animal Science, Ahmadu Bello University, Zaria ,under the supervision of Prof. C.A.M Lakpini and Dr. S.B Abdu. The information derived from the literature has been dully acknowledged in the text and the list of references provided. No part of this thesis was previously presented for another Degree or Diploma at this or any other Institution.

____________________________ _______________________

OKEREKE, Lilian Ijeoma **Date**

CERTIFICATION

This thesis titled **EFFECT OF ENSILING EGGPLANT (*Solanum melongena L*) FORAGE ON INTAKE AND NUTRIENT DIGESTIBILITY BY YANKASA RAMS** meets the regulations governing the award of the degree of masters degree of the Ahmadu Bello University and is approved for its contribution to knowledge and literal presentation.

Prof. C.A.M. Lakpini Chairman, Supervisory Committee Nat. Anim.Prod.Res.Inst. Ahmadu Bello University Zaria.	___________________ Signature	_________________ Date
Dr. S.B. Abdu Member, Supervisory Committee Dept. Anim.Sci. Ahmadu Bello University Zaria	___________________ Signature	_________________ Date
Prof. S. Duru Head of Department of Anim. Sci. Ahmadu Bello University Zaria	_________________ Signature	_______________ Date
Prof. A.Z. Hassan Dean, Post- Graduate School of Studies Ahmadu Bello University Zaria	_________________ Signature	_________________ Date

DEDICATION

To the GOD of Chosen and my lovely family mother Josephine Innocent, father late Innocent Okolorie, brothers Uchenna and Ugochukwu Innocent, sisters Chinwendu and Rachel Innocent for their love and care to me.

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ABSTRACT

Forty-eight (48) Yankasa rams with average weight 21.67±1.6kg were used to study the effects of ensiling eggplant (*Solanum melongena L.*) forage on nutrient digestibility, intake, anti-nutritional factors, mineral content, nitrogen balance and haematological parameters in rams. The rams were randomly assigned to eight treatments, with six rams per treatment in a completely randomized design. The forage consisted of *Digitaria smutsii* hay and concentrate which was fed at 3 and 2 % of body weight (BWT), respectively. A metabolism trial was conducted to investigate the effect of the forage on nutrient digestibility and nitrogen balance. The results indicated that feeding the ensiled eggplant forage had significant ($P<0.05$) effects on nutrient digestibility, dry matter intake (DMI) (62.65±2.67) and crude protein (CP) (69.98 ±2.28). The nitrogen balance in ensiled eggplant forage had significant ($P<0.05$) effects on all parameters measured (N intake 40.88 to 47.96 ± 3.77gm, retention13.01 to 28.66 ±3.00) The forage had the best result in eggplant plus urea treatment in dry matter intake (DMI) 875.5 g/d which translated into higher ($P>0.05$) weight gain of 1.40kg and average weight gain (ADWG) of 75.00 g/d. The anti nutritional factors were higher in oxalate and Saponins (22.88 to 28.60 and 14.17 to 24.43). Bleeding period had no effect ($P>0.05$) in all blood metabolites expect blood urea nitrogen and creatinine ($P<0.05$). The blood haematocrit (plasma) had significant ($P<0.05$) effects in all parameters. The mineral content was higher in calcium and potassium (1.68 to 2.67 and 2.54 to 3.44). The pH ranged from 3.81 to 4.25 which indicated good silage. The studies showed that ensiled eggplant forage had effect on nutrient digestibility, nitrogen balance and the blood haematocrit (plasma) in Yankasa rams. Therefore eggplant forage as unconventional feed can be used to feed Yankasa rams during critical period of feed scarcity without any adverse effects.

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ABBREVIATIONS

ADF	Acid Detergent Fiber
ADWG	Average Daily Weight Gain
BWT	Body Weight
CF	Crude Fiber
CP	Crude Protein
CSC	Cotton Seed Cake
DMI	Dry Matter Intake
EGPT	Eggplant
FCR	Feed Conversion Ratio
H/C	Hemicellulose
KG	Kilogram
LAB	Lactic Acid Bacteria
Mg	Milligram
NAPRI	National Animal Production Research Institute
NDF	Neutral Detergent Fibre
PCV	Packed Cell Volume
RBC	Red Blood Cell
WAD	West Africa Dwarf
WBC	White Blood Cell

CHAPTER ONE

1.0 INTRODUCTION

Eggplants are widely grown in most parts of sub-Saharan Africa, especially, in the urban and rural areas, and they constitute the most macro and micro nutrients which can be purchased in affordable price. The name "Egg plant" was derived from the shape of the fruits of some varieties which are white and shaped like chicken eggs *(*Chen *et al.*, 2001). The plant (*Solanum* spp) is a vegetable with increasing popularity in the world (Pessarakli and Dris, 2003), and it originated from Tropical Africa (Norman, 1992). It is an economic flowering plant belonging to the family Solanaceae, of which members of about 1,400 species are found in the temperate and tropical regions of the world. The fruits of the plant come in a wide array of shapes and colours, some are yellow, green, white, yellow stripes and green stripes fruits are widely grown in most parts of sub-Saharan Africa**.** Chen *et al*, (2001).

Nutritionally, the fruits of an egg plant contain water (92.5%), protein (1%), fat (0.3%), and carbohydrates (6%) Sabo and Dia (2009). They contain between 30 and 50% of iron (Fe), fiber, potassium (K), manganese (Mn), copper (Cu) and vitamins; thiamin (vitamin B1), B6, folate, magnesium (Mg), sodium (Na) and niacin. Egg plant also contains phyto-nutrients such as nasunin and chlorogenic acid (Sabo and Dia, 2009). It is a very good source of dietary fiber. Eggplant are medically processed and used in the preparation of condiments and products used in treating different diseases and health problems (Burkill, 1985). A meal of eggplants is proven to be of benefits to patients suffering from raised intraocular pressure (glaucoma) and convergence insufficiency, as well as in heart diseases and *Arteriosccerosis* (Harish *et al.*, 2008). The plant can be regarded as a brain food because it houses the anthocyanin phytonutrient found in its skin, Nasunin, a potent antioxidant and free radical scavenger that has been shown to protect cell membranes from damage Harish *et al.*, *(*2008).

However, the presence of toxic factors or anti-nutritional components in eggplants forge has been one major challenge in realising the full benefits of the nutritional value of eggplant forage (Liener, 1969; Nwokolo and Bragg, 1977; Lewis and Frenwick, 1987). Although the presence of these anti nutritional factors is always in large quantities, they have been established to play significant roles in the nutritional quality of food. The anti nutritional factors (ANFs) interfere with metabolic processes and availability of nutrients, which may also cause toxicity during period of scarcity (Kumar, 1992). The ANFs in this vegetable can be tannins phytate, oxalate, saponins, alkaloid and cyanides.

Tannins have the ability to precipitate certain proteins. They combine with digestive enzymes thereby making them unavailable for digestion (Abara, 2003; Benita and Khetarpau, 1997). Phytic acid (inositol hexa phosphate) is an organic acid found in plant materials (Heldt, 1997). Phytic acid combines with some essential elements such as iron, calcium, zinc and phosphorus to form insoluble salts called phytate, which are not absorbed by the body thereby reducing the availability of these elements (Erdman, 1979).

Oxalate binds to calcium to form complexes (calcium oxalate crystals). These oxalate crystals prevent the absorption and utilization of calcium by the body causing diseases such as rickets and osteomalacia (Ladeji *et al.,* 2004). The calcium crystal may also precipitate around the renal tubules thereby causing renal stones. The formation of oxalate crystal is said to take place in the digestive tract (Thompson and Yoon, 1984).

Saponins are naturally oily glycosides occurring in wide variety of plants. When eaten, they are practically non poisonous to warm blooded animals, but they are dangerous when injected into the blood stream and quickly haemolyse red blood cells (Applebaum *et al.,* 1969).

Alkaloids cause gastrointestinal and neurological disorders (Aletor, 1993). The glycoalkaloids in *Solanum melongena L (*Saito *et al.*, 1990) are haemolytically active and toxic to fungi and humans. Some of the toxicological manifestations of potato glycoalkaloids involve gastrointestinal upsets and neurological disorders, especially in doses in excess of 20 mg/100 g sample (Aletor, 1993). The cyanide ions inhibit several enzyme systems; depress growth through interference with certain essential amino acids and utilization of associated nutrients. They also cause acute toxicity, neuropathy and death (Osuntokun, 1972). Cyanogenic glycoside on hydrolysis yields toxic hydrocyanic acid (HCN). Despite the fact that eggplant forages are not consumed by ruminant animals due to high level of anti nutritional factors, there is lack of information on the anti-nutritional composition of this forage which makes it unacceptable to ruminant animals.

1.1 Justification

There are many types of vegetable forages not consumed by man and which have very limited use in feeding animals because of their high content of anti nutritional factors and are wasted by farmers. These forages which are presently wasted and burned can become useful as feed for sheep and other ruminants if the ant nutritional factors are reduced to tolerable limits. Therefore the aim of this study was to evaluate the effect of treated ensiled eggplant forage on performance of Yankasa rams.

1.2 Objectives

The objectives of this study were to;

1. Evaluate selection preference of different ensiled eggplant forage
2. Determine the effects of feeding ensiled eggplant forage on digestibility and blood metabolite in Yankasa rams.
3. Determine the effect of ensiled eggplant forage with different additives.

1.3 Hypothesis

Null Hypothesis (Ho): Ensiled eggplant *(Solanum melongena L.)* treated with some additives has no significant effect on digestibility and blood metabolites of Yankasa rams.

Alternate Hypothesis (Ho): Ensiled eggplant *(Solanum melongena L.)* treated with some additives has significant effect on digestibility and blood metabolites of Yankasa rams.

CHAPTER TWO

2.0 LITERATURE REVIW

2.1 Importance of Small Ruminants

The importance of small ruminants in the tropics in general is well recognised (Williamson and Payne, 1978). Small ruminants are reared mainly for four functions, namely: Meat, milk, skin and wool, according to order of importance FAO (1982). Sheep contribute enormously to the protein requirements of most developing countries (Mandal *et al*. 2007; Muhammad *et a*l. 2008). In Sub-Saharan Africa, sheep provide almost 30% of the meat consumed and around 16% of the milk produced. David-West (1985) estimated that sheep and goats contribute about 35% of the total animal meat production in Nigeria. This ranks small ruminants as the second most important suppliers of meat protein to the population after cattle (Maigandi 2001; Ajala *et al*. 2003; Ugwu 2004). Sheep and goats constitute a good source of family income and livelihood, assets and agricultural resources for smallholder farmers (Iyayi and Tona 2004; Shittu *et al.* 2008; Salem-Ben and Smith 2008). This makes small ruminant farming an important and secured form of agricultural investment to the Nigerian rural and urban farmers Integration of sheep with crop agriculture usually occurs under subsistence conditions on small-scale farmers. They form an integral part of the system, providing milk, meat, manure and cash to the farm family during the time of need. 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 (Ngatazie 1989; Rege 2001). Small ruminants have been reported to be prolific (Otchere 1985) and need only short gestation periods to increase flock size. This therefore makes traditional small ruminant production system a low input but high output enterprise with predictable profitability and economic returns (Nwafor2004)

2.2 Distribution of Small Ruminants in Africa.

Wilson (1982) reported that sheep and goats accounted for 17% of the total ruminant population in Africa Total meat produced from small ruminants in Africa was 1.3 million metric tonnes (about 16% of the world total from sheep and goats). Within Africa, sheep and goats contributed 10.9% and 8.4%, respectively, of our total meat. Total meat from African sheep and goats contributed 12.0%, respectively, of the world total meat production from these two species David (1985) Sheep and goats in Africa produced 8.6% and 18.2% respectively, of the world total amount of milk produced from these two species and the production from both accounted for 13.6% of milk collected from small ruminants in the world Jimmy (2007). Tropical Africa has about 22% and 17% of the total world sheep and goat population of 1,028 million and 765 million respectively (Tibbo 2000; LDC 2002; Chantalakhana and Skunmum 2002; Nwafor 2004).

2.3 Population and Distribution of Small Ruminants in Nigeria

The total population of sheep and goats as reported by Bourn *et al.*, (1994) was 22,100,000 for sheep and 34,500, 000 for goats. Nigeria is home to about 22.1 million sheep and about 70% of the small ruminants are found in the semi-arid zones of Nigeria and these belong to the agro-pastoral farmers utilizing extensive and semi-intensive management systems (Ajala *et al*. 2003; Mbilu 2007). Alawa (2002) reported that the bulk of sheep and goats in Nigeria is of traditional free–rang type while Bayer (1984) also said that within Nigeria, livestock density in the sub-humid zones is lower than the semi arid zones. Wilson (1982) cited Mosi *et al*., (1982) reported that 73% and 20% of farmers owned goats and sheep respectively in the forest and derived savanna of south west Nigeria. They reported a mean flock size of 2.8 and 3.1 for goats in the forest zone and derived savanna zone, respectively and 2.0 sheep in the forest. 13% and 16% of agro-pastoralists in Giwa, in Kaduna state owned sheep and goats (Otchere, 1985).

2.4 Importance of Small Ruminants in Nigeria

Small ruminants have a high fertility rate and high prolificacy which range from 120 -135%. Twining rate is generally high in goats up to 55 -60% while that of sheep is about 20-22%. Estrous cycle of sheep is about 16 to 17 days while that of goats is 18days. (Devendra and Mcleroy, 1982). It has important role in the national economy and in the lives of small scale farmers. The are primarily kept for meat in Nigeria (Fajemisin, 1991). Small ruminants contribute an estimated 35% of total meat in Nigeria (Bayer, 1984). Goats meats have been estimated to account for about 20%, while sheep account for 15% of all meat eaten in Nigeria (Brinkmann and Adu, 1977) Small ruminants also contribute to the economic welfare of small scale farmers. The are kept as investments which provides easy and very fast source of income (Jimmy 2007). The are sold when the need arises and the income generated is used for household or farming activities. The also play an important role in the socio-cultural lives of the Nigerian population. The are highly demanded for and utilized during ceremonies and festivals.

2.5 Breeds of Sheep

There are four main breeds of sheep in Nigeria, namely, Balami, Uda, Yankasa and West African Dwarf. These differ considerably in size, coat-colour and other characteristics (Oni, 2002).

2.5.1 Balami

It is found throughout the North-eastern part of the country but is more concentrated in Borno State. The Balami is a big, predominantly white sheep with a pronounced convex face. The ear is large and droopy. Horns are prominent in males but absent in the females. The mature male has a characteristic dewlap-like fold of skin with heavy hairy white mane. Mature body weight varies between 45 and 60kg in males and 35 to 45kg in ewe (Oni, 2002).

2.5.2 Uda

The breed is more predominantly found in the Sahel and savanna zones of tropical Africa as well as North-western part of the country. It has a characteristic coat colour pattern of black or brown in front and white behind. The Uda is a large long-legged sheep with a convex face, the ear is long, large and pendulous. The rams possess horns which become large, wide and spiral as they mature. Horns are usually absent in the ewes. Mature live weights are 30 to 45kg in ewes and 30 to 55kg in rams (Oni, 2002).

2.5.3 Yankasa

It is the most numerous and widely distributed sheep breed in Nigeria. It is found throughout the Sahel, Sudan and guinea savanna zones. The breed is intermediate between large long legged uda, balami and short legged West Africa Dwarf. The coat colour is typically white with black patches around the eyes, ears, muzzle and feet. Some of the ewes have wattles. The rams have horns. The mature rams have heavy hairy white mane. Mature live-weights are 30 to 45kg in rams and 25 to 30kg in ewes (Oni, 2002).

2.5.4 West African Dwarf Sheep

The breed is found predominantly in the southern part of the country. It is small and short-legged. The coat-colour varies from all white, all black or brown to a spotted black or brown on a white coat. Many of the sheep have wattles. Males carry horns. The breed is a hardy animal with a compact body. It is tolerant to trypanosomosis (Oni, 2002). Matured females have tassels while matured males have spiral or crescent shaped horns. The breed has a slow growth rate and matures between 18-24months. Matured females weigh 20-25kg and matured males weigh 20-30kg

2.6 Small Ruminants Management and Production System

Management encompasses all the total care given to animals in order to enhance their productivity and survival. These include feeding, housing, health care, record keeping and several other practices. To a large extent, it determines the productivity of the animals being reared (Lakpini, 2002). According to Mack *et al*. (1985), management of sheep and goats in Nigeria are under extensive and intensive systems. In the sub-humid regions, goats and sheep are reared in association with cattle under a production system characterized as nomadic pastoralism. In the humid regions, they are integrated into the traditional farming system. They are tethered in the homesteads and fed with cut fodder and other household refuse. Three systems of small ruminant production are practiced in Nigeria and these include extensive, intensive and semi intensive (Gefu, 2002).

2.6.1 Extensive System

This system requires low input which consequently results to low productivity. Animals under this system are left to graze by themselves on natural pastures with no supplements being provided. Housing and medical care are also not provided. In general, the animals are exposed to a great deal of environmental hazards. It is the most predominant system practiced in the rural areas (Gefu, 2002). However, Devandra and Burns (1970 in Jimmy, 2007) stated that such fully extensive system of goat management is hardly possible in the tropics, since in most countries where they are kept, it appears customary to house them during rain. Some form of ethno veterinary care is also provided in some places.

2.6.2 Intensive System

This system involves zero-grazing, that is, the animals are not allowed to graze at all. They are completely confined in their houses where feed and water are taken to them. Good quality fodder such as hay, silage and soilage are fed and this is also supplemented with concentrates. Good health care is also provided for the animals. This involves taking preventive measures by vaccination, endo- and ectoparasite control and therapeutic treatment. Proper records are also kept for planning and breeding purposes. This system involves high capital and labour but is usually very productive. The system is becoming less common in Nigeria (Aden'ova, 1985) although it still exists in some government and corporate farms (Nuru, 1985).

2.6.3 Semi intensive System

This system is an intermediary between the intensive and extensive systems such that it combines features of both systems. Housing and other infrastructures are provided but the animals are not completely confined. The animals are allowed to graze on improved fenced pastures for some time and are later fed with concentrates as supplements. Health care and other management practices are also provided (Lakpini, 2002).

2.6.4 The Improved Production System

The improved systems of sheep production are the intensive and semi-intensive systems. The intensive production and management system involves complete confinement of the animals where feeds, water, housing and health care are provided (Lakpini, 2002). The animals are zero grazed. This system is obtained in Research Institutes; Universities, and Livestock Investigation and Multiplication Centers. The semi-intensive production system is partially intensive and incorporates some practices in the extensive system. Here, the use of crop residues and agro-industrial by-product are effectively and economically combined with grazing (Aregheore, 2009).

2.7 Forage Feed Resources of Ruminant Animals

With the current increase in crop production through massive land clearing, coupled with population growth and hence the development of more and larger towns, cities land-use pattern is changing, less land is available for crop livestock production, natural vegetation forms the most important feed for ruminant livestock.

The dominant vegetation of the semi-arid and arid zones is forages and they constitute the major component of the natural pastures. The zones are characterized by long, dry season and grasses during this season are dry and of low quality. The density and importance of livestock is however, highest in this region. This type of imbalance in animal population in relation to pasture and availability is found in certain parts of Asia and the far East(Attah-Krah,1989.Devendra,1990).This creates feed constraint to livestock and alternative feed to grasses are utilized especially in the dry season. Adegbola (1982) reported that the period animal could graze on the range annually varies with ecological zones of the country. Sahel could support three to four months of grazing while Sudan and Guinea Savanna might support about five to seven months, respectively (Areghore, 2009).

2.7.1 Natural grass

The Northern Guinea savanna consists of open woodland and has the following grass species: *Hyparrspheni spp., Andropogon gayanus, Imperata cylindrical, Pennisetum pedicellatum, Digitaria spp.* and *Setaria sphacelata* ,while Southern Guinea savanna has *Pennisetum purpurerum, Andropogon tectorum, Panicum maxmum* grass species. (Areghore, 2009). During the wet season, some minimum level of animal production can be supported by these grasses without supplementation (Otaru, 1998).

Pasture grasses exhibit some growth characteristics which affect their quality. The forage mature early in the wet season which results in a rapid increase in lignifications and a decline in nitrogen and soluble carbohydrates content (Bosman, 1989; Areghore, 2009). Protein is the most critical nutrients for animals grazing poor quality pasture especially during the dry season

(Ademosun,1988).Crude Protein (CP) content ranging from 7 to10% has been reported for the native grasses in early wet season while during dry season the CP falls to about 1.5 and 3% (Smith,1992; Adamu *et al*.,1993), hence the reduction in voluntary dry matter and animal performance. According to Smith (1993), the minimum level of CP in forage that enhances voluntary intake, digestibility and utilization is about 7%

2.7.2 *Digitaria smutsii* stent (Woolly finger grass)

Digitaria smutii is a robust, tufted, non-stoloniferous perennial with culms up to 150cm high, usually branched, lowest leaf-sheaths densely hairy at the base, leaves otherwise glabrous or with scattered tubercie- based hairs on the lower sheaths, blades up to 60cm long, 6-12mm or more wide expanded ligule 2- 3.5mm long, eight to ten, sometime four to six racemes up to 15cm long, arranged digitally or more often ,alone or in whorl on central axis up to 7cm long, the flower often divided and compound in the lower half, spikelet 3.5-4mm long fairly conspicuously hairy (Gibbs-Russell *et al*.,1990).It is native to Transvaal, Orange Free State, Northern Cape Province in southern Africa. It is propagated by division of root-stocks or by seed. It has the ability to spread from stolons and it is tolerant to heavy grazing, drought and it responds to fertilizer application.

2.7.3 Crop residues

Crop residues improved the soil organic matter and total soil N levels in the soil (Cassman *et al*., 1996). Crop residue is a good source of nutrients in many agro-ecosystems for crop production (Blanco-Canqui and Lal, 2009) and reducing dependency on chemical fertilizers. Crop residues are the plant materials that remain after food crops have been harvested. The main crops in the Sahelian zone are millet, sorghum, cowpea and some tubers. Millet is the principal grain crop in the dry semiarid zone (sole-cropped or intercropped with cowpea), comprising 65% of total output of 7 West African countries, with yields of the residues estimated to be 1000 to 2000 kg DM/ha

(Williams *et al.*, 1997). As a greater proportion of the land is brought under cultivation to meet the needs of a growing population, crop residues have become an important source of livestock feed (Harris, 2002).

2.7.3.1 Cereal crop residue

Ademosun (1985) reported that in the sudano-sahelian zone of Nigeria, crop residues have traditional constituted a substantial component of feeds of ruminants to the mutual advantage of nomadic pastoralists and crop farmers. This has become a relevant area of research as a result of the ever increasing price and often shortages of the conventional energy and protein feeding stuffs in Nigeria. Ikhatua *et al;* (1992) and Ikhatua (1996) reported the nutritive values of maize stover, cowpea haulms (and cassava peels). On Deccan plateau of India, Rama Devi *et al*. (2000) concluded that food from grain/pods and fodder from the crop residues almost equally contribute to livelihoods in mixed-crop livestock systems .The quality of the material when fed depends on degree of care taken in handing. Grains by –products are classified to serve as energy and protein sources Ehoche *et al*., (2003). They are by- products of flour mill such as wheat bran, maize offal, rice offal, wheat offal, etc Varying levels of wheat bran have been used in sheep and goat diets at 12% ,35% Adu and Lakpini (2003), (Malau-Aduli *et al.*,2004).

Another milling by-product of importance apart from maize offal and wheat bran is rice bran .It is fairly palatable to animals and it is a good source of B-vitamins. It contains about 10-15% CF (Umoh, 1982). The composition and usefulness of these products vary with milling efficiency and the level of husk present. The limitation to the use of these by-products include; inadequate knowledge of the chemical composition and optimal feeding level, processing facilities, irregular supply and transportation. Wheat bran contains most vitamins and protein of the grain. It is a bulk feed that can be used to lighten dense and heavy feed mixture. It has slight laxative effect because its fibre is modest digested.

2.7.3.2 Legume crop residues.

Legumes are second only to grasses with respect to number of species. Legumes have very much higher protein level than grass (Agishi, 1998). The collection of legume haulms can be related to their high quality as feed and also to their low availability compared to cereal straws (De leuw, 1997). Groundnut (*Arachis hypogaea*) is one of the key crops of the semi-arid tropics. It is commonly cultivated as a food and feed crop that provides pods for human food and haulms for livestock feeding (Larbi *et al*. 1999; Omokanye *et al*, 2001). Lakpini (2003) reported that fed chopped groundnut haulm to Yankasa lambs recorded live weight gain of 130g per day while 90.2g per day for the unchopped haulm, crop residues of groundnut (*Arachishypogaea* L.) provide important feed resources for livestock production. Pande *et al*.,(2003), Bdliya (2007) reported that leaves of legume crops can provide good quality forage material in farms, groundnut haulms are rich in protein and more palatable than many other fodders (Liao and Holbrook, 2007). It is a nutritious feed for livestock containing protein (8-15%), lipids (1-3%), minerals (9-17%), and carbohydrates (38-45%) at levels higher than cereal fodder. It also releases energy up to 2.337cal kg-1 of dry matter (Singh and Diwakar, 1993).

Legumes are characterized by the fact that rhizobia organisms in the nodules attached to their roots systems have the ability to transform atmospheric N into a forum that can be used by the plant: therefore, nitrogen doses not need to be provided (Kellems and Church, 2002). These plants have high crude protein content and are also rich in mineral required for growth and development in pregnancy and lactation. Many crop legumes are dual purposes they are produced for human consumption and forage for livestock .Some at the stage of maturation lose their leaves and become stemmy, resulting in decline in their nutritive value (Lakpini, 2002).

2.7.3.4 Agro-industrial by products

Agro-industrial byproducts are used for animal feeding (Qureshi, 1987), in many developing countries they constitute the main feed resource (Qureshi, 1993). Nordblom and Shomo (1995) reported that agro industrial by products are important in feeding of sheep and goats under different management system. Small ruminants in the Asian region obtained a substantial maintenance from residues (Jayasuriya, 1985). Agro-industrial by-products are abundant in Lebanon. The by-products are Wheat bran, Dried beet pulp, Beet molasses, Citrus pulp, Citrus molasses, Carob pulp, Dried whey, Tomato pulp, Spent grains, Olive pulp and Leftovers from canning industries (IFAD,1991)

Recently, animal nutrition in Nigeria based on minimum input and efficient utilization focuses on the use of agro-industrial by-products in ruminant feeding (Uamai, 2000). Ikahtua and Asaka (2000) found that 50% supplementation level of rice bran-based concentrate in supplementing grass forage (*Panicum maximum*) gave the best response in feed utilization ,live weight gains and blood parameters of the West African dwarf goats.

Concentrate are less fibrous feed condensed in nutrients and in little quantity given to livestock to make up for the deficient nutrients in basal diet (Lakpini, 2002). They are usually more digestible than either grains or their by-products. They can be fed sole or compounded to meet maintenance and production requirements. Few by-products make complete diets while some have to be mixed with other available feeds.

2.7.4 Browse Plants

Browse refers to leaves and twigs from shrubs and trees available to ruminants as feed and in a broader sense including also flowers and fruits or pods. Browse is a complex issue, as discussed by Le Houerou (1980), depending on plant species, animal species, forage availability and accessibility and the nutritional state of the animals. Wicken (1980) reported that the flora of tropical Africa browse contains more than 7000 species of trees or shrubs of which at least 75% are browsed have greater extent, probably about 50% are useful to man. Apart from being browsed. It has a multiple usage to man, , farmers in semi-arid zone of West Africa have traditionally desired specie such as *Acacia albida* are valuable because of its ability to improve soil fertility through nitrogen fixation,, vegetation cycle of tree, and produces green leaves in the dry season for feeding animals, and production manure from the animals. The trees serve as source of income through the sale of leaves, fruits and wood, and ethno medicinal (Akpo *et al.*, 2003).

2.7.5 Importance of Browse Plants to Ruminants.

Browse trees and shrubs have nutritive importance to ruminants (Briggs *et al.*, 1999; Thorne *et al.*, 1999; Komwihangilo *et al.*, 2001). Browse has attracted scientists' attention during drought periods. This important information was reported on International Conference of Browse in Africa, dealing with various aspects of browse plants (Le Houerou, 1980). Indigenous browse species are well adapted to the local environment well acceptable to the farmers. Browse planting materials can easily be collected in the area. Some researchers (Komwihangilo *et al.*, 1995; Roothaert and Frankel, 2001; Okoli *et al.*, 2003) reported the diversity of browse species, their palatability by livestock, quality and chemical analysis (Bayer, 1990 and Scoones, 1994) as well as their preference by some selected animals (Mtengeti and Mhelela, 2006). They serve useful purposes to famers such as the provision of food, drugs, firewood and constructional materials. Dicko and Sangare (1981) reported that Browse are harvested and marketed and income are generated in some rural areas, fodder trees and shrubs trade are lucrative business in the Sahelian zone of West Africa.

2.8 EGGPLANT (*Solanum melongena L.*).

Eggplant was introduced throughout the Mediterranean area by the Arabs in the early Middle Ages. It is native to the Indian Subcontinent (Doijode, 2001). It has been cultivated in southern and eastern Asia (Dunlop, 2006). Eggplant fruit is popularly called aubergine (UK), garden egg, brinjal (India: Singh *et al.,* 2009). The name eggplant derives from the shape of the fruit of some varieties, which are white and shaped very similarly to chicken eggs. The color, size, shape of the eggplant fruit vary significantly with the type of eggplant cultivar (Tiwari *et al*., 2009).

Cooke (1972) reported that the major nutrients required by the crop are nitrogen (N), phosphorus (P) and potassium (K). Inadequate supply of any of these nutrients during crop growth is known to have negative impact on the reproductive capability, growth and yield of the plant (Vine, 1953; Solubo, 1972). Garden eggs are resistant to molds, mildews, and certain soil-borne pathogens. It is drought resistant, and has the ability to grow in humid areas. It can be intercropped and yield more fruits on a small piece of land. In addition, it is easy to grow and a good plant for research (Stone *et al*., 2011).

2.8.1 Varieties of Eggplant Fruits.

There are over 1,000 species of eggplants cultivated worldwide, out of which about 25 species are domesticated in Nigeria (Bonsu *et al*., 2008; Manoko and van der Weerden, 2004). In Nigeria, eggplant fruits are called with different names such as gauta in hausa, afufa or anara in igbo or igba in yoruba (Edem *et al*., 2009). They come in different species and varieties, varying in fruit color, shape, and size (Akanitapichat *et al*., 2010; Chinedu *et al*., 2011). *Solanum gilo* is varity of egg plant. it is commonly used for hospitality in place of kola nuts and as stew condiments with other *Solanum species* in traditional medicine as antioxidants and laxatives Hanson *et al* (2006) .*Solanum gilo* is grown in areas of high rainfall Knapp(2011) This species of eggplant has bitter taste and is cultivated in the same way with other species Shell *el at* (2008) The fruit turn red or orange in colour when ripened. The egg plant can be used in indigenous medicine for treating several ailments including constipation, weight loss, obesity, diabetes, glaucoma, rheumatic disease and swollen joint pains Mennella *et al* (2010).

Solanum aethiopicum L and *Solanum macrocarpon* L, are another species of eggplant. Schippers (2000).*Solanum zuccagnianum*. (Nakati) this another specie of eggplant used in Cameroon. This species is mostly found in the higher rainfall zones of most West and Central African countries. It is of local importance especially in Uganda and south-eastern Nigeria. Ugandan people call it *nakati* and this is the most abundant leafy vegetable found in the Kampala market Daunay (1991).

2.8.2 Importance of eggplants in nutrition.

Eggplant is low in calories, rich in vitamins and minerals, prevents cancer and lowers cholesterol (Traci, 2013). It contains chlorogenic acid and nasunin which act as antioxidants and anti-mutagenic agents. Eggplant is believed to lower blood cholesterol in South American countries (Botelho *et al*. 2004), which has prompted some of the research into its possible effects on cardiovascular disease. However, an early trial in humans showed only a modest and transitory effect of consumption of a powdered eggplant preparation in terms of total cholesterol and its fractions, triglycerides and apolipoproteins in blood (Guimaraes *et al*. 2000). Also contrary to expectations, Bothelo *et al*. (2004) found that rather than decreasing plasma cholesterol and preventing the development of atherosclerosis, in a mouse study eggplant appeared to increase oxidative stress. It is also an excellent source of dietary fiber (Traci, 2013). It is one of the important fruit vegetable crops grown in Nigeria (Thompson and Kelly, 1977). Its fruits which are utilized as vegetables contribute essential nutrients in our diet (Norman, 1974; Langer and Hill, 1976; Siemonsma, 1981). It contains a higher content of free reducing sugars, anthocyanin, phenols, glycoalkaloids (solasodine) and amide proteins. The bitterness in some varieties of eggplant is due to the presence of glycoalkaloids.

Eggplant contains some medicinal properties used in the treatment of diabetic and liver patients (Salunkhe and Kadam, 1998).

Joseph, (2014) reported that the leaves and roots of eggplants are juiced or boiled to treat throat and stomach troubles, asthma, skin diseases, rheumatism, inflammation, intestinal hemorrhages, foot pain, coughs, anorexia and toothache. Eggplant fruits had low calorie, low sodium and low protein, and high in dietary fibre and potassium. it regulate the blood pressure, and help to maintain and regulate the function of the heart. Because of the high fibre and low soluble carbohydrate content of the eggplant fruits, it controls glucose absorption and reduces the risk of hypertension. Eggplant fruits had anti-ulcer remedy, which could be used as treatment for ulcer. It is good for patients with glaucoma because it served as antioxidants, which prevent cells in the body from damage. Eggplant leaves are also useful in treating snake bites. Sodipo *et al* (2012) reported that in Kenya, the juice of boiled roots is drunk to get rid of hookworms while the crushed leaves are used to treat stomach disorders

2.8.3 Effect of eggplants in animal nutrition

Eggplants contain 0.01mg per 100g of nicotine; it also contains same amount of nicotine as a cigarette (Edward *et al.,* 1993). Joseph (2014) reported that ancient Mediterranean people believed that constant eating of eggplant daily causes insanity. The flowers and leaves can be poisonous if consumed in large quantities due to the presence of solanine (Wikipedia, 2014).

2.9 Anti- Nutritional Factors in Plants

The anti-nutritive factors or antinutrients (ANFs) are substances generated in normal metabolism of natural feedstuffs (plants) by animal species which affect breakdown and utilization of feed (Aganga and Tshwenyane, 2003). Igile (1996) reported that these substances in plants may be acquired naturally or from chemicals such as fertilizer and pesticides. Some of these chemicals are known as ‘‘secondary metabolites’’ and they are highly biologically active in plant (Zenk, 1991). They include saponins, tannins, flavonoids, alkaloids, trypsin (protease) inhibitors, oxalates, phytates, haemagluttinins (lectins), cyanogenic glycosides, cardiac glycosides and coumarins.These substances either inactivate some nutrients, diminute the digestive process or metabolic utilization of feed (Kumar, 1992). However, trypsin inhibitors, (ANFs for monogastric animals), do not have adverse effects in ruminants because rumen microorganisms can degrade it in the rumen. (Cheeke and Shull,1985). ANFs limit the utility of the leaves, pods and edible twigs of shrubs and trees as animal feed (Kumar, 1992)

. 2.9.1 Tannins

Tannins are water soluble phenolic compounds with a molecular weight greater than 500 Daltons and with the ability to precipitate proteins from aqueous solution. They occur almost in all vascular plants. Different tannins in different plant samples may vary not only in total content, but also in their ability to affect degradability and to bind to proteins or fibre (Silanikove *et al.*, 2001). There are two chemically distinct types of tannins; soluble tannins (gallotannins and ellagitannins) and condensed tannin (Bederski, 1991). Generally, tree and shrub leaves contain both types of tannins. The two types differ in their nutritional and toxic effects. Soluble tannins can be absorbed into the blood stream and can reduce toxicological effects. Silanikove *et al.* (1999) reported that increasing content of tannins in foliage is associated with an increase of bound free material (mainly protein) and a decrease in the degradation rate of the degradable matter in the rumen, but not with an increase of the non degradable fraction. Therefore, organic matter, protein and cell wall digestibility are inversely related to tannin concentration.

Tannin are secondary plant metabolites found virtually in all plants but more quantitatively in dicotylendon, especially leguminous plants and other plants found in the tropic (Mueller-Harvey *et al.*,1987). Tannins are produced in response to stress factor including high intensity, high temperature, severe drought (Burn, 1966) and low soil fertility or nutrients (Barry and Forss, 1983). Tannins may have negative effect on nutritional value acceptability to browse by animals. Low to moderate level of tannis in forage is helpful to animals. They prevent bloating (Jones *et al.*, 1973; Ross and Jones, 1974) and more important reduce degradation of protein in the rumen, thus making available to the hind gut intact plant protein (Leinmuller *et al.*, 1991). Consequently, such forage with moderate content of tannins may be good sources for enhancing high nitrogen retention (Mcnabb *et al*., 1993), growth rate, as well as growth hormone (Barry *et al.*, 1986).

Feeds with more than 5% condensed tannins cause low intake, reduced digestibility and poor growth by ruminants (Leinmuller *et al.*, 1991). This agrees with earlier report by Diagayete (1981, cited by Leinmuller *et al.*, 1991) on high level of tannins in *Acaccia albida* forage (2.6% DM). Hydrolysable tannins do not enter into rigid binding with protein within the pH range of the rumen (Loomis and Battail, 1966) and therefore, it has little effect on digestibility of feed.

2.9.2 Phytate

Phytate is an important constituent of certain legumes, cereals and forage plants which is capable of chelating divalent cationic minerals like calcium, iron, magnesium and zinc. Such chelates make the elements nutritionally unavailable, thereby inducing dietary deficiency (Nelson *et al.*, 1968). Phytate can react with protein to from phytate-protein complex thereby rendering the protein unavailable to the animals. This reaction is influenced by the pH of the medium. Phytate is not destroyed readily by heat or soaking, but fermentation does liberate phosphates from phytate. Paul and Sontgate (1978) reported 1.06mg/g as lethal dose of phytate that cannot be tolerated by ruminant animals.

2.9.3 Oxalate

Oxalate like phytates bind minerals like calcium and magnesium and interfere with their metabolism. They also cause muscular weakness and paralysis (Soetan and Oyewole, 2009). Oxalates cause gastrointestinal tract irritation, blockage of the renal tubules by calcium oxalate, development of urinary calculi and hypocalcaemia (Blood and Radostits, 1989). The bioavailability of the essential nutrients in plant food could be reduced by the presence in these plants of some anti-nutritional factors such as oxalate and cynogenic glycoside (Akindahunsi and Salawu, 2005). Galloway and Cowling (2002) reported that oxalates affect Ca and Mg metabolism and the complex have inhibitory effect on peptic digestion. Ruminants, unlike monogastric animals, can consume considerable amounts of high oxalate plans without adverse effects, due principally to microbial decomposition in the rumen (Oke, 1968). It was reported that the oxalate content in eggplant is 0.19% (Vegetables and Vegetable Products, 1984).

2.9.4 Saponins

Saponins are secondary metabolite containing carbohydrate moieties to an aglycone which may either be steroidal or tritepenoid in structure. They are found in many plant species including those used for human and livestock feeding. Saponins have characteristic bitter taste and foaming properties (Agarwal and Rastogi, 1974). In non- ruminants, retardation of growth rate due primarily to reduction in feed intake is probably the major concern. Such effects have also been noted when *Sesbania sesban* leaf meal (saponin 0.71%) was incorporated in chick diet (Shgueir *et al*., 1989). Saponins have been reported to increase microbial nitrogen flow from rumen and decrease methane production, presumably due to defaunation of ruminal protozoa (Abreu *et al*., 2004). However, in ruminants because saponins may undergo bacterial degradation in the rumen, they may not retard their growth. Shodipo and Arinze (1985) have indicated a threshold for saponins of 2g for ruminants.

2.9.5 Alkaloid

Alkaloids are complex compounds containing nitrogen usually in heterocyclic and aromatic ring structures. They are basic in reaction, forming salt in the presence of acids. Often, they are poisonous to livestock but there are many examples of alkaloids with medicinal properties. They are almost universally bitter in taste.

Unlike some other anti-nutritional factors such as tannins and amino acids which tend to be concentrated in certain plant parts, alkaloids are often uniformly distributed throughout the plant, all parts being equally dangerous to livestock (Kingsbury,1964). One important sub-group of alkaloids is the pyrrolizidine alkaloids. They are hepatotoxins which will cause fatal liver failure if ingested in sufficient quantities over a period of time (Molyneux and Ralph, 1992). There is, however, a range of susceptibility to these compounds. Sheep are able to graze pastures considered dangerous for cattle, because of either better detoxification of the alkaloid in the rumen or through differences in hepatic activities (Hooper, 1978). Some alkaloids are reported to cause infertility (Olayemi, 2007). Alkaloids have powerful effects in animal physiology and are of interest in pharmaceutical industries for drugs manufacture (Edeoga and Erinta, 2001). They are stimulants and act by prolonging the action of several hormones. The presence of alkaloid in eggplant is also a great importance to human because of their medical value which is used to prevent colon cancer.

2.9.6 Cyanide

Cyanogens are glycosides of 2-hydroxynitriles and are widely distributed among plants such as Rosaceae, Leguminosae, Gramineae and Araceae (Bell and Charlwood, 1980; Conn1981; Rosenthal and Berenbaum, 1991 and Bisby *et al.*, 1994). In case of emergency, when plans are wounded by herbivorus organisms, the cellular compartmentation breaks down and cyanogenic glycoside come into contact with an active β-glucoside which hydrolyses them to yield 2-hydroxynitrile. This can also cleave into the corresponding aldehyde or ketone and HCN. HCN is highly toxic to animal or microorganisms because of the mitochondrial respiration chain (ie, cytochrome oxidases). The toxic effect of cyanogens can serve as mobile nitrogen storage compounds in seed during germination.

Cassava is a crop plant rich in cyanogenic glycosides. Farmers in marginal areas plants "bitter" varieties for food production and it has been suggested that the prevention of (cyanide) poisonings through improved detoxification procedures may be more effective than the development of "low cyanide" cultivars (Tylleskär *et al.*, 1992).

Hanelt and Tschiersch (1967) reported that *Vicia sativa sensu lato* accessions from the Balkan and Turkey contained the cyanogenic glycoside vicianine, while the material from Iran was predominantly HCN-free (Cyanide-containing a glycone). Cyanogens can be hydrolysed by enzymes to release HCN which is a volatile gas. Glycosides occur in vacuoles in plant cell and enzymes are found in the cytosol. Cyanide can cause goitrogenic effects due to thiocyanate produced during detoxification. Excess cyanide ion inhibits the cytochrome oxidase. The HCN is absorbed and is rapidly detoxified in the liver by the enzyme rhodanese which converts CN to thiocyanate **(**Kumar, 1991). Cyanogens cause poor animal performance (Tanner *et al.*, 1990) and it has teratogenic effects (Keeler, 1984)

2.10 Methods of Reducing Anti Nutritional Factors in Eggplants Leaves

Antinutritional factors in eggplant leaves and fruits can be reduced by proper processing before consumption. It can be reduced by cooking, either by boiling, blanching, steaming, stewing, frying or pressure cooking. These methods are found to be effective in improving digestibility, increasing nutrient availability and also minimizing food-borne diseases (Fellows. 1990). Boiling can help to reduce the oxalate content in the leaves (Noonan and Savage, 1999). Baruah (2002) reported that the leaves of eggplants have been richer in nutrients, including minerals and vitamins such as calcium, phosphorus, nitrogen, magnesium among others.

2.12 Sheep Nutritional Requirements

Apart from being adequate in amount and composition to meet requirements for protein and energy, feed for sheep must also satisfy a set of interrelated behavioral and physiological factors (Adams and Mckinley, 1995). Ruminants have cyclical activities which are geared to demands for water, food and the response necessary for the processes of rumination and digestion in the herbivorous mode of life. Exploration of feed and their learned innate preferences and selectivity can be investigated (Adam sand Mckinley, 1995).

Sheep possess a complex digestive system to deal with their mixed diet of digestible plant components and relatively indigestible cellulose. Feed take long hours (25-35hrs) to pass through the gut and is exposed to microbial fermentation in the rumen during this time, which provide micro-organism and the products of cellulose breakdown for digestion. Sieving process are involved, with large particles been regurgitated for re-mastication by the processes of ruminating and small particle less than one to two mm pass into the stomach.

Sheep production system is such that it is difficult to achieve the desired degree of precision in the annual nutrient supply (Robbison, 2002). Nutrients recommendations therefore merely provide guideline for the development of improved feeding strategies. It is thus more important to ensure that requirements are based on sound understanding of the animal's physiology and how this influences net nutrient requirements (ARC, 1965)

2.12.1 Energy Requirement of Sheep

Energy is not a nutrient, but an end product of carbohydrate, fat, and protein metabolism in the body. The energy released from oxidation of these nutrients is used for body maintenance, growth, reproduction, lactation, fiber growth, and activity. Energy is necessary to maintain body temperature, drive essential body process, fuel physical activity and promote growth (Kirby, 2003). All animals require energy and the amount depend on the physiological state of the animal. Energy requirement are expressed according to the relationship of 100kcal of gross energy (GE) =76 kcal digestible energy (DE) = 62kcal metabolizable energy (ME) = 35kcal net energy (NE) (Huston, 2002). Maintenance energy is defined as amount of energy required keeping an animal in a state of energy equilibrium. The maintenance requirements for energy remain the same for most sheep except dairy lambs; they require 22% energy higher than the average.

2.12.2 Protein Requirement of Sheep

Protein is usually the most expensive component of the sheep diet. Protein is required for both the ruminant and the bacteria and to supply amino acids for protein synthesis in the body. Animals require protein for growth, reproduction, and production. The amount depends on the physiological state of the animal. The requirement for maintenance will be met if the total feed fed contains 15% protein for animal on zero grazing (Lakpini, 2002). Younger growing animals have higher protein requirement than more mature animals hence a finishing diet for weaned prime lamb should contain between 14.0 to16.0% crude protein (Kirby, 2003).This should be the minimum amount of nitrogen or protein in the diet to enable the animal to replace losses due to damage to the muscle tissue, hoofs horns, hair and skin. Hafez and Dyer (1969) stated that the subjection of animal tissue to constant wear and requires constant replacement.

Protein from microbial protein synthesis supplies an average of 50% of the protein and amino acid needed by ruminants. However, protein deficiency is the common nutrient deficiency. When forages contain less than 7% crude protein, there may not be sufficient rumen ammonia for the growth and activity of the microbes (Smith, 1993). This reduces digestion of forage and therefore limit forage intake (Bowman and Sowell, 2002; Brown, 2005).

2.12.3 Mineral Requirement of Sheep

The minerals contents in forage depend on soil, climate, previous stock history and fertilizer application (Preston and Leng, 1987). The mineral element known to be essential for ruminants include; calcium, magnesium, sodium, potassium, chlorine, sulphur, copper, zinc, iron, cobalt, manganese, iodine and selenium (Ranawana, 1986). The first seven are macro- while the remaining are micro-minerals. The macro-minerals are required in relatively larger quantities. The later are trace elements which are required in smaller amount but it does not mean that they are less important. Calcium and phosphorus are usually the two major minerals that should be given the most attention in the diet formulation. Calcium accounts for 49% of total mineral composition requirement of the body, and phosphorus 27%. All the rest together accounts for only 24%.

2.12.3.1 Functions of Minerals

Minerals work in relationship with the vitamins (Huston, 2002), regulate acid-base balance and control the tone and nerves muscles. They also control the fluid balance and excretion, activate enzyme system and give rigidity to the skeleton (Ogundipe, 2005)

2.12.4 Vitamins Requirement of Sheep

Vitamins are organic substances required by animals in very small amounts for regulating various body processes towards normal health, production and reproduction. In sheep, only a few vitamins are likely to be periodical limiting, because most vitamins are synthesized by rumen microorganisms. The fat-soluble vitamins include vitamins A, D, E, and K. Among all these vitamins only vitamin A is likely to be deficient to the point of limiting productivity in ruminants.

The B vitamins are all synthesized in adequate amount by rumen bacteria, with possible exception of vitamin B_{12} in regions with a cobalt deficiency (Ogundipe, 2002; Huston, 2002).

2.12.5 Water Requirement of Sheep

Water is a nutrient of extreme importance for animals and must be considered vital in any rearing phase. The quantity, and placements of water are very important aspects of sheep health and nutrition. Water covers almost 98% of the molecules in the animal organism (NRC, 2001). It is distributed throughout the body including extracellular and intracellular fluids, which contain respectively, from 20% to 40% and form 60% of the total body fluid. It is also considered the most abundant and vital chemical substrate of all living beings (NRC, 2007).

According to NRC (2007), the success of the nutritional management depends on supplying enough water for an animal so its water requirement is met by voluntary intake. However, determination of water requirement is a complex process. Water can be fed to the animals from three source; drinking water, feed water, and metabolic water from nutrient catabolism (Esminger *et al.,* 1990). Water use or ingestion by the animal is related to different variables such as body weight, dry matter intake, energy intake, effect of year seasons (temperature, radiation and humidity), restriction effect (drinking trough availability and spacing), water quality, species breed and different physiological stages such as growth and pregnancy.

The physiological stage also affects water ingestion. Water requirement increases by 126% from the first to the fifth month of gestation in sheep. The water intake and dry matter intake ratio (WI/DM) are from 4.3 to 5.2 litter/kg, in pregnant sheep with only 1 fetus and from 7 to 8 litter/kg in sheep with two fetuses. This represents almost two times the maintenance requirement (2 to 3 L/kg for sheep with only one offspring and 3.5 times for sheep with twins (NRC, 2007). Low water availability in pregnancy in sheep causes low feed intake and toxemia.

2.12.6 Effect of temperature on Sheep Production

Decreased dry matter intake and increased evaporative and cutaneous cooling are the two major effects on water intake of sheep exposure of high temperatures (NRC, 2007). Luke (1987) described linear increase of water intake by sheep as the daily maximum temperature increased. In these researches, the higher temperature coincided with the dry season of the year and the high DM level of the forage. The temperature of the water ingested is also an important factor because water may become a thermal buffer in the rumen-reticulum protecting or changing the fermentation capacity and therefore affecting the microbial function.

Aganga (1992) studied the water use by sheep and goat in the North of Nigeria and observed significant differences ($P<0.01$) on several variables, such as water intake, expressed in l/kg of metabolic weight, that was higher in sheep than goat. In relation to age, the older animals drink more water than younger ones, because the older animals had larger body size and required more water for proper digestion and feed utilization. In a recent work, Hadjigeorgiou *et al.*, (2003) found a water intake for sheep 15% higher than goats. Lower water intake by goats has been observed when compared to sheep and other animals.

2.12.6.1 Animal Diets and Water Intake

Animal diets are also a determinant factor for water intake. This is because water intake is related in the feed intake and feed intake is correlated with productivity. Osuhor *et al*., (2004) reported that rams offered feed at higher levels consumed more water than rams on low levels of feed. They reported 3 liters per head per day for rams offered high levels of maize stover and hay mixture for maintenance and production.

2.12.6.2 Water Availability During Feeding

Water availability sometime is limiting to herd in the arid and semiarid regions around the world. During the dry season, the animals ingest forage with low moisture level and low nutritional value and have irregular and limited access to portable water.

2.12.7 Feed Intake in Ruminant

Voluntary intake is very important as it determines the amount of nutrients that can be released for animals' maintenance and production .The intake of nutrients depends on the type of food available, the amount eaten and also the energy density of the diet (Gatenby, 1991). The aim in sheep and goat feeding is to feed as much forage as possible and satisfy the largest part of requirements. The quality and quantity of roughage available will determine the amount and type of supplement to be fed. The higher the quality of the roughage, the higher the intake and performance with sheep on all roughage diets.

Ruminants like all animals are individualistic and where selection is possible, the intake of different feeds varies among animal. The appetite for particular feed obviously varies among individuals (Preston and Leng, 1987). Goats have been considered more efficient in the digestion of crude fiber and the utilization of poor roughages than sheep (Reid *et al* 1990; Masson *et al* 1991; Toikamp and Brouwer, 1993). Voluntary feed intake is the quantity of feed eaten by an animal or group of animals during a given period of time during which they have free access to food (Forbes, 1995).Voluntary intake of feeds was usually expressed as the amount of dry matter (DM) that an animal consumed per day (Charray *et al.*, 1992). There are many factors that affect feed intake which include palatability, effect of exercise on feed intake, sensory appraisal, physiological state, rumen distention and nutrient imbalance as well as fatigue.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Experimental Site

The experiment was conducted in the Experimental Unit of Small Ruminant Research Programme of the National Animal Production Research Institute,Shika, Zaria Nigeria. Shika falls between latitude $11^{0}11'6N$ and longitude$7^{0}34'0E$ with an altitude of 640m above sea level. Shika is located within the Northern Guinea Savanna Zone with an average annual rainfall and temperature of 1107mm and $24.4^{o}C$, respectively. The seasonal distribution of the annual rainfall is approximately 0.1% (11.00mm) in the late-dry season (January-March), 25% (285.6mm) in the early-wet season (April-June), 69.6% (770.4mm) in the late-wet season (July-September) and 4.5% (49.8mm) in the early dry season (October-December). The experiment was conducted during the wet and dry season (August-December).

3.2 Feed Preparation

Fresh eggplant leaves of mixed varieties were harvested from three villages Hunkuyi, Shika town and Sabon-Gari between the month of November and April 2013.The forages were harvested from different farms ensiled and in the Experimental Unit of the Small Ruminant Programme. After harvesting the forage, it was spread on the floor for some hours to wilt reduce the moisture content. The leaves were manually cut with cutlass, carefully weighed and mixed with 0.4% solution of additives like urea, saline, urea plus saline, tamarind, tamarind plus urea, tamarind plus saline, tamarind plus urea plus saline and water. During ensiling process, the chopped eggplant leave was mixed with required amount of additives. The ensilaging was prepared in polythen bags in an anaerobic condition. After filling of the polythen bags with eggplant leaves, it was covered with another black thick layer polythen bag. After a period of 21 days, the bag were opened and silage was spread on floor, packed before commence of experiment. The concentrate feed which served as supplement was supplied by the small Ruminant Research Programme Unit.

3.3 Silage Making

Forage crops, harvested at maximal yields and nutritional value, are preserved for continuous and consistent forage supply throughout the year. They are preserved in order to retain the original nutritional value of the feed at the highest value during storage. They are preserved either by hay making (field drying) or by ensiling: hay with its low water content restricts detrimental microbial activity (Weinberg and Ashbell, 2003).Ensiling is a method of preserving large masses of moist crops. It is based on lactic acid fermentation whereby anaerobic lactic acid bacteria (LAB) convert water-soluble carbohydrates into organic acid (Woolford, 1990). Weinberg and Ashbell (2003) suggested that application of silage additives is another method of ensiling crop residues. Plant material and by-products mostly ensiled include whole-crop corn, alfalfa, grasses, whole-crop wheat, sorghum and various legumes (Wilkins *et al*., 1999).

3.4 Steps and methods of ensiling crop residues

Steps and methods of ensiling crop residues include the following: (i) harvesting of the crops at the peak stage of maturity;(ii) wilting (if forage) to ensure adequate reduction of moisture content;(iii) chopping: involves cutting of crop residues which can be mechanically or manually;(iv) mixing of additives: involves mixing of chopped crop residues or forage with a required amount of additives;(v) loading: the chopped and mixed crop residues or forage are loaded into a silo or polythene bags;(vi) compaction, expelling of air and sealing: removal of air from the silage bags and tying it under anaerobic respiration;(vii) storage and fermentation: it involves storing the ensiled crop residues or forage for 21 days whereby lactic acid bacteria convert water-soluble carbohydrates into organic acid resulting into reduced pH value;(viii) unloading, air drying and feeding the animal (Woolford, 1984; Weinberg and Ashbell, 2003).

3.4.1 Characteristics of good/high quality silage

Good quality silage must have a pleasant odour, a typical colour of pale-yellow or dark-brown, a breaking even texture, and a high nutritional value.

Table 3.1 Ingredient Composition of Concentrate Feed

Ingredients	Percent
Maize offal	11
Maize	22
Wheat offal	11
Cotton seedcake	52
Bone meal	2.5
Salt	1.5
Total	100

3.4.1 Preference and Feeding Trials

3.4.2 Preference trial

Forty-eight (48) Yankasa rams with an average body weight of 18.17kg were used for this study. The rams were randomly assigned to eight (8) treatments and balanced for weight with 6 animals per treatment in completely randomized design. They were individually penned and given prophylactic treatment, Albendanzole 1.5% suspension for deworming, at 3ml/kg of body weight (BWT) against worms like tapeworms, hookworms etc before commencement of the experiment. The tested feeds (ensiled eggplant forage) were offered separately in different feeding troughs at 3% and supplemented concentrate 2% of body weight, respectively.

The test forage and concentrate were fed to the animals for twenty four hours while left-over of both feeds were weighed in the next day and the left over was recorded separately. The differences between quantity offered and left-over was recorded as voluntary intake. This experiment lasted for fourteen 14 days (2weeks). Water was offered *ad libitum* on daily basis.

3.3.2 Feeding Trial

After the preference study, same forty-eight (48) Yankasa rams with an average body weight of 18.57kg were used for this study. The rams were randomly assigned to eight (8) treatments and balanced for weight with 6 animals per treatment in completely randomized design. The rams were adjusted to these feeds for 7 days before data collection. The animals were weighed at commencement of the study and after the study. The forage was offered at 3% of body weight (BWT) to all the animals while concentrate was fed at 2% of the body weight BWT across the treatments. Water was provided *ad libitum.* At 24.00hrs, left-over of forage and concentrate fed the previous day were weighed and recorded separately. The difference between the quantities of feed offered and the left-over was recorded as intake. Weights gain was recorded as the difference between initial weights deducted from final weight of the feeding trial. The animals were bleed before and after the feeding trial.

3.4 Digestibility Study

Twenty 20 rams ranging from 20.5 to 21kg were used for this experiment .The animals were balance for weight and blocked into five treatments with four rams per treatment. The component ingredients ration is show in Table 3.1. Each ram was individually offered its appropriate corresponding ration to evaluate the digestibility of the diets. The study comprised a one-week preliminary period of realimentation and adjustment, and two week of sample collection. The animals were housed in individual metabolism crate with facilities for separate collection of faeces and urine. The animals were weighed at the beginning and end o f the study. Feces were collected each morning just before feeding. 10% of each daily faecal and urine outputs were collected and stored at 4^0C in a deep freezer for chemical analyses. Samples of the ensiled forage fed were taken daily and bulked, from which sub samples were taken for laboratory analysis. Digitaria smutsii hay was used to feed the rams as a control during digestibility. Water was made available to the animals ad libitum.

3.5 Chemical Analysis

The chemical composition of feed and feacal analysis was determined. Dry matter (DM), crude protein (CP), organic matter (OM), ether extract (EE), crude fibre *(CF),* and ash were determined using the procedures outlined by the Association of Official Analytical Chemists (A.O.A.C2000). Acid Detergent Fibre (ADF) and Neutral Detergent Fiber (NDF) were determined according to Van Soest *et al* (1991) procedure. Urine nitrogen was determined using Micro Kjeldahl method (A.O.A.C, 2000). Mineral content of treatment diets, eggplant forage and *D. smutsii* were analyzed using the Flame Spectrophotometer as described by Kennedy (1984). Tannin was determined using

Folin Ciocalteu as described by Makkar (2000). Saponins, cyanide and alkaloid were determined according to A.O.A.C, (2000), oxalate (Oke, 1969) and phytate (Reddy *et al*., 1982).

3.6 Statistical Analysis

Data generated during preference study was analyzed using SAS (2005). All other data such as feed intake, digestibility and live weight were analyzed statistically using the General Linear Model (GLM) procedure of SAS (2005). Significant difference between treatments mean was determined using Duncan Multiple Range Test using the following model;

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

Y_{ij}=Overall observation

μ=Overall mean

T_i=Effect of the ensiling forage

e_{ij}=experimental error

CHAPTER FOUR

4.0 RESULTS

4.1 Physical Properties of Dried Ensiled Eggplant Forage

Table 4.1 presents the result of physical properties of ensiled eggplant forage. According Pettersson (1988) he categorized silage with pH 3.0 to 4.5 as good and at pH of 4.5 to 4.8 as fair silage. The eggplant silage PH ranged within the good this can attributed to the reduced lactic acid production by microbes during ensiling (Thomas and Chamberlain 1982). The pH of this silage ranged from (3.81 to 4.25) which was good and has a pleasant smell. The colour was pale yellow and dark brown and the texture is firm. The silage had a pleasant smell. The acceptability of this silage is due its palatability.

4.2 Proximate Analysis of Dried Ensiled Eggplant Forage and Concentrate

The results of proximate analysis and feed composition of ensiled eggplant forage fed to Yankasa rams are presented in Table 4.2. It shows that the dry matter of the forage ranged from 91.99 to 95.35%. The CP content ranged from 17.69 to 26.31%. The CF content ranged from 25.38 to30.53%. The EE content ranged from 3.97 to 6.98%. The NDF content range from 39.16 to 61.12%. The ADF content ranged from 30.66 to 45.06% .The NFE ranged from 23.76 to 37.09% and Hemicellulose ranged from 7.17 to 20.48%. The DM content of the concentrate was 94 79% ,CP was 37.63%, CF was 20.26%, EE was 10.67% ,NDF was 39.61%.,ADF was 27.51%, NFE was 23.21% and Hemicellulose 12.01%.The ingredient for concentrate composition content of DM which consist of maize offal, maize, wheat offal and cotton seed cake consist of (93.92, 93.59, 93.37,and 95.46%). The CP content consists of (12.69, 10.05, 13.19 and 33.63%), The CF content consists of (26.20, 4.06, 3.57 and 32. 20%). The EE content consists of (12.47, 9.07, 5.59 and

7.69%). The NDF content consists of (40.65, 14.00, 61.93 and 43. 17%). The ADF content consist of (10.74, 2.06, 48.12 and 38. 99%) The NFE content consist of (45.02, 75.28, 66.63 and 21. 46%) and The Hemicellulose content consist of (29.91, 11.94, 13.81 and 4. 18%), respectively.

Table 4.1: Physical Properties of Eggplant Forage

Treatment	PH	Color	Texture	Odor
Urea	3.86	Pale yellow	Breaking even	Sweet sour
Saline	3.87	Pale yellow	Breaking even	Sweet sour
U+ S	3.96	Pale yellow	Breaking even	Sweet sour
Tamarind	4.25	Pale yellow	Breaking even	Sweet sour
T+U	3.75	Dark brown	Breaking even	Sweet sour
T+S	3.92	Pale yellow	Breaking even	Sweet sour
T+U+S	4.18	Pale yellow	Breaking even	Sweet sour
Water	3.81	Dark brown	Breaking even	Sweet sour

U+S= Urea plus Saline, T+U= Tamarind plus Urea, T+S= Tamarind, plus saline, T+U+S=tamarind, plus U and Saline

Table 4.2: Proximate Analysis and Feed Composition of ensiled egg plant forage and concentrate.

parameter	Treatment									
	Egpt Urea	Egpt+ Saline	Egpt U+S	Egpt+ Water	*Digitriai*	Maize offal	Maize	Wheat offal	CSC	CONC
Dry Matter	94.82	93.63	91.99	95.31	95.45	93.92	93.59	93.37	95.46	94.79
Crude Protei	21.63	18.69	26.31	17.69	5.44	12.69	10.05	13.19	33.63	37.63
Crude Fiber	28.51	26.31	25.59	30.53	40.70	26.20	4.06	3.57	32.20	20.26
ASH	9.59	7.57	9.35	8.31	6.39	3.62	1.54	11.02	5.02	8.23
EE	5.35	3.97	6.98	5.06	4.53	12.47	9.07	5.59	7.69	10.67
NDF	61.12	55.33	47.72	39.16	60.86	40.65	14.00	61.93	43.17	39.61
ADF	40.64	37.02	30.66	31.99	45.06	10.74	2.06	48.12	38.99	27.51
Hemicellulos	20.48	18.31	17.06	7.17	15.8	29.91	11.94	13.81	4.18	12.1
NFE	29.74	37.09	23.76	33.72	42.94	45.05	75.28	66.63	21.46	23.21
OM	76.29	76.8	68.35	70.86	89.06	90.3	92.05	82.35	90.44	86.56

U+S=urea + saline, CSC=Cotton seed cake, CONC=Concentrate, DM=Dry matter, OM=Organic matter, CP=Crude protein, CF=Crude fiber, EE=Ether extract, NDF=Neutral detergent fiber, ADF=Acid detergent fiber, H/C=Hemicellulose, NFE=Nitrogen free extract.

4.3 Anti-nutritional Factors in Ensiled Eggplant Forage

The results of anti-nutritional factors in ensiled eggplant forage are presented in Table 4.3. The result from this study shows that Tannin contents ranged from 0.46mg to 0.90mg/100g in (water and saline-treated). Phytate content ranged from 0.53 to 0.79mg/100g in (Tamarind and Tamarind plus urea-treated). Alkaloid content ranged from 2.61mg to 4.42mg/100g in (Tamarind and water-treated). Oxalate contents ranged from 22.88mg/100g to 31.68mg in (Tamarind and saline-treated). Cyanide content ranged from 0.97 to 1.62mg/100g in (Tamarind plus urea plus saline and saline-treated). Tamarind had the highest alkaloid and oxalate content which ranged from (4.42 and 31.68mg/100g), respectively. Tannins, Phytate and cyanides of ensiled forage were within tolerable limit.

Table 4.3: Anti-nutritional Factors in ensiled eggplant forage

Anti-nutrients mg/100g)	Egpt+ urea	Egpt+ saline	Egpt+ U+S	Egpt +T	Egpt+ T +U	Egpt+ T+S	Egpt+ T+U+S	Egpt+ water
Tannins	0.87	0.90	0.77	0.79	0.83	0.73	0.72	0.46
Phytate	0.74	0.70	0.70	0.53	0.79	0.58	0.78	0.74
Oxalate	27.72	31.68	27.94	22.88	28.60	28.60	24.64	25.30
Saponins	19.32	21.85	24.43	14.72	23.41	22.53	24.44	14.17
Alkaloids	3.31	3.47	3.20	3.61	2.61	3.37	3.69	4.42
Cyanides	1.52	1.62	1.30	1.40	1.19	1.08	0.97	0.97

Egpt=eggplant, U+S=urea+saline, T=Tamarind, T+U=Tamarind plus urea, T+S=Tamarind plus saline, T+U+S=Tamarind plus urea plus saline.

4.4 Mineral content in treated ensiled eggplant forage

The mineral content of the ensiled eggplant forage is presented in Table 4.4. The result from this study shows that treated eggplant forage contained calcium, phosphorus, sodium, potassium, magnesium ranging from 0.88% to 2.67%, 0.20% to 0.43%, 0.06% to 2.28%, 0.69% to 3.44% and 0.52% to 0.66% respectively. The mineral content in potassium of treated forage with water was higher than others. Eggplant forage without additives has higher content of potassium than others. The phosphorus content of eggplant forage ranged the same level both treated and untreated but was a slightly higher in urea treated forage. The mineral content of calcium of treated forage with urea plus saline is higher than others. The magnesium content of eggplant forage ranged of the same level but higher in water treated forage without additives. The sodium content was higher in eggplant forage treated with saline across the treatment.

4.5 Preference Study of Yankasa Ram fed Treated Ensiled Eggplant Forage.

The result of preference study of Yankasa rams fed treated ensiled eggplant forage is presented in Table 4.5. The result shows that initial and final weights of the rams fed ensiled eggplant forage was not significantly (P>0.05) different across the treatments. The weight change was significant (P<0.05) slightly higher on rams fed with tamarind than urea, saline and urea plus saline while others loss weight. The average daily forage intake of rams fed with urea, saline and urea plus saline was significantly (P<0.05) higher than others across the treatments. The average daily concentrate intake was not significantly (P<0.05) different across the treatments. The average total daily feed intake of the forage was not significantly (P<0.05) different across the treatments.

Table 4.5: Feed intake and weight change of Yankasa rams during preference study

Parameters	Egpt+ urea	Egpt+ saline	Egpt+ U+	Egpt+ T	Egpt+ T+U	Egpt+ T+S	Egpt + T+U+S	Egpt+ water	SEM	LOS
Initial weight (kg)	18.33	18.17	18.17	18.17	18.17	18.17	18.17	18.07	1.45	NS
Final weight (kg)	18.40	18.33	18.33	18.80	17.83	17.90	17.17	17.23	1.45	NS
Weight changes (kg)	0.07^b	0.17^b	0.17^b	0.63^a	-0.23^c	-0.27^c	-0.83^c	-0.93^c	0.18	*
Avg forage intake(g)	540.00^a	515.55^a	543.00^a	477.81^b	452.48^b	459.05^b	472.24^b	468.33^b	31.44	*
Avg con intake(g)	360.00	349.33	362.00	362.47	354.67	346.67	337.00	356.67	24.59	NS
Avg feed intake(g)	900.0	864.7	905.00a	840.5	807.1	805.7	809.2	825.2	55.47	NS

abc: Means with different superscripts in the same roll are significantly (P<0.05) different Ept = Eggplant treated with urea. U+S=Urea plus saline,T=Tamarind-,T+U=Tamarind plus Urea,-T+U+S=Tamarind plus Urea plus Saline Avg= Average

4.6 Effect of treated ensiled eggplant forages on the Performance of Yankasa Rams

The result of the performance of Yankasa rams fed treated ensiled eggplant forage is presented in Table 4.6 The initial and final weights of the rams were not significantly ($P>0.05$) different across the treatments. The weight change was significant ($P<0.05$) slightly higher on rams fed urea, saline and tamarind plus urea plus saline than others. The average daily forage intake of rams fed forage without additives water was significantly ($P<0.05$) higher than others across the treatments. The average daily concentrate intake was not significantly ($P<0.05$) different across the treatments. The average total daily feed intake of the forage was significantly ($P<0.05$) higher on water, saline and urea plus saline treated forage than other rams across the treatments. The feed efficiency ratio was significantly ($P<0.05$) higher on rams fed urea, saline and tamarind plus urea plus saline than others across the treatments. The relative mean of forage intake was significantly ($P<0.05$) higher on rams fed urea, saline, urea plus saline and water while others had the least feed intake. The relative mean concentrate feed intake of the rams across the treatment was significantly ($P<0.05$) higher except rams on concentrate with forage treated water had least concentrate feed intake. The result shows that rams fed with urea treated forage had significantly ($P<0.05$) lower feed intake.

Table 4.6: Feed intake and weight change of Yankasa rams

Parameter	Egpt+ Urea	Egpt+ Saline	Egpt+ U+S	Egpt +T	Egpt +T+U	Egpt +T+S	Egpt +T+U+S	Egpt+ Water	SEM	LOS
Initial weight (kg)	18.58	18.65	18.63	18.65	18.33	18.57	18.53	18.42	1.01	NS
Final weight (kg)	19.92	20.05	19.55	19.68	19.42	19.45	19.82	19.37	1.04	NS
Weight changes (kg)	1.33^{a}	1.40^{a}	0.92^{b}	1.03^{b}	1.08^{b}	0.88^{b}	1.28^{a}	0.95^{b}	0.11	*
Av daily forage intake (g)	480.0^{b}	492.1^{b}	502.9^{b}	460.6^{b}	483.4^{b}	464.2^{b}	462.7^{b}	620.9^{a}	48.94	*
Av daily Con. intake(g)	369.00	372.33	372.6	373.0	370.0	371.3	370.7	368.3	20.49	NS
Av total daily intake(g)	849.0^{b}	864.5^{a}	875.5^{a}	833.6^{b}	853.4^{b}	835.5^{b}	833.4^{b}	989.2^{a}	64.86	*
Feed efficiency ratio	5.01^{a}	5.01^{a}	8.19^{d}	67.81^{b}	6.43^{b}	7.49^{c}	5.13^{a}	7.16^{c}	5.65	*
Weight gain /day(g)	73.48^{a}	75.00^{a}	55.95^{b}	49.62^{b}	52.76^{b}	47.19^{b}	68.33^{a}	55.95^{b}	7.16	*
RMFI (%)	56.37^{a}	56.81^{a}	57.35^{a}	55.20^{b}	56.53^{b}	55.56^{b}	55.65^{b}	57.84^{a}	0.99	*
RMCI (%)	43.63^{a}	43.19^{a}	42.65^{b}	44.80^{a}	43.47^{a}	44.44^{a}	44.35^{a}	42.16^{b}	0.99	*

^{abc}: Means with different superscripts in the same roll are significantly (P<0.05) different Egpt= Eggplant, U+S=Urea plus saline-,T= eggplant Tamarind-,T+U= Tamar plus Urea, T+U+S=Tamarind plus Urea plus Saline, %RMFI=Relative mean forage intake in percentage, %RMCI=Relative mean concentrate intake in percenta SEM=Standard Error of Mean LOS= Level of significance

4.7: Feed intake and weight change of Yankasa rams during Digestibility stud

The result of feed intake and weight change of Yankasa rams during digestibility from this study is presented in Table 4.7 The result shows that the initial and final weights of the rams had no significantly ($P>0.05$) difference across the treatment. The weight gain of the rams fed urea treated forage was significantly ($P<0.05$) higher than others across the treatments. The average forage intake, concentrate and average total feed intake of Yankasa ram was not significantly ($P<0.05$) different across the treatment. The feed efficiency ratio was significantly ($P<0.05$) higher on urea treated forage while other feed had the least. From this study, urea treated forage had good efficiency than others.

Table 4.7: Feed intake and weight change of Yankasa rams during Digestibility study

Parameters	Egpt+ Urea	Egpt+ Saline	Egpt+ U+S	Egpt+ Water	D.*smutsii*	SEM	LOS
Initial weight (kg)	19.50	19.10	19.00	19.00	19.65	1.59	NS
Final weight (kg)	21.25	20.10	20.13	20.35	20.65	1.62	NS
Weight gain (kg)	1.75[a]	1.00[c]	1.13[c]	1.35[b]	1.03[c]	0.07	*
Forage intake(g/day)	590.00	536.30	520.00	545.00	542.50	47.95	NS
Concentrate intake(g/day)	390.00	382.00	380.00	380.00	387.50	31.84	NS
Total feed intake(g/day)	980.00	918.3	900.0	925.0	930.0	79.52	NS
Efficiency of feed ratio	3.93[a]	6.71[c]	5.58[b]	4.89[b]	6.37[c]	0.39	*

[abcd]: Means with different superscripts along same row differ significantly at ($P< 0.05$), Egpt=Eggplant, U+S= Urea+Saline, SEM= Standard Error of Mean s , LOS=Level of significant,

4.8 Nutrient Digestibility of Treated Ensiled Eggplant Forage, *D.smutsii* and Concentrate taken by Yankasa Rams.

The result of nutrient digestibility of treated ensiled eggplant forage fed to Yankasa rams is presented in the Table 4.8. The result from this study showed that there was significant (P<0.05) difference on dry matter feed digestibility of rams fed urea treated, saline treated and water treated forages which were higher than others. Organic matter and Ash digestibility were significantly (P<0.05) higher in feed treated urea than others. Crude protein, crude fiber and ether extract digestibility were significantly (P<0.05) higher than others. The neutral detergent fiber digestibility was significantly (P<0.05) lower for *D.smutsii* than other treatments. Acid detergent fiber digestibility was significantly (P<0.05) higher for urea treated than others.

Table 4.8: Nutrient Digestibility, Concentrate and *Digitaria Smutsii Hay* of Treated Ensiled Eggplant Forage.

	Treatments						
Parameters (%)	Egpt+ Urea	Egpt+ Saline	Egpt+ U+S	Egpt+ Water	*D.smutsii*	SEM	LOS
Dry matter digestibility	62.65[a]	60.27[a]	55.95[b]	62.45[a]	43.21[c]	2.67	*
Organic matter digestibility	65.70[a]	62.70[a]	58.92[b]	64.07[a]	47.28[c]	2.59	*
Ash	46.47[a]	36.79[b]	37.11[b]	34.52[b]	25.01[c]	1.94	*
Crude protein digestibility	75.20[a]	56.34[c]	69.98[b]	60.79c	56.88[c]	2.28	*
Crude fiber digestibility	68.62[a]	53.89[c]	64.80[a]	64.13[a]	63.85[b]	2.26	*
Ether extract digestibility	84.65a	77.05[b]	82.34[a]	67.86[c]	49.22[d]	1.43	*
Neutral detergent fiber	94.37[a]	93.69[a]	93.07[a]	92.45[b]	84.96[c]	0.68	*
Acid detergent fiber	60.23[a]	41.36[b]	47.79[b]	41.15[b]	37.69[c]	3.60	*

[abc]: Means with different superscripts along same row differed significantly at (P< 0.05) NS=not significant, Egpt=Eggplant, Egpt+ U+S= Eggplant +Urea+saline

4.9 Nitrogen Balance of Treated Ensiled Eggplant, Concentrate and *D. smutsii.*

The result of nitrogen balance of rams fed treated ensiled eggplant forage, concentrate and *D.smutsii* is presented in Table 4.9. The result shows that rams fed urea-treated and urea- plus- saline treated forage was significantly ($P<0.05$) higher than for the other treatments. The urine nitrogen was significantly ($P<0.05$) higher in urea- plus- saline treated and water- treated forages than the treatments. Feacal nitrogen was significantly ($P<0.05$) higher in rams fed urea, urea plus saline forage than other treatments. The nitrogen retention was significantly ($P<0.05$) higher in rams fed urea treated forage than others. The percent nitrogen retained was significantly ($P<0.05$) higher in rams fed urea and saline treated forages than other treatments.

Table 4.9 Nitrogen Balance of Treated Ensiled Eggplant, Concentrate and *D. smutsii*

	Treatments						
Parameters	Egpt+ Urea	Egpt+ Saline	Egpt+ U+S	Egpt+ Water	*D. smutsii*	SEM	LOS
Feed N intake(mg)	47.94^{a}	40.42^{b}	49.38^{a}	40.88^{b}	25.29^{c}	3.77	*
Urinary N(mg)	5.75^{b}	8.53^{b}	16.38^{a}	17.89^{a}	6.32^{b}	2.38	*
Fecal N(mg)	13.52^{a}	10.27^{b}	14.57^{a}	9.96^{b}	14.59^{a}	0.98	*
N Retained(mg)	28.66^{a}	21.63^{b}	18.43^{b}	13.01^{c}	4.38^{d}	3.00	*
%NRI	58.76^{a}	53.30^{a}	36.49^{b}	33.52^{b}	17.48^{c}	4.02	*

^{abcde}: Means with different superscripts along same row differ significantly at (P< 0.05) Egpt=Eggplant, U+S= urea+ saline, SEM= Standard Error of Mean LOS=Level of significant, N=Nitrogen, %NRI= percent of Nitrogen retained.

4.10 Blood Metabolite of Rams Fed Ensiled Eggplant Forage and Concentrate Feed

The blood metabolites of rams fed with treated ensiled eggplant forage are presented in Table 4.10 The packed cell volume of rams fed urea was significantly (P<0.05) higher than others except rams in urea plus saline that had the least across the treatments. The red blood cell of rams fed urea was significantly (P<0.05) higher than others except rams in urea plus saline that had the least across the treatments. The white blood cell of rams fed tamarind plus urea plus saline were significantly (P<0.05) higher than others except rams in tamarind that had the lower white blood cell. Though, the range fall within the physiological ranged for health rams according to Jain (1993) which range from 4.0-10.09/l

Table 4.10: Blood Haematocrit (Plasma) of Rams fed treated ensiled eggplant forage and concentrate

Parameters (unit)	Treatments								SEM	LOS
	Egpt+ Urea	Egpt+ Saline	Egpt+ U+S	Egpt+ Tamarind	Egpt+ T+U	Egpt+ T+S	Egpt+ T+U+S	Egpt+ Water		
PCV(*10^6/µl)	35.33[a]	30.33[b]	26.33[c]	30.33[b]	30.00[b]	31.67[b]	33.33[b]	32.00[b]	1.03	*
RBC (%)	11.78[a]	10.11[c]	8.78[d]	10.33[c]	11.00[b]	10.56[b]	11.11[b]	10.67[b]	0.30	*
WBC(l)	10.70[b]	10.57[b]	10.73[b]	9.30[c]	10.40[b]	10.17[b]	11.77[a]	10.40[b]	0.30	*

[abc] Means on the same row with different superscripts are significantly ($P<0.05$) different.; U+S=Urea plus saline T+U=Tamarind plus urea, T+S=Tamarind plus saline, T+U+S=Tamarind plus urea plus saline , SEM= Standard Error Mean, LOS=Level of significant, PCV=Packed cell volume, RBCs= Red blood cells, WBC=White blood cells

4.11 Blood (serum) Metabolite of rams fed the ensiled eggplant forage and concentrate

The blood (serum)-metabolites of rams fed treated ensiled eggplant forage and concentrate are shown in Table 4.11. The Blood urea nitrogen of the rams fed urea, urea plus saline, tamarind and tamarind plus urea were significantly ($P<0.05$) higher than other across the treatments while rams fed forage treated with water had least. Creatinine differed significantly ($P<0.05$) in rams fed tamarind plus urea while those on water treated forage had least creatinine. Rams on tamarind, tamarind plus urea had significantly ($P<0.05$) higher globulin than other rams across treatments while the water treated is least Rams fed forage treated on tamarind plus urea, tamarind plus urea plus saline had significant ($P<0.05$) higher albumin than other rams across treatments except water treated forage had the least albumin. The total protein of the rams fed with urea, saline, urea plus saline, tamarind plus saline, and water treated forages were significantly ($P<0.05$) lower than others except in tamarind plus urea had significantly ($P<0.05$) higher protein.

Table 4.11: Blood (serum) Metabolite of rams fed the ensiled eggplant forage and concentrate

Parameters(unit)	Egpt+ Urea	Egpt+ Saline	Egpt+ U+S	Egpt+ Termarin	Egpt+ T+U	Egpt+ T+S	Egpt+ T+U+S	Egpt+ Water	SEM	LOS
	Treatments									
Blood ureanitrogen(mmol/l)	7.73^{b}	7.35^{b}	8.38^{a}	7.88^{a}	8.48^{a}	7.10^{b}	7.53^{b}	5.70^{c}	0.42	*
Creatinine (µmol/l)	79.90^{b}	77.22^{c}	87.18^{b}	82.70^{b}	93.18^{a}	73.63^{c}	85.05^{b}	82.82^{b}	2.94	*
Globulin(g/l)	35.95^{b}	34.30^{c}	37.20^{b}	40.30^{a}	38.98^{a}	36.07^{b}	36.87^{b}	32.60^{c}	1.17	*
Albumin(g/l)	31.33^{c}	33.33^{b}	32.00^{c}	31.17^{c}	37.50^{a}	32.00^{b}	36.17^{a}	34.50^{b}	0.92	*
Total protein(g/l)	67.28^{c}	67.63^{c}	69.10^{c}	71.47^{b}	76.48^{a}	68.07^{c}	72.93^{b}	67.10^{c}	1.70	*

^{abc}: Means with different superscripts along same row differ significantly ($P<0.05$) Egpt=eggplant, U+S= urea plus saline, T+U=tamarind plus urea, T+S= tamarind p saline, T+U+S= tarmarind plus urea plus saline , SEM= standard error of means

4.12 Bleeding Periods of Blood Metabolite of Rams Fed Ensiled Eggplant Forage and Concentrate Feed

Table 4.12 presents the bleed periods of blood metabolite of rams fed ensiled eggplant forage and concentrate. The blood urea nitrogen and creatinine of the rams bled in the first period were significantly ($P<0.05$) lower than the second bleeding period. All other metabolites were not significant.

Table 4.12: Blood Metabolite of 1st And 2nd Bleeding of Rams Fed with the Treated Ensiled Eggplant Forage and Concentrate Feed

Parameters(unit)	First bleeding period	Second bleeding period	LOS
BUN(mmol/l)	6.22±0.29[b]	8.81±0.30[a]	*
Creatinine(mmol/l)	78.62±2.77[b]	86.72±2.82[a]	*
Globulin(g/l)	36.89±1.13	36.58±1.15	NS
Albumin(g/l)	32.54±0.92	34.38±0.94	NS
Total protein(g/l)	69.43±1.67	70.91±1.70	NS

[ab:] Means with different super script along same raw differ significantly at ($P< 0.05$),BUN=blood urea nitrog

CHAPTER FIVE

5.0 DISCUSSION

5.1 Chemical Composition of Feed Ingredients and Concentrate

The chemical composition of treated ensiled eggplant forage, D. *smutsii,* and concentrate are presented in Table 4.2. *D.smutii* hay had CP of (5.44%) which was higher than the reported value of 4.75 % (Malau-Aduli *et al.,* 2004) on chemical composition feed intakes and digestibilities of crop residue based rations in non-lactating Red Sokoto goats in the sub - humid zone of Nigeria but lower than the result of Otaru, (2009) who reported 6.00% on varying the level of palm oil. The CP of treated ensiled eggplant forage which ranged from 17.69 to 28.51% when compared with the result Vijayakumar *et al.,* (2006) who assess the suitable conservation method for tapioca leaves for effective utilization by ruminants was similar in CP. The EE was similar to Vijayakumar *et al* (2006) result who reported 10.57%.It showed that eggplant leaves are source of energy. NFE of this study was lower to Okeafor (2012) who reported 39.38 to50.28% on Dried *Gmelina arborea l*eaves as replacement Forage to groundnut haulms in the diet of fattening red Sokoto bucks, but had a similar CF.

The NDF ranged from 39.16 to 61.12% compared to Vijayakumar *et al* (2006) was similar while ADF was higher compared to Vijayakumar *et al* (2006) result. The Ash of Eze *et al* (2014) who reported 14.48% when compared was similar to this result. Hemicellulose of this study was similar to Okafor (2012).The high content CP can be the addition of urea in silage, this can contributed to its acceptability.

5.2 The Mineral Content of the Treated Ensiled Eggplant Forage Fed to Yankasa Rams

The observed values in ensiled eggplant forage leaves for calcium agrees with the reported values of (Ravindran and Ravindran 1988; Gomez and Valdivieso 1984 and Ravindran 1993 in Vijayakumar 2006).The potassium and calcium are similar to the result of Nupo (2013) who reported (2.05 to 2.83 and 1.73 to 2.15) for squeezed and dried *solanum nigrum spp.* Okafor (2012) had a similar result (2.05 to 2.83 and 1.73 to 2.15) for phosphorus and calcium in *Gmelina arborae* used to feed Red Sokoto bucks. Muhammad *et al* (2008) who reported low phosphorus, potassium , sodium, calcium and magnesium(0.024, 0.34, 0.22, 0.27 and 0.017% respectively) used as feed by grazing livestock in cholistan rangelands which was lower than the results from this study. Soil mineral status can influence the mineral status of the plants. The area where plant is harvest can also influence the mineral status. It is possible that the differences would be due to the mineral profile of soil. The calcium and potassium contents are higher than phosphorus, sodium and magnesium. Eggplants are good source of calcium and potassium including other minerals required by ruminants for bone and teeth formations. Minerals, particularly Ca, P and Na, are essential for small ruminants for optimum productivity (Ghazanfar *et al*., 2011) Ricks (1996) reported that young animals absorb minerals such as Ca more efficiently than older animals. The alkaloid observed from this study was higher compared to Agoreyo (2012) who reported 1.16 in comparative nutritional and phytochemical analyses of two varieties of *Solanum melongena* L.

5.3 The Anti-nutritional Content of the Treated Ensiled Eggplant Forage

From this study, it could be observed that treated ensiled eggplant forage had slight tannin content which ranged from (0.46 to 0.87mg/100g) this result was lower to the findings of Eze

(2014) similar to Okafor (2012) who has similar tannin in *Gmelina arborea* used to feed Red Sokoto bucks. Sood *et al.* (2012) reported high phytate contenti in different chenopodium cultivars leaves which ranged from (67.16 to 75.62mg/100g). The phytate content obtained from this study (0.53 to 0.78mg/100g) was lower than the results of Okafor, (2012) who reported 0.84 to 1.14mg/100g in the *Gmelina arborea.* The results of oxalate and saponins was lower compared to Hang *et al* (2011) who reported 36mg/100 in oxalate content of different taro cultivars grown in vet Nam and the effect of simple processing method on oxalate concentration of the processed forage. High level of phytate in food can cause adverse effect on digestibility also phytic acid binds cations like calcium, zinc, iron and other minerals, thereby reducing their availability in the body (FAO, 1990). They also inhibit digestion of proteins by forming complexes with them (Singh and Krikoran 1982).

5.4 Intake of Treated Ensiled Eggplant Forage and Concentrate Fed to Yankasa Rams

The result of the performance of Yankasa rams fed ensiled eggplant forage in average total feed in take which was 900.00(g/head) compared with the reported value of 464.25g/head in Gmelina arbora leaves Okafor (2012) fed to Red Sokoto bucks. The high intake of this feed could be due to it’s palatability or nutritive value. Intake of urea treated forage was significantly higher compared to other treatments which agrees with the findings of Colpan (1983), Ho Quang *et al.*,(1999) and Ali *et al.* (2009) who reported higher forage intake for sheep and buffalo calves fed with different experimental rations treated with urea. Otaru *et al* (2010) had similar result of total feed on effect of varying the level of palm oil on feed intake by Red Sokoto goats. On the average, the lost of body weight might be due to lower forage intake (table 4.5).

5.5 Feed intake of Yankasa rams treated in ensiled eggplant forage and concentrate.

The result of the performance of Yankasa rams fed ensiled eggplant forage is on Table (4.5) The average total forage intake of the rams were significant compared with the reported value of 464.25g/head in Gmelina arbora leaves Okafor (2012) fed to Red Sokoto bucks. The high intake of this feed could be due its nutritive value. The weight gain. This can be due to the palatability of the forage .The concentrate intake was not significantly different. The average daily gain (ADG) increased. This was attributed to increased protein supply to rumen microbes for effective utilization of the forage which made nutrients available for the animals' absorption (Jamie *et al*, 2009 and Ranjhan, 2001).The ADG obtained were 130.95 g/d to147.62 g/d respectively. The feed efficiency ratio was (5.01 to 8.19) was lower compared to Kolan (2010) reported 20.88 to 37.74 as feed efficiency ratio of Djallonke sheep.

5.6 Nutrient Digestibility of Yankasa ram fed Treated Ensiled Eggplant

The digestibility of ensiled eggplant forage is presented in Table 4.8 Dry matter digestibility of urea treated forage fed rams (62.65%) compared to report of Nwagu (2004) 83.49% on *Gmelina* leaves and Panicum maximum to West African Dwarf rams. The difference in dry matter intake could .be attributed to the disparity in body weights of animals and composion of forage used in the eight experiments as Adebowale and Ademosun (1985) had early reported no species variation in dry matter intake of sheep and goat. The organic dry matter digestibility of treated forage (62.65%) was lower compared to Sharon (2005) reported 80.5% resulted who fed forage to cattle. Digestibility of forage is influenced by forage composition, available energy of feeds and retention time in the gastrointestinal tract (Weiss 1993; Driedger and Loerch 1999). The result of Okafor (2012) and Abdu *et al.(* 2012)) who reported decrease in CP digestibility with increasing *Gmelina* leaf meal in the diets of Red Sokoto bucks did agree with this observation. The crude protein digestibility value Improvement in the digestibility of dry matter and crude protein by the sheep could be attributed to the effects of additives on rumen environment. Urea is a source of fermentation nitrogen to the rumen microbes. Ammonia nitrogen that is produced from hydrolysis of dietary and endogenous urea favors the proliferation and increased activities of microbial populations inside the rumen (Domingue *et al.,* 1991). A threshold level of ammonia is required for efficient functioning of the rumen.

5.7 Nitrogen Balance of Treated Ensiled Eggplant Forage

The value of nitrogen balance in eggplant forage obtained feed N intake obtained from this study ranged from 40.42 to 49.3mg which was lower compared to the findings of Maigandi and Abubakar, (2004) reported 128.93-138.55 g/d fed varying levels of *Faidherbia albida* pods to Red Sokoto bucks. The improved protein utilization and retention in this study is in agreement with the report of Osakwe, (2004) that forages with low concentration of condensed tannins could improve the efficiency of N digestion. The values of N-retained indicate that all the rams were in positive nitrogen balance. The urine nitrogen of this study agreed with Elamin *el at* (2012) who reported a similar values 5.75 to 17.89mg. Digestibility and nitrogen balance of sudan goat ecotypes fed different energy/protein level The N retention data indicate that the treated ensiled eggplant retained relatively more Nitrogen. The positives balance values obtained signified that anti- nutrients contents of the forage did not depress utilization and the forage were adequate in their supply of nitrogen.

5.7 Blood (Plasma) Metabolites of Rams Fed the Ensiled Eggplant Forage and Concentrate

The red blood cell (RBC) counts obtained from this treatment fall within the normal physiological range of 9.0 –15.0*10^6/µl for healthy sheep (Jain, 1993). RBC counts aid in the characterization of anemia when the range is below expected from 7.0 below (Ikhimioya and Imasuen, 2007) by Jain (1993). Pack cell volume values ranged in eggplant forage (26.33 to35.33%) agreed by Jain, (1993) on physiological health in ruminants 27.0 – 45.0%.The white blood cell also agreed by Jain (1993).The ensiled eggplant forage could not attribute to the presence of antinutritional factors in blood. However, these values are within the ranged of RBC, PCV and WBC, respectively, reported for clinically healthy sheep (Siros, 1995). The insignificantly different haemoglobin concentrations were within the reported rang for sheep (Siros, 1995). The WBC count did not indicate any decreased showing that the presence of oxalate and Saponins in the forage could not suppress the production of WBC.

Since the serum blood urea N were within the established range of 3.5-10.7mmol/L for sheep (Siros, 1995) the significantly difference in urea N showed antinutritional free forage for rams The creatinine values in the study were within the normal range of 80-150µmol/L reported for healthy sheep by Siros (1995).The significantly difference in total protein and albumin of rams fed the ensiled eggplant forage is an indication of the relatively good protein quality of the forage and, ofcourse, the level and availability of the forage protein. But since these forage quality were within the ranges of 56-96 g/L and 18.9-44.5 g/L for total protein and albulmin, respectively, for healthy sheep (Žučić, 2001),he results indicate the absence of proteinuria and hypoproteinaemia reportedly observed in cattle consuming tannin-rich oak foliage and manifesting tannic acid toxicosis (Garg *et al.*,1992).

CHAPTER SIX

6.0 SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 Summary

Rams fed with treated ensiled eggplant forage had selection preference. The anti nutritional contents of ensile eggplant forage had significant difference Blood Haematocrite nitrogen balance and digestibility. The anti nutritional contents of ensile eggplant forage which was higher in oxalate and saponins had no effect on the metabolites of the rams. The rams fed with ensiled eggplant forage were in good health condition and all the parameters are within ruminants requirements.

6.2 Conclusion

The treated ensiled eggplant forage had effect on intake, weight change, nutrient digestibility, nitrogen balance and blood metabolite in rams. The anti-nutritional factors contents of the treated ensiled eggplant forage were within the tolerable levels that are not harmful to ruminants. Eggplant forage is good source of energy with high dry matter contents.

6.3 Recommendation

- The treated ensiled eggplants forage gives better results in anti nutritional contents and minerals had good performance in Yankasa rams, it can used during critical period of feed scarcity.
- It is recommended that further studies shall done on eggplant varieties anti nutritional contents and minerals based on the soil profiled.

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Plate 1: Eggplant plant plantation at the Ahmadu Bello University Farm, Shika.
Source: Ahmadu Bello University teaching farm, Shika-Zaria.

Plate 2: Funtua Green-yellow stripe
Source: Dobbys signature: Nigerian food blog (1991)

Plate 3: Funtua white unstrip
Source: Prosi Exotic Supermarket, Vienna (1991)

Plate 4: Funtua green stripe
Source: inmagic DB/Text Web Pulisher PRO (1991)

Plate 5: Funtua red stripe
Source: Inmagic DB/Text WebPulisher PRO (1991)