EFFECT OF ENSILING PERIOD AND ADDITIVES ON SUGARCANE BAGASSE *IN SACCO* RUMEN DEGRADABILITY

SALAHUDDEEN JAMILU MANSUR

SPS/15/MAS/00002

B. AGRICULTURE

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DECLARATION

I hereby declare that this work is the product of my research efforts undertaken under the supervision of (Dr. Aminu Nasiru) and has not been presented anywhere for the award of a degree. All sources have been duly acknowledged.

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SALAHUDDEEN JAMILU MANSUR

SPS/15/MAS/00002

CERTIFICATION

This is to certify that the research work for this thesis and the subsequent write-up (Salahuddeen Jamilu Mansur SPS/15/MAS/00002) were carried out under my supervision.

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Dr. Aminu Nasiru	Dr. Nuhu Bello Rano
(Supervisor)	(Head of Department)

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DEDICATION

This research thesis is dedicated to my beloved parents Late Alh. Jamilu Mansur and Hajiya Binta Suleman for their tireless guide support and prayers towards accomplishing my studies successfully, may Almighty Allah shower his endless blessing upon them.

TABLE OF CONTENTS

CHAPTER THREE

CHAPTER FOUR

4.3 DISCUSSION

LIST OF TABLES AND FIGURES

ABSTRACT

An experiments were conducted to evaluate the effect of additives and ensiling period on *in sacco* rumen degradability of sugarcane bagasse silage (SBS). Two experiments were carried out to achieve the objectives; the first one was to determine the effect of ensiling period and silage additives on physical quality and proximate composition of (SBS). The experiment was laid out in 3 x 4 factorial arrangements in RCBD with three ensiling period (3, 5 and 7 week) and four additives (control, urea, molasses and yeast). The second experiment was to determine the effect of first experiment on *in sacco* degradability. Orskov *et al.* (1980) procedure was used to conduct the experiment. Data generated from the two experiments were subjected to analysis of variance. Results obtained revealed that the physical properties of treated sugarcane bagasse were improved in urea and molasses treated. There was also improvement with the increasing ensiling period from 3 - 7 week. The desirable pH (4.0 - 4.7) was obtained in all silages at 3, 5 and 7 weeks. Crude protein content was higher significantly ($P<0.05$) with the urea and yeast (9.56 and 9.00%). Dry matter and crude fibre contents decreased significantly ($P<0.05$) after ensiling with urea, molasses and yeast treatments. The highest dry matter and crude fibre was found to be 92.21 and 47.66% in the control. The crude protein contents increased after ensiling from 3 - 7 weeks while the crude fibre decreased with increasing ensiling time. The highest crude protein (10.00%) due to interaction was obtained in urea treated at 7 week. Result obtained for the second experiment shows that the highest dry matter and organic matter disappearances were recorded at 7 week ensiling period for all the additives after 48 hours of incubation. The dry matter and organic matter degradability were increased by ensiling with urea and molasses after 7 week. The highest organic matter potential degradability PD due to interaction was obtained in urea and molasses at 7 week (100%) while the highest effective degradability ED due to interaction was recorded in urea 7 week (41.60%). Therefore, it can conclude that the addition of urea or molasses improved the physical, nutritional and degradation characteristics of sugarcane bagasse silage.

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND INFORMATION

Fibrous crop by-products or farm wastes are characterized by extensive lignification of the cellulose and the hemicelluloses and by low levels of protein, soluble carbohydrates and minerals (Van Hao & Ledin, 2001). Crop residues are leftovers of crop harvest. They differ from by-products of processing such as bran, oil cakes among others and they are classified based on crop type such as cereals, grain legumes, roots or tubers. Crop residues are source of feedstuffs available as livestock feed during the dry season. The main constraint to the use of crop residues as ruminant feed is the rapid decline in quality, slow rate of digestion due to high lignin content and relatively poor nutrient content (Fajemisin, Fadiyamu, Fajemisin, & Alokan, 2012).

Agricultural by-products, crop residues and other agricultural by-products categorized as wastes have been used as a major ingredients in ruminants feeds since ancient times, because ruminants have the ability to digest these materials by microbes in their rumen (Boucque & Fiems, 1988; Leng, (1990) and Nair, Verma, Dass & Mehra, (2002) reported that the majority of tropical and sub-tropical countries use agricultural by-products for livestock feeding or graze pasture of low quality in range lands.

Improvements of the performance of ruminants in Sub-Saharan Africa (Kaitho *et al*., 1998; Mekonnen, Glatzel, & Sieghardt, (2006); Mekoya, Oosting, Fernandez-Rivera & Van der Zijpp, 2008) require the use of methods to extend the availability and quality of local feedstuffs especially to reduce feed cost. In order to accomplish this, farmers should be offered the option to choose available, abundant, and cheap feedstuffs. This option is pointed out to utilize crop residues and or agro industrial by product beside the available forages. However, the weakness of crop residues as feed is generally less palatable, low degradability and low in nutrients content. Feedstuff from agricultural wastes or crop residues are high in cell wall and low in nitrogen content or imbalance, therefore, the digestibility is low (Soeharto, 2004) and these characteristics will inhibit feed intake.

Lignocelluloses are a major component of crop residue cell wall, especially secondary cell wall, with cellulose, hemicelluloses and lignin content in which lignin inheres in the cellulose and hemicelluloses matrix. The low ability of lignocelluloses to hydrolyze (more for crystalline structure of cellulose fibrils and presence of lignin) reduces the digestibility and restricts efficient utilization of the feed produced by ruminal microorganisms. Although, microorganisms within the rumen are able to exude enzymes that have potential to directly hydrolyze cellulose and hemicelluloses in the rumen. The complex network formed by cellulose, hemicelluloses and lignin reduces their digestibility because of lacking ligninolytic activity (Falcon *et al*., 1995; Zadrazil, 1985; Otjen, Blanchette, Effland, & Leatham, 1987).

In Sacco (*in situ*) degradability is the most frequently used methods for determination of degradability parameters of dry matter, organic matter (OM), protein, fibre, and other nutrients of feeds (Van Vuuren, Tamminga, & Ketelaar, 1991). The rate and extent of drymatter fermentation in the rumen are crucial determinants of the nutrients utilized by ruminants (Kamalak, Canbolat, Gurbuz & Ozay, 2005). The main factor influencing the rate of fermentation of feeds is the structure of the carbohydrate fractions, especially the extent of lignifications of the cell wall (Nagadi, Herrero & Jessop, 2000).

Sugarcane is a tropical grass from which sugar is extracted leaving two by product which are molasses and baggase (fibrous residue). Sugarcane bagasse is highly fibrous residue remaining after extraction of juice from cane stem which can be used as a source of roughages for ruminants. Bagasse is a high fiber, low protein product of very low digestibility which is sometimes mixed with the cane molasses for cattle feeding. Utilization of Sugarcane bagasse for animal feeding is limited due to their bulkiness that hinders their transport to areas of consumption and their poor digestibility due their high content of fiber which contain more than 60% of its dry matter in the form of cellulose, hemicellulose and lignin. Kewalramani, Kamra, Lall and Pathak, 1988; Ramli, Imura, Takayama & Nakanishi, (2005) reported that sugarcane bagasse contained about 50% cellulose, 27.9% hemicellulose, 9.8% lignin and 11.3% cell content that included 1.3% CP.

Use of sugarcane bagasse in ruminant diets for fattening livestock resulted in the reduction of live weight gain from 970 to 810g /day as the proportion of sugarcane bagasse reached 30% of the feed ingredients. The reduction in gain was accompanied by reduction in DM digestibility from (76.2% to 66.8%) the digestibility of the fiber content was also reduced from 47.2 to 20.2% due to the high lignin content of sugarcane bagasse (Elkhidir, 2004).

The major biological constraint of the use of sugarcane bagasse in livestock feeding is the vast amount of lignocellulosic material which has a very low digestibility. Torres, Ferriera,Verasa, Melo & Andrade (2003) pointed out that due to low crude protein content in dry matter, approximately 90% of the nitrogen may be unavailable as it is associated with fiber; and the acid fiber content of bagasse has values between 58 and 62%. The potential of the use of sugarcane bagasse as a ruminant feed ingredient may be realized through the development of physical, chemical and biological treatments (Yalchi, Seif-Davati & Seyed Sharifi, 2010) which have been applied successfully to break down lignocellulose chemical structure and increase the soluble carbohydrate fractions. This results increase in the nutritive value of agricultural crop residues, and improvement of the rumen digestibility and performance of ruminants.

1.2 PROBLEM STATEMENT

Sugarcane bagasse is the fibrous product resulting from the crushing of cane sugar in the extraction or direct transformation of alcohol. (Bulle, Ribeiro & Leme, 2002) stated that the use of bagasse from sugar cane in animal feed, on a commercial scale, has been poorly studied, leading to accumulation of large quantities in industries. This creates problems due to the lack of storage space and also reduces consumption by animals, since there may be contamination of the pulp by fungi and bacteria. (Pereira, Ferreira & Garcia, 2008), reported that, a major factor that limits the use of sugarcane bagasse for animal feed is the low digestibility of dry matter, which is usually less than 50%. The fiber in cane sugar contains about 40% cellulose, 35% hemicelluloses and 15% lignin, the latter being responsible for their low use in ruminant feed.

1.3 JUSTIFICATION

Non-conventional feedstuff can be used to solve the problems of livestock feeding and reduce the competition between man and livestock. This will make the non-conventional ingredients more utilized. The availability relatively differs from state to state or from nation to nation and from time to time within a particular country. The agricultural and industrial by-products could be used in animal feed at certain percentage depending on their nutritive value, palatability and toxic effect or nutritional factor. Nigeria has large number of livestock, therefore the used of non-conventional feeds has become essential in addressing the problem of feeding livestock and to reduce the competition between Man and livestock. Due to unavailability of the conventional feed resource, non-conventional feedstuff offer the best alternative in our environment for reduction of feed cost and therefore reduction in the cost of meat, milk and other animal products (Dafwang *et al.*, 2001). Sugarcane bagasse being a crop residue with low nutritive value, treatment and ensiling with other ingredients high in other nutrients could enhance its intake and fermentation compared to feeding untreated sugarcane waste alone. Sugarcane bagasse is especially important during the dry period when other feed materials are inadequate.

1.4 OBJECTIVES OF THE STUDY

The objectives of this experiment were to determined:

i. The nutritive value of ensiled sugarcane bagasse treated with urea, molasses and yeast
ii. The degradability of ensiled sugarcane bagasse using *In sacco* nylon bag techniques
iii. The effect of treatment on some physical qualities (colour and aroma) of ensiled sugarcane bagasse

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Economic Importance of Agricultural Byproducts.

Agricultural by-products, crop residues and other agricultural by-products categorized as wastes have been used as a major components in ruminants feeding since ancient times, because ruminants have ability to digest these materials by microorganism in their rumen (Boucque & Fiems, 1988; Leng, 1990; Nair, Verma, Dass, & Mehra, 2002) indicated that the majority of tropical and sub-tropical countries used agricultural by-products for feeding livestock or graze pasture of low quality in range land.

In Nigeria a variety of cash crops are grown. Some of their products and processing by-products include cereal straw (sorghum, wheat and millet), sugar-cane by-products (bagasse, sugarcane tops and molasses), and groundnut and cotton by-products. These by-products are not fully utilized in animal feeding. However some of these are now being incorporated in ruminants feed. The increasing use of these by-products is due to several factors as: competition between human and animal for cereal grains, increasing price of cereal grains, seasonal changes in availability of forages and good quality feed, increasing demand of animal protein of high quality and low price due to increasing population and their low income, increasing pressure on agricultural land use and serious economic and environmental problems caused by improper disposal of these resources (Jayasuriya & Pearce, 1983; Saewar, Nisa, Khan & Mushtaque, 2006).

Crop residues and most of agricultural by-products like cereal straw and sugar-cane bagasse are fibrous and high in content of lingo-cellulose. Roughly three-quarters of straw is cellulose plus hemicellulose (De La Cruz, 1990) and (Preston & Leng, 1987) mentioned that agricultural by-products and crop residues have special physical and chemical characteristics which make them difficult to incorporate in conventional balanced rations. Thus cereal straw and sugar-cane bagasse are classified as low quality feedstuff. (Leng, 1990) defined low quality forage as those forage which are (less than 80g crude protein/ kg) and low in soluble sugars and starches (less than 100g/kg).

2.2 Use of Agro-Industrial Byproducts for Animals in Northern Nigeria.

There are three observable features of the livestock policy environment that inhibit the use of crop residues and industrial by-products in Nigeria. Agricultural industries are generally not located in the same areas as the main livestock population; therefore by-products which accumulate in the industrial areas cannot be distributed to livestock owners at the time and in the form and quantity desired without incurring transport costs. This constraint could be overcome by the development and use of suitable means of treatment, preservation and transport of the by-products. Although crop residues are widely distributed throughout the country, their use as livestock feed is limited to the Northern zone, on the other hand, the use of industrial by-products is only popular in the south (Ayoola & Ayoede, 2004).

2.3 Estimation of the Nutritive Value of Ruminant Feed

Evaluation of feeds should provide nutritionist with the necessary information to formulate a diet from both physiological and economical view points, in order optimize the animal performance (Theodorou *et al.*, 1994).

Laboratory methods to estimate nutritive value of feed have improved since the first idea in 1725,when ruminant feed were evaluated as Straw Units (Blaxter, 1986). Initially, the techniques were designed mainly to characterize nutritive value of feed stuff rather than to predict animal performance. Improvements in the methods of food evaluation have followed new concepts in chemistry, animal physiology, rumen microbiology knowledge and related field of science (Flatt, 1988).

Feed evaluation needs to define roughage characteristics which determine animal performance, for example live weight Gain, Milk, Yield, Wool growth etc (Blummel *et al.*, 1997) of a particular relevance is the prediction of the animal intake which is an important aspect of related to feeding forages (Minson, 1990).

The future development of feed evaluation system should incorporate new information on the relationship between specific end products of digestion and performance of the animals, as well as information on animal and microbial metabolism, feed composition and effect of various factors on feed utilization (Flatt, 1988). An adequate dietary analysis of any sort requires that the methods employed are relevant to a nutritional classification of the dietary chemical components (Van Soest & Robertson, 1985).

In the evaluation of ruminant feedstuffs, different methods are currently available, some of these methods will be considered in this review. Nowadays, the *In sacco* techniques is probably the most widely used method for feed studies, however some drawbacks have been pointed out (Michalet, Doreau & Ould Bah, 1993). Others procedures are also in used proximate analysis, its alternative procedure for the fibre (Van Soest, 1967) and modern instrumental techniques.

2.4 Small Ruminant Production in Nigeria

Small ruminants which include goats and sheep play a significant role in the food chain and overall livelihoods of rural households. Sheep and goats can be reared for various reasons such as income generation, religious purposes, household consumption, hobby and as security against crop failure (Ozung, Nsa, Ebegbulem & Ubua, 2011). According to (FAOSTAT, 2008), sheep numbers were in excess of one billion (1,078,200,000) and goat numbers (861,900,000) were steadily approaching that number. And about 22% and 17% of the total world sheep and goat population belongs to tropical Africa (Ahmed *et al.,* 2013). Nigeria is about 70% of the small ruminants which are found in the semi-arid zones of Nigeria and these belong to the agro-pastoral farmers utilizing extensive and semi-intensive management systems (Ahmed & Egwu, 2014)

Among all the livestock in Nigeria, ruminants comprising sheep, goats and cattle, constitute the farm animals largely reared by farm families in the country's agricultural system. Nigeria has population of 34.5million goats, 22.1million sheep and13.9million cattle. The larger proportion of these animals' population are however largely concentrated in the northern region of the country than the southern region. And specifically about 90 percent of the country's cattle population and 70 percent of the sheep and goat populations are concentrated in northern region of the country (Adebowale, 2012). These animals are mostly reared for meat and are also important sources of milk, skins and manure. Their fecundity, short generation interval and capability for fitting into all existing agricultural production systems, as well as the prevailing demand for mutton, place them in a unique position (Ozung, Nsa, Ebegbulem & Ubua, 2011). Sheep and goats constitute a good source of family income and livelihood, assets and agricultural resources for smallholder farmers (Shittu *et al.*, 2008; Salem Ben & Smith, 2008). This makes small ruminant farming an important and secured form of agricultural investment to the Nigerian rural and urban farmers. Despite the potentials of small ruminant, shortage of animal protein still remains a major problem confronting the ever increasing human population in the developing countries (Salami, Makinde & Garba, 2010). In Nigeria and other developing countries is inadequate nutrition to small ruminants (Ahamefule & Udo, 2010). And the situation becomes worse during the dry season when the animals are unable to meet their protein and energy requirement from available poor quality herbage with consequent marked weight loss and low productivity (Ngele *et al.,* 2010).

Available breeds of sheep and goat as mentioned by (Adebawole, 2010) in the country are mainly indigenous, and for the sheep *(Ovis aeris)* are 'West African Dwarf (WAD) sheep, Balami, Uda and Yankasa. Out of these four major of breeds of sheep in the country, the WAD breed is common to southern region against the widespread of Balami, Uda and Yakansa breeds in the northern region of the country. Characteristics analysis of sheep in the country, especially among the Fulani pastoralists showed that ewes had approximately 120% fertility rate, 12% rate of twinning and 25% lamb mortality rate at 3months old. Sheep productivity index puts lamb weight at 0.327 kg at a weaning age of 90 days, and 0.490 kg at a weaning age of 180days per ewe per year. Mature males of the local breeds of sheep have a live weight of about 30 to 65kg and their female counter parts often weigh between 30 and 45kg.

The goat (*Capra hircus L.*) represents one of the most important livestock species found in many part of the world, and the first to be domesticated by man as livestock about 10,000 years ago (Muhammad, 2017). The largest number of goats is found in Asia, followed by Africa, representing about 59.7% and 33.8% respectively, and the lowest population of goats is found in Oceania accounting of 0.1% of the total world population (FAOSTAT, 2008). However, the breeds of goats in Nigeria are largely indigenous which includes the West African Dwarf (WAD) goat, Sahel/desert goat- known as West African long-legged goat and Sokoto Red/Maradi. The Kalahari goat breed, which is of South Africa origin is gradually being adapted to the Nigeria's ecological zones on experimental efforts. Distribution of the goat breeds in the country showed that the West African Dwarf (WAD) goat is common to southern Nigeria while the Sahel or desert goat and Sokoto Red are common to the northern region of the country.

Production characteristic of the small ruminant showed that breeds of goats in the country had low fertility rate (below 100%), 40% twins and triplets birth rates, and low mortality rates of 22% for kids and 14.4% for adults. The productivity indices for 90 and 180 days weaning age were 0.259 kg and 0.437 kg kid/kg doe respectively (Adebawole, 2010).

2.5 Crop Residue Utilization in Small Ruminant Feeding

Crop residues sometimes referred to as "farm waste", are post-harvest roughage materials or plant materials left after the removal of the primary food from the crop plant and are distinct from agro-industrial by-products which are products arising from factory or household processing of the harvested crop. It was been observed that most of the crop residues are abundant during the months of September to November, while they are mostly needed and utilized between March and July (the late dry and early rainy seasons) when the available pasture is low in quantity and quality (Kubkomawa *et al.,* 2015). These crop residues are used as mulch, bedding, fuel, building materials or source of organic fertilizer. These can supply enough roughage for the ruminant population in the country if properly harnessed, processed and preserved (Kubkomawa *et al.,* 2015).

Crop residues have high fiber content and are low in protein, starch and fat. So the traditional method of increasing livestock production by supplementing forage and pasture with grains and protein concentrate may not meet future meat protein needs. Use of the grain and protein for human food will compete with such use for animal feed. These problems may be circumvented by utilizing residues to feed domesticated animals (Obi, Ugwuishiwu & Nwakaire, 2016*)*. It is an important feed resource in Sub-Saharan Africa they are becoming a dominant feed resource as rangelands are being converted into crop land. However, the level of incorporation of crop residues in the complete diet is influenced by the quality of crop residue (Anandan *et al*., 2010). In Sub-Saharan Africa, crop residues are sometimes left on the field as standing hay or stacked on traditional structures or on trees exposing them to losses due to the effects of the weather. The problem of dry season livestock feeding in particular, has directed research efforts towards harnessing and enhancing the utilization of abundant arable by-products and crop residues. The abundance of crop residues makes them cheap sources of nutrients for ruminants. Crop residues from maize (*Zea mays* L.), sorghum (*Sorghum bicolor* L.), millet (*Pennisetum glaucum*), cowpea (*Vigna unguiculata* L.) and groundnut (*Arachis hypogaea* L.) are very important livestock feed in the savanna region particularly during the long dry season.

The residues from cereal crops are relatively in abundance, but of low nutritive value compared to the leguminous crop residues, which are normally in short supply (Musa *et al.*, 2011). However, crop residues, being unpalatable and low in digestibility, cannot form a sole ration for livestock, low-density fibrous materials, low in nitrogen, soluble carbohydrates, minerals and vitamins with varying amounts of lignin which acts as a physical barrier and impedes the process of microbial breakdown. In West African region, farmers mostly feed their livestock with sorghum, millet and maize stovers as basal diet, while cowpea and groundnut haulms are fed as protein supplement and other agricultural by-products such as brans, oilcakes are also fed to livestock as energy and mineral supplement. The knowledge of the availability and utilization of crop residues and agro-industrial by-products in the agro-ecological zones of Nigeria is important for assessing the potential of those resources (Onyeonagu, 2010).

However, large quantities of crop residues were produced in Nigerian farms are wasted year after year, some are left to rot in the field, which may improve soil fertility anyway, but most are burned. Integration of livestock and crop residue allow resources to be recycled more effectively in livestock production enterprises. There is evidence that livestock fed with crop residues and agro-industrial by-products could achieve substantial weight gains (Onyeonagu, 2010). So to meet the nutritional requirements of animals, the residues need processing and enriching with urea and molasses, and supplementing with green fodders.

2.6 Nutritional Composition of Crop Residue

Crop residues have high fiber content and are low in protein, starch and fat and it was observed (Obi, Ugwuishiwu & Nwakaire, 2016*)* that crop residues are characterized by high content of fibre usually above 40%, low content of nitrogen (0.3 to 1.0%) and low content of essential minerals such as sodium (Na), phosphorous (P) and calcium (Ca). Cell wall estimated by neutral detergent fibre (NDF) accounts for at least 72% of the dry matter and represents a large source of potential energy for ruminants and the ability of rumen microorganisms to digest cell polysaccharides, consisting mainly of cellulose and hemicelluloses is limited by lignin (Kubkomawa *et al.,* 2015) It is well recognized that cereal crop residues are of low nutritive value this is because of their relatively low digestibility (<500 g digestible organic matter (DOM) per kg dry matter (DM), low crude protein content (<50 g/kg DM) and low content of available minerals and vitamins. These deficiencies combine to make crop residues unpalatable, thus their consumption is also low (usually less than 15 g DM/kg live weight daily). And according to (Van Soest and Robertson, 1988) since fibre is often used as a negative index of nutritive value in predicting the total digestible nutrient (TDN) and net energy, the available energy from crop residues is likely to be low in relation to crop residue yield. Therefore, crop residues, being fibrous in nature require that their quality be upgraded for effective utilization by livestock. They are characterized by low levels of one or more key nutrients which limit their utilization by livestock so when fed to ruminants their intake is low and their utilization is limited by the slow rate and total degradability and the rate at which particles breakdown to a critical size small enough to leave the rumen. However, leguminous crop residues are usually better and may be used to complement forages if they are in adequate quantities (Kubkomawa *et al.*, 2015)

2.7 Sugarcane Bagasse

Sugarcane is processed for its sugar which leaves two by-products, molasses and a fibrous residue termed bagasse. Bagasse is a high fiber, low protein product of very low digestibility which is sometimes mixed with the cane molasses for cattle feeding. Sugarcane bagasse is one of a highly fibrous residue remaining after extraction of juice from cane stem which can be used as a source of roughages for ruminants. Utilization of Sugarcane bagasse for animal feeding is limited due to their bulkiness that hinders their transport to areas of consumption and their poor digestibility due their high content of fiber which contain more than 60% of its dry matter in the form of cellulose, hemicellulose and lignin. Kewalramani, Kamra, Lall & Pathak, 1988; Ramli, Imura, Takayama & Nakanishi, (2005) reported that sugarcane bagasse contained about 50% cellulose, 27.9% hemicellulose, 9.8% lignin and 11.3% cell content that included 1.3% CP.

The limitation in availability of energy to the ruminant animals from ligno-cellulose of agricultural byproducts is due to physical and chemical association between structural carbohydrate and lignin and the crystalline arrangement of the cellulose polymer in plant cell wall (Morris & Bacon, 1977; Hartley & Jones, 1978; Scalbert *et al.*, 1985). It is clear that, with respect to animal feeding, the major biological constraints the use of sugarcane bagasse are the vast amount of lingo-cellulosic material which has a very low digestibility. A potential for the use of sugarcane bagasse as a ruminant feed may be realized through the development of physical, chemical and biological treatments to disrupt the lingocellulose complex. Alkali, acid and oxidative reagent treatments are kinds of chemical treatments for roughages (Sundstol &

Coxworth, 1988; Suksombat, 2004). Ammoniation of low quality roughages with urea or ammonia solution improved digestibility and nutritive value (Ngyuen, Dan, Ly & Sandsle, 2002).

2.7.1 Use of Sugarcane Bagasse as Livestock Feed in Nigeria

Shortage in animal feeds is a well-known problem; several studies have been carried out to improve to find out an effective and practical solution to overcome the feed shortage problem in animal feeds and resources. (Salman *et al.,* 2011). Agricultural by-products such as rice straw and bagasse have enough potential to be used as dairy cattle feed, although these agricultural by-products are low in protein palatability, digestibility and thus their nutritive values (Suksumbat, 2004). Utilization of sugarcane bagasse as animal feeding is limited due to their bulkiness that hinders their transport to areas of consumption and their poor digestibility due to their high content of fiber which contains more than 60% of its dry matter in form of cellulose, hemicellulose and lignin. (Ahmed *et al.,* 2013). The use of *Sacharum officinarum* has been recommended as forage in animal production systems. Recently, an increase of the use of sugarcane silage has been observed in animal feeding (Santos *et al.,* 2009). As a forage resource to ruminants, it is considered as one of the alternatives used for minimizing the inadequate nutrition of animals, especially in drought periods (Freitas, Rocha & Zonta, 2008), which coincides with the off-season production of tropical pastures (Oliveira *et al.*, 2002), favoring it use as a forage for ruminants in the dry season. In recent years there has been an increasing trend towards more efficient utilization of agro-industrial residues, including sugarcane bagasse. Several processes and products have been reported that utilize sugarcane bagasse as raw material (Pandey *et al.,* 2000). One of the significant uses of sugarcane bagasse has been for the production of protein enriched-cattle feed. Although the economy of such processes in submerged fermentation is severely affected by the high cost of product isolation (and low value of the product), Pandey *et al*. (2000).

2.7.2 Nutritive Value of Sugarcane Bagasse

Bagasse is the residual fibre that remains after extraction of sugarcane juice. There are two main types of bagasse factory and pressed cane stalks or farm bagasse, Bagasse consists approximately 50% cellulose and 25% each of hemicellulose and lignin. Chemically, bagasse contains about 50% α-cellulose,30% pentosans, and 2.4% ash (Pandey *et al.,* 2000) Because of its low ash content, bagasse offers numerous advantages in comparison to other crop residues such as rice straw and wheat straw, which have 17.5% and 11.5% ash respectively (Sindhu & Gnansounou, 2016).

2.7.3 Methods of Preparing Sugarcane Bagasse

Sugarcane Bagasse, rice straw and other agricultural byproducts, contain lignocellulosic materials (Suksumbat, 2004). The main components are cellulose, hemicellulose and lignin. As a result of its high content of lignin, ruminal digestion is inhibited and thus the nutritive value of bagasse and pith is low for ruminants. To improve the nutritive value of these agriculture residues, it is important to breakdown the linkages among cellulose and lignin, by mechanical, chemical or biological treatments (Salman *et al.*, 2011), according to (Pereira, Ferreira & Garcia, 2008) a factor that limits the use of sugarcane bagasse for animal feed is the low digestibility of dry matter which is usually less than 50%. However its nutritional use can be increased sufficiently increased by physical, chemical and biological treatments (Costa *et al.,* 2015).

2.7.4 Physical Treatment of Sugarcane Bagasse

Use of steam and pressure treatments alone or in conjunction with chemical treatments is known to disrupt the lignocellulosic material in a way that allows for the improved utilization of cell wall polysaccharides by cell free enzymes (Fan, Lee & Beardmore, 1981; Grohman, Torget & Himmel, 1985; Brownell & Saddler, 1987). Physical treatments include soaking/wetting, chopping, grinding, pelleting, steaming under pressure and gamma radiation. (Suksombat, 2004). These can result in a lower cellulose crystallinity resulting in cellulosebeing better degradable by enzymes (Agbor *et al.,* 2011; Hendriks & Zeeman, 2009; Sarkar, Ghosh & Banneree, 2012; Sarnklong, Cone, Pellikaan & Hendriks, 2010). These physical treatments have a limited feasibility to be applied on farm, because machines or industrial processes are required (Sarnklong, Cone, Pellikaan & Hendriks, 2010).

2.7.5 Chemical Treatment of Sugarcane Bagasse Silage

Santos *et al.* (2009) reported an increase in the use of sugarcane silage in animals feeding. However, during the fermentation process, the high water soluble sugar contents results in sugarcane silage with high ethanol levels which in turn increases the dry matter loses and lowers its nutritive value. Thus, silage fermentation may be altered using chemical and biological additives.

Chemical pretreatments using acid are considered effective and economical (Pandey *et al*., 2000). Acids hydrolyze hemicellulose and produce a liquid phase that is rich in xylose, with minor amounts of lignin derivatives (Rezende *et al.,* 2011). High yields of hemicellulose removal (up to 90%) with only 15% of cellulose loses were also obtained by (Rocha *et al*., 2011) on sugarcane bagasse, using a mixture of sulfuric and acetic acids.

Alkali treatments were initially used to increase the biomass digestibility for animal feeding. Diluted alkali solutions lead to disruption of lignocellulosic cell walls by dissolving hemicellulose, lignin and silica, by hydrolyzing uronic and acetic acid esters and by swelling cellulose (Zhang & Lynd, 2007; Jackson, 1977). Sodium hydroxide presents the greatest degradation and subsequent fermentation yields when compared to other alkalis, such as sodium bicarbonate, ammonium hydroxide, calcium hydroxide and hydrogen peroxide (Rodriguez-vazquez & Villanuevaventura, 1992a; Rodriguez-vazquez & Diazcervantes, 1994b) used a NaOH hydroxide solution to treat the pith component of the sugarcane bagasse(0.2g of NaOH per pith gram), obtaining a maximum digestibility of 71% at 92 degree celsius.

2.7.6 Biological Treatment of Sugarcane Bagasse Silage.

Recycling of agricultural residue can be achieved naturally or artificially by micro-organisms (Olagunju *et al.*, 2014). Fibrolytic enzymes from fungi and bacteria have been added to lignocellulosic biomass in order to improve the accessibility of cellulose and hemicellulose. Addition of fibrolytic enzymes from different white rot fungi to wheat straw did result in a higher in vitro neutral detergent fiber (NDF) rumen degradability of 13% (Rodriguez *et al.*, 2008). Biological treatments of some by-products are very essential in order to degrade lingo-cellulosics into lignin, cellulose, hemicellulose and improve the crude protein content (Abdel-Aziz *et al.*, 2014). Fermentative bacteria especially the lactic acid bacteria, utilize plant sugars to produce acids that drive silage to a stable, terminal pH (Mahanna, 2007). While yeasts are not producing, they remain metabolically active, producing heat, carbon dioxide and ethanol and also by-products, including acetic acid, aldehydes and esters (Dennis, 2007). It is also known that, for every alcohol that is produced, a carbon dioxide molecule is generated, which further contributes to dry matter loss (Mahanna, 2007).

2.8 Silage Additives

Silage additives have been in use for a very long time (Owen, Ngodigha & Amakiri, 2008) but it is only in the last 15 to 20 years that the availability of machinery, knowledge of silage fermentation processes, grassland management practices and awareness of the value of forage in the ruminant diet have contributed to the significant growth in additive usage. Jones (1994) observed that over 130 silage additives were available in UK. Over 50 million tones of silages were produced in 1994, but only about 18 million tones of these silages were treated with silage additive. (Owen, Ngodigha & Amakiri, 2008) summarized the factors which may be regarded as important characteristics of silage additive and reported that silage additives should produce high quality stable silage with no secondary fermentation, which would improve animal performance. The silage additives should also be non- corrosive to machinery, and easy and safe to handle. Finally, the silage additives should be well-proven and backed by major company. Additives are used to improve silage preservation by ensuring that lactic acid bacteria dominate the fermentation phase .They can be divided into three general categories: Fermentation stimulants, such as bacterial inoculants and enzymes, Fermentation inhibitors such as propionic, formic and sulphuric acids, Substrate or nutrient sources such as maize grain, molasses, urea and anhydrous ammonia (Woolford, 1984; Henderson, 1993; Bolsen, Ashb & Wilkinson, 1995).

A number of trials resulted in the conclusion that only strong acids, either alone or in combination with formaldehyde, have the potential consistently to modify fermentation (Thomas & Thomas, 1985). However, these additives have largely lost popularity due to both cost and handling difficulties on the farm. Bacterial inoculants have inherent advantages over other additives, due to their low cost, safety in handling, a low application rate and no residues or environmental problems. However, results of their application are variable, probably due to the differing ensilage conditions prevailing at the time of application .However, when the additives are applied together with enzymes, which degrade plant cell walls and starch providing addition sugars for fermentation to lactic acid. They appear to have achieved improvement in fermentation and nutritional quality of tropical grasses and legumes (Bolsen, 1999). On small scale farms, commercial additives, which comprise inoculants and enzymes, may be too costly. It is likely therefore that the third category of additive will be of most benefit to silage made in small holdings. Possibly the most important benefit of additives such as maize or sorghum grain or cassava meal improved dry matter in early cut crops when moisture content is high where rapid drying (wilting) is not possible or effluent is lost to the silage through seepage . Tropical grasses have been successfully ensiled when supplemented with maize meal (Onselen & Lopez, 1988) cassava meal (Panditharane, Allen, Fontenot & Jayasuriya, 1986) and sorghum grain (Alberto, Portella & De oliverira, 1993).

2.8.1 Yeasts

The yeast used in ethanol production (Saccharomyces cerevisiae) has a by-product with the potential for animal feed, due to its high protein and vitamin content. Among the microorganisms studied, yeasts appear to meet the more favorable characteristics for using in animal feed. (Moreira *et al.*, 2002) reported that the content in crude protein is variable (30 to 60%), the total nitrogen is about 80% of amino acids, 12% of nucleic acids and 8% of ammonia. Approximately 7% of total nitrogen occurs as free amino acids and in other compounds, such as flutationa, lecithin, Adelino acid, vitamins, enzymes and coenzymes in small quantities. Carbohydrates constitute 15 to 60% of the dry weight of yeast, being represented averagely as 33% trehalose, 27% glucans, 21% mannans and 12% glycogen.

Alcohol industry is concerned with processing the yeast in order to preserve its nutritional properties, such as enzymes, nucleotides and metabolites of fermentation, which are of fundamental importance in improving animal performance. Despite the seasonal production, concentrated between the months of May and November, the sugar mills ensure the supply of yeast for 12 months. (Blumer, 2002) stated that in the rumen, the yeast appear to increase consumption by increasing the rate of fiber degradation, causing an increase in the number of anaerobic bacteria and more stable ruminal environment. They do this by reducing diurnal variations of pH, ammonia and volatile fatty acid. Yeasts seem to be related to reduce the production of methane in the rumen by promoting increased competition between methanogenics and acetogenics bacteria. (Possenti *et al*., 2008) affirms that in diets for ruminants, yeasts have been used to improve the symbiotic relationship between rumen microorganisms and their host, improving rumen fermentation processes in animals given diets rich in starch.

2.8.2 Molasses

Molasses is a by-product or end product of sugar cane (Saccharum officcinarum L.) or sugar-beet (Beta vulgaris L. var. Conditiva) resulting from the manufacture of raw or refined sugar. It is a viscous liquid and heavily condensed to separate into a low degree, of which not all of sugar can be crystallized by the usual processes. It can be found in the market in liquid or solid (powder). Molasses contains an average of 5% protein, but is rich in energy, and a very palatable laxative (EMBRAPA, 2015). Molasses is the carbohydrate source used most frequently and is of particular benefit when applied to crops low in soluble carbohydrates such as tropical legumes and grasses.

Valadares *et al*. (2002) pointed out that molasses should be used, diluted in water at a ratio of 1:1 to 1:2, and given together with dried forages and concentrates, properly supplemented with protein. Molasses, by weight, has 67% of energy from corn, but offers the advantage of stimulating the multiplication of bacteria in the rumen, therefore leading to the digestion of fibrous feed. Since the cost of molasses is not more than 60% of the cost of corn, it can be mixed in a ratio to 1/3 of concentrated feed and the gradually introduced in the diet. Molasses has been used widely as a food supplement in the diet of ruminants with good results, and the percentage composition of the feed used in cattle-will depend on the stage of the flock and the type of pasture (nutritional value of pasture).

Najafpour & Shan (2003) asserted that molasses can vary from 85 to 92° Brix. The Brix content measured (in degree Brix), are very close to the concentration of sucrose in the product, 25 to 40% sucrose from 12 to 35% of reducing sugars, 2.5 to 9% crude protein, 7-15% ash, 3100 kcal/kg gross energy and 80% TDN. According to these authors, there are differences in the chemical composition of molasses produced from sugar cane grown on organic soils in relation to those of mineralized soils and it is possible that these differences may produce different effects when fed to animals.

Molasses is an energy supplement used in order to stimulate consumption in feed for ruminants and as a reduction of powder to substitute other ingredients for the same purpose, provided it price is competitive. There are reports of supply of sugarcane molasses for cattle since 1890, originally used pure. This product has entered the match in the 30's and then to urea in 50 years. With time, other nutrients were added to the formulations true protein, lipids, minerals, vitamins, additives and even homeopathic ingredients (Freitas, Rocha & Zonta, 2008).

High prices of protein food and alternative sources to provide adequate nitrogen for the animals has become necessary in order to minimize production costs in feed.

2.8.3 Urea

Urea is a source of non-protein nitrogen and it has been frequently used in ruminant feed. However, for the best utilization of urea by ruminants, it is important to increase energy source. Molasses is a good alternative, besides improving the palatability of urea, it improves intake. It has been shown that when provided in adequate amounts, molasses is a good source of energy, improves the palatability of food, stimulates the activity of microorganisms in the breakdown of cellulose and is good source of trace minerals. Molasses can be an excellent binder for making up rations and is a good solvent for urea, vitamins and other ingredients (Freitas, Rocha & Zonta, 2008; Najafpour & Shan, 2003) showed that the aroma of molasses and the use of low quality residues such as straw, cobs and hay make them a food with higher nutritional quality, increasing weight gain and improving the fur of animals as well as causing the increase of food consumption by 30%. They also stated that the dose of molasses for sheep should be 100 to 250 g for lambs and adults per head. The methods of use of molasses are mixed; the best is around 2% in the diet, or 200 g/day when mixed with chopped grass, hay and straws in general. In beef cattle in confinement, 350 g/day molasses should be used (mixed into fodder). Feeding creep-feeding system in the molasses is a good alternative, since this increases the palatability of the diet, causing the animal to increase the consumption of feed, allowing greater rumen development

2.9.0 Nylon-Bag Technique (*in situ*)

The nylon-bag technique provides a means of ranking feeds according to the rate and extent of degradation of dry matter, organic matter, nitrogen or other nutritional parameters. It involves incubating samples of feeds in the rumen of fistulated animals for periods of 60 to 120 hours and subsequent determination of the disappearance of different feed components (Osuji, Sibanda & Nsahlai, 1993). The nylon technique uses bags (9cm x 18cm) made of nylon mesh (30-50µm) in which a sample of known weight is tightly sealed in the nylon bags and placed in the rumen of fistulated animal. After the required period of time, the sample is removed, washed, dried and weighed. Degradability (or disappearance) of the substrate is determined by the weight loss during the incubation periods. The dried residue may also be used for chemical analysis (Osuji, Sibanda & Nsahlai, 1993). Nylon bag (or *in situ*) techniques, are, however, quite useful for evaluating kinetic aspects of digestion in ruminants through the use of multiple incubation times and computer models, rates of nutrient digestion can be estimated (Khan, Nisa & Sarwar, 2003).

2.9.1 *In Sacco* Rumen Degradability

In sacco method, also named as nylon bag or *In situ* is based on depositing separately feed stuffs into bags which are incubated into the rumen of an animal fitted with a rumen cannula. The main objective is to measure the disappearance of dry matter and or other nutrients. In early experiments (Quin, Vanderwath & Mayburdh, 1939) silk bags were used to incubate samples. These were later replaced by other types of clothes e.g nylon, polyester or Dacron.

Mehrez & Orskov (1977) proposed the use of *In sacco* methods as a routine procedure for measuring protein degradation rate, incubating several bags in order to obtain kinetic evaluation of the degradation. Van Soest, Mertens & Deimum 1978; Orskov, Reid & Kay, (1988) have suggested the use of kinetics of fermentation data to improve the estimation of nutritive value of feed when both *in vitro* and *In sacco* methods are considered. Such a dynamic approach improves markedly the potential of this technique as suggested by (Orskov, Hovell & Mould, 1980) in forage evaluation.

2.9.2 Rumen Degradation of Feeds

Degradation is one of the most important quantitative factors determining the nutritional value of feed protein, the supply of ammonia, peptides and branched-chain fatty acids to ruminal microorganisms, and the passage of undegradable proteins to the intestine (Hvelplund & Weisbjerg, 2000). The nylon bag technique described by (Ørskov, Hovell & Mould, 1980) for the determination of the degradation of feedstuffs in the rumen at various incubation periods can be used to screen feeds at the initial stages of assessing their nutritive values. Applying the equation of McDonald (1981), $y = a + b\ (1- e^{-ct})$, to describe the course of degradation of the feeds, the constants, a, b, and c obtained can also be used to predict feed intake and growth rate (Ørskov, Reid & Kay, 1988; Blummel & Ørskov, 1993) reported that the *in vitro* gas production technique developed by (Menke *et al.*, 1979) could also be used to determine gas production at various incubation periods and these values could be used to describe the course of fermentation of the feeds, by applying the equation of (McDonald, 1981). These workers reported high positive correlation between the in vitro gas production and the dry matter degradability values of feeds at the various incubation periods (Blummel, Steingass, Becker & Soller, 1993).

The technique used to estimate ruminal fermentation by the incubation of small samples of feed in the rumen was first used by (Quinn, Wath, Vander & Myburgh, 1938). However, it was not until the introduction of mathematical tools capable of transforming the data of ruminal disappearance rates in values of effective degradability (Ørskov & McDonald, 1979) that the method became widespread (Hvelplund & Weisbjerg, 2000). Today, the *in situ* method is the most widely used in research to determine estimates of rumen protein degradability, having been adopted in several countries (Schwab, Tylutki & Ordway, 2003) as well as by the (NRC, 2001). Ørskov *et al.* (1980) observed that the nylon bag technique was not only a powerful tool for indexing the relative degradability of feedstuffs, but that it may also be used to study rumen processes, as it is possible to vary the factors within the bag, or within the rumen.

The *in-situ* procedure consists of placing feed samples in a nylon bag with a defined pore size (40-60 µm), and infusing them into cannulated animals (cattle, sheep or goats). The pores must be small enough to prevent the loss of particles and large enough to allow for access of microorganisms to the material. Due to the small quantity of incubated samples, they do not interfere with ruminal fermentation, and it is assumed that the conditions inside the bags are similar to those in the rumen.

CHAPTER THREE

3.0 MATERIALS AND METHOD

3.1 EXPERIMENTAL LOCATION

The experiment was conducted at the Laboratory and Research Farm Department of Animal Science, Bayero University Kano. The laboratory is located in the new site campus of the University, about 13 kilometers from Kano metropolis in Ungogo Local Government Area of Kano State. Kano State lies on longitude 9^0 30' and 12^0 30' North and latitude 8^0 42' and 9^0 30' East in the semi-arid region in the northern Nigeria (Olofin, 2007). Kano state occupies a total land area of 24,400 square kilometers (NPC, 2006). The mean annual rainfall vary from 600-1000mm (KNARDA, 2001). The location has about 4-8 months of dry season with maximum and minimum temperatures of 33^0C and 15.2^0C, respectively.

3.2 EXPERIMENTAL DESIGN AND TREATMENT

Thirty six bottles (jam bottles) were used for the ensilage with four treatment combinations designated as control, urea, molasses and yeast respectively, and each treatment were replicated three times the sample to be ensiled for 3^{rd}, 5^{th}, and 7^{th} (weeks). A 3 x 4 Factorial Experiment in Randomized Completely Block Design (RCBD) was used for this study. The treatment are:

T0 = untreated sugarcane bagasse

T1 = sugarcane bagasse + urea solution

T2 = sugarcane bagasse + molasses solution

T3 = sugarcane bagasse + yeast

3.3 COLLECTION AND PREPARATION OF TEST MATERIALS

The sugarcane bagasse was collected from *Yan rake* Market, Sharada in Kano metropolis and chopped into about (1-3cm) length using a medium crushing machine to make compaction easy (Ogunlolu, Jolaosho, Akinola & Aniwe, 2010). All foreign materials (stones, metals and polyethene) were removed. The bottles was properly washed with detergent then dried under shade in a clean environment. The sugarcane bagasses were crushed using a medium crushing machine of the Animal Science Laboratory, Bayero University Kano.

3.4 EXPERIMENTAL MATERIALS

The materials used for the experiment include; sugarcane bagasse, Jam bottle, Laboratory yeast, urea, sugar molasses, plastic tube, rubber band/nylon thread, nylon bag, washing machine, and rumen cannulated animal. The Jam bottle and chemicals was purchased from market around Kano State metropolis.

3.5 ENSILING PROCEDURE

Before the ensiling, 7.0kg of sugarcane bagasse were chopped into smaller pieces of about 1-3cm. four combinations of sugarcane bagasse, treated with urea, molasses, laboratory yeast, and untreated sugarcane bagasse were used. The crushed sugarcane bagasse was treated by sprinkled with the solution of (urea molasses and yeast). The mixtures was ensiled and tightly packed into the bottles and compressed using a wooden stick to remove air. Each treatment was replicated three times and kept for three ensiling period of 3, 5 and 7 week and stored under shade. Grease was rubbed at the brim to ensure tight condition after filling with silage materials and compressed. At the end of each ensilage period samples was drained for chemical analysis and degradability studies.

Treatment of Molasses at a level of 3% dry matter of sugarcane bagasse was diluted in 1000ml of water and mixed thoroughly with sugarcane bagasse. Good silages have been reported when molasses was applied at 3-5 % (Valadares *et al*., 2002). **Yeast at a level** 1% was used on dry matter basis of sugarcane bagasse and dissolved in 3000ml of water and mixed with bagasse as described in the procedure of (Gattass *et al*., 2008). 1% of urea on dry matter bagasse was dissolved in 3000ml of water and mixed with bagasse as described in the procedure of (Roy & Rangnekar, 2006). 2000ml of water was added to the raw sugarcane bagasse and ensiled directly. The bottle was covered air tight and kept for a period of 3, 5 and 7 weeks of fermentation.

3.6 DESCRIPTION OF SILAGE QUALITY

After 3, 5 and 7 weeks, the fermentation was terminated and the silage were opened for silage quality evaluation. The assessed quality characteristics were colour, aroma and pH according to (Babayemi & Igbekoyi, 2008). The pH was determined by adding 100ml of distilled water to 25g of each treatment in a beaker and a pH meter was inserted to determine the pH. The physical characteristic of the ensiled material were determined for its aroma and colour by three independent scorers on a subjective scale of 1 to 4 for aroma and colour as shown in the table below.

Table 1: Physical Quality Parameter Scales

Rating	Colour	Aroma
1	Dark or deep brown	Putrid or rancid
2	Light brown	Pleasant
3	Pale yellow	Sweet
4	Yellowish green	Very sweet

Source: (Muhammad *et al.*, 2009)

3.7 *IN SACCO* DEGRADABILITY

Degradability study of sugarcane bagasse were carried out in cannulated Kano brown bucks with an average age of 48 months old according to the nylon bag technique (Orskov *et al.*, 1980). The animals were allowed ten days period to adapt the feeding and housing condition prior to suspension of bags. The diet of the animals would be as similar to the feeds under investigation. Sugarcane bagasse silage was allowed to dried and ground through a 2.0 mm sieve before rumen incubation. Duplicate samples of about 4/g each was placed in nylon bags (bag size 18×140mm, pore size 45 μm) and suspended in the rumen of three fistulated bucks for 8, 12, 18, 24, 36, and 48 hrs (Orskov & Mc Donald, 1979).

After removal from the rumen, the bags were dipped into cold water (13 degree F) depending on the weather condition and the environment, to stop microbial activity then washed with tap water to remove rumen matter from outside the bags for about 30 minutes. Samples of 0 hr were prepared by washing the bags containing the test samples for 30 minutes. The washed bags and contents were dried for 48 hours at 60^{o}C in an oven as described by (Nocek, 1985). The bags were allowed to cool and their weights were recorded and used to calculate percent dry matter loss. The results from the *in-situ* study were fitted to model of $P=a+b\ (1-e^{-ct})$ (Orskov and Mc Donald, 1979) to determine the degradation characteristics of incubated samples.

$P = a + b\ (1-e^{ct})$

Where

P = Potential degradability after time't'

a = Water Soluble Fraction (zero hour)

b = Insoluble but degradable fraction after time 't'

c = Rate of degradation of slowly degradable fraction b

t = Incubation length i.e. 8, 12, 18, 24, 36 and 48 hours

e = exponential

3.8 ANALYTICAL TECHNIQUES

3.8.1 Proximate Analysis

The result of the ensiled samples of the sugarcane bagasse was analyzed in the Animal Science Laboratory, Bayero University Kano. According to standard procedure of (AOAC, 2005) for determination of moisture content, crude fibre, crude protein, ash, Ether extract, and nitrogen free extract were calculated as 100 – (%ash + %moisture + %crude fiber + %crude protein + %ether extract) according to (Mathew *et al.*, 2014).

3.8.2 Fiber Fraction Determination

A representative sample of silage (1grms) from each treatment was analyzed for fiber fraction neutral detergent fiber (NDF) and acid detergent fiber (ADF) according to the procedure of (Van Soest, Robertson & Lewis, 1991).

3.8.3 Statistical Analysis

The data generated were subjected to analysis of variance (ANOVA) sing SAS package, (1999) significant differences detected between the means were separated using Duncan Multiple Range Test (DMRT) and considered significant at probability level of 0.05.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 RESULTS

4.1.1 Effects of Aditives on Sugarcane Bagasse Silage Characteristics

Result of additives on sugarcane bagasse silage characteristics are shown in Table 2. The result shows that colour of silage made from (urea, yeast and molasses) were pale yellow with sweet aroma except in (control). The pH values ranged from 4.12 – 4.70 and there was significant ($p<0.05$) difference among the treatments. The silage made from (control) has the higher value of pH (4.70) and the least value was recorded on urea treatments. All silage treated with sugarcane bagasse had pH value less than 5.0.

Table 2: Effects of Additives on Sugarcane Bagasse Silage Characteristics

	Parameter		
Treatment	pH	Colour	Aroma
Control	4.70^{b}	Light brown	Pleasant
Urea	4.12^{c}	Pale yellow	Sweet
Molasses	4.66^{a}	Pale yellow	Sweet

Yeast	4.57^{a}	Pale yellow	Sweet
SEM	0.039	-	-

Means with different superscripts within the same column are significantly different (P<0.05).

4.1.2 Effect of Ensiling Period on Sugarcane Bagasse Silage Characteristics

The result of ensiling period on sugarcane bagasse silage characteristics are presented in Table 3. The pH values of silages were significantly affected (P<0.05) by ensiling period. The pH values varied from 4.28 at 7 weeks, 4.33 at 5 weeks and 4.38 at 3 weeks. In terms of colour and aroma, all silage made at different period was light brown and pleasant aroma at 3 weeks, pale yellow colour and sweet aroma at 5 and 7 weeks respectively.

Table 3: Effects of Ensiling Period on Sugarcane Bagasse Silage Characteristics

	Parameter		
Period	pH	Colour	Aroma
Week 3	4.38^{a}	Light brown	Pleasant
Week 5	4.33^{b}	Pale yellow	Sweet

Week 7	4.28^{b}	Pale yellow	Sweet
SME	0.074	-	-

Means with different superscripts within the same column are significantly different (P<0.05

4.1.3 Interaction Effect of Additives and Ensiling Period on Sugarcane Bagasse Silage Characteristics

Results of additives and ensiling period on sugarcane bagasse silage characteristics are shown in Table 4. The result revealed that a treatment (urea and yeast) has Pale yellow colour with sweet aroma, control and yeast has a combination of both Pale yellow and Light brown colour with sweet and pleasant aroma in all the period of ensiled, pH range from 3.76 – 4.75 at all treatments and period of ensiled.

Table 4: Interaction Effects between Additives and Ensiling Period of Sugarcane Bagasse Silage Characteristics

		Parameter		
Treatment	Period	pH	Colour	Aroma
Control	3	4.75	Light brown	Pleasant
	5	4.69	Light brown	Pleasant
	7	4.63	Pale yellow	Sweet

Urea	3	4.32	Pale yellow	Sweet
	5	4.21	Pale yellow	Sweet
	7	4.10	Pale yellow	Sweet
Molasses	3	4.59	Light brown	Pleasant
	5	4.51	Pale yellow	Sweet
	7	4.48	Pale yellow	Sweet
Yeast	3	4.10	Pale yellow	Sweet
	5	3.86	Pale yellow	Sweet
	7	3.76	Pale yellow	Sweet
SEM		0.029	-	-
T x P		*		

Means with different superscripts within the same column are significantly different (P<0.05). T x P = Treatment by Period Interaction

4.1.4 Effect of Additives on Chemical Composition of Sugarcane Bagasse Silage

The results of additives on chemical composition of sugarcane bagasse silage are shown in Table 5. The result revealed that there were significant ($p<0.05$) difference among all the parameters evaluated. Percent DM of silage made from SBS (control) has the highest value of 92.21% while the least value 89.21% was recorded from the silage made from SBS (yeast). Treatment (urea) had highest CP (9.56%) among the treatment and the lowest CP (5.18%) was recorded in the (control) followed by (molasses) respectively. CF value was higher at (control) (47.66%) and the remaining treatments were close to similar value. The treatment (urea and yeast) had the higher value of NFE and the lower value was recorded in (control). The lowest value of ADF and NDF were recorded in treatment (urea) while the higher value ADF and NDF were recorded also at treatment (urea). The result revealed that DM increasing as the treatment increasing, the higher content of CP recorded at (urea and yeast) while the lowest content of ADF and NDF were recorded both at the same treatment.

Table 5: Effects of Additives on Chemical Composition of Sugarcane Bagasse Silage

	Parameters							
Treatment	DM	Ash	CP	CF	EE	NFE	ADF	NDF
Control	92.21^{a}	5.30^{b}	5.18^{c}	47.66	1.31^{d}	40.51^{b}	57.78^{a}	71.45^{b}

Urea	90.07^{b}	5.81^{a}	9.56^{b}	25.24^{b}	1.97^{c}	57.42^{a}	51.45^{b}	66.03^{c}
Molasses	89.51^{bc}	5.35^{b}	8.66^{c}	27.65^{b}	3.36^{b}	54.87^{a}	55.31^{a}	75.32^{a}
Yeast	89.21^{c}	4.98^{c}	9.00^{a}	24.62^{b}	4.56^{a}	56.81^{b}	51.87^{b}	72.63^{b}
SEM	0.128	0.21	0.254	1.500	0.174	1.673	1.635	1.006

Means with different superscripts within the same column are significantly different (P<0.05). DM: Dry matter, CP: Crude protein, CF: Crude fiber, EE: Ether extract, NFE: Nitrogen Free Extract, ADF: Acid detergent fiber, NDF: Neutral detergent fiber

4.1.5 Effect of Ensiling Period on Chemical Composition of Sugarcane Bagasse Silage

The effects of ensiling period on chemical compositions of sugarcane bagasse silage are shown in Table 6. The parameters evaluated are DM, ASH, CP, CF, EE, NFE, ADF, and NDF and they were all significant (p<0.05) at all the period of ensiled. The DM percentage was highest at 3 weeks ensiling period (90.50%) compared to 5 and 7 weeks respectively. ASH was highest at 7 weeks (6.33%) and lowest at 3 weeks (4.47%). Crude protein CP content was highest at 7 weeks (10.10%) while the least CP content was obtained at 3 weeks (5.82%). CF content was highest at 3 weeks (48.73%) and lowest at 7 weeks ensiling period (32.10%).

Table 6: Effects of Silage Period on Chemical Composition of Sugarcane Bagasse Silage

	Parameter							
Period	DM	Ash	CP	CF	EE	NFE	ADF	NDF

Week 3	90.50^{a}	4.47^{c}	5.82^{c}	48.73^{a}	2.42^{b}	38.33^{c}	46.41^{c}	67.81^{c}
Week 5	90.31^{b}	5.26^{b}	9.84^{b}	37.93^{b}	2.23^{c}	44.74^{a}	52.80^{b}	74.80^{a}
Week 7	89.94^{c}	6.33^{a}	10.10^{a}	32.10^{c}	3.75^{a}	47.70^{b}	63.10^{a}	71.46^{b}
SEM	0.236	0.176	0.331	1.273	0.252	1.259	1.169	1.040

Means with different superscripts within the same column are significantly different ($P<0.05$). DM: Dry matter, CP: Crude protein, CF: Crude fiber, EE: Ether extract, NFE: Nitrogen Free Extract, ADF: Acid detergent fibre, NDF: Neutral detergent fiber

4.1.6 Interaction Between Additives and Ensiling Period on Chemical Composition of Sugarcane Bagasse Silage

The effect of interaction between additives and ensiling period on chemical composition of sugarcane bagasse silage are shown in Table 7. Additives and ensiling period significantly affect the chemical composition of the silage. Percent dry matter (DM) of silage made without additives (control) at 3 week ensiling period was highest (92.58%) while yeast at 7 weeks was least (88.60%). Percent Ash shows that there is increasing value as the ensiled period increase were the highest value recorded at (molasses) week 7 and the least value observed at (control) week 3. The CP result revealed that (urea) had the greatest CP content at 7 weeks of ensiled 10.00% and the least was recorded at (control) 3.53% at 3 week. The lowest CF interaction was recorded in urea 7 weeks (29.20%). The highest ether extract ware obtained in yeast 3 weeks (4.60%) and 7 weeks (5.76%) while the least was recorded in control 3 weeks (0.46%). The nitrogen free exract was highest in urea 3 weeks (62.66%) and lowest was recorded in control 7 weeks (30.36%). The interaction between additives and ensiling period on chemical composition of sugarcane bagasse silage were all significantly ($p<0.05$) different of all parameters evaluated.

Table 7: Interaction Effects between Additives and Ensiling Period on Chemical Composition of Sugarcane Bagasse Silage

		Parameters							
Treatment	Period	DM	ASH	CP	CF	EE	NFE	ADF	NDF
		92.58	3.73	3.53	53.93	0.46	41.69	59.00	75.26

Control	3								
	5	91.80	4.43	4.34	51.48	0.60	49.49	47.30	69.00
	7	92.26	7.73	5.10	49.55	2.86	30.36	67.06	70.10
Urea	3	90.35	4.55	9.56	38.55	2.23	62.66	41.66	63.33
	5	89.28	6.01	9.75	33.72	4.33	32.40	59.63	85.00
	7	88.90	5.50	10.00	29.20	3.53	42.56	64.63	77.63
Molasses	3	91.56	5.28	7.66	51.34	2.40	57.05	40.00	59.00
	5	89.85	4.43	7.75	41.35	0.66	49.49	47.30	69.00
	7	88.81	7.73	8.92	38.48	2.86	30.36	67.06	70.10
Yeast	3	89.78	4.33	8.38	43.35	4.60	43.96	45.00	73.66
	5	89.26	6.16	8.78	38.32	3.33	43.44	57.00	76.20
	7	88.60	4.46	9.84	37.21	5.76	38.03	53.63	68.03
SEM		0.031	0.029	0.063	0.24	0.021	0.23	0.48	0.22

T x P	*	*	*	*	*	*	*	*

Means with different superscripts within the same column are significantly different (P<0.05). T= Treatment x Period Interaction, 3= weeks 3, 5= weeks 5, 7= weeks 7

4.1.7 Dry matter Disappearance of Sugarcane Bagasse Silage Over Incubation Time

The *in sacco* dry matter disappearance of sugarcane bagasse revealed the possible degradation of sample incubated after certain period of time. Disappearance of dry matter from the bags incubated in the rumen increased with increasing time. After 48h of incubation time almost 50% - 70% of the feed ingredients have disappeared.

Figure 1 below shows dry matter disappearance DM of sugarcane bagasse (control) with the period of silage during *in sacco* rumen incubation. Sugarcane bagasse SCB has an effect on DM dry matter disappearance for all the silage week 3, 5 and 7. Dry matter disappearance of week 7 has higher value (control) after 48h of incubation. The results of dry natter disappearance of urea treated sugarcane bagasse are shown in Fig 2. The urea dry mater curve revealed that, sugarcane bagasse treated with urea and ensiled at 3 weeks produced greatest DM disappearance values after 48 hours incubation period. The disappearance pattern show that period 3 had higher value of 59.42% after 48h of incubation. There was significant (p>0.05) difference on dry matter disappearance at week 5 and 7 when compared with period 3. The results of dry matter disappearance of molasses treated sugarcane bagasse at different ensiling period are shown in Fig 3. The dry matter disappearance curve revealed that molasses treated sugarcane bagasse at 7 weeks produced greatest DM disappearance (68.91%) after 48 hours followed by 5 weeks (55.84%) and least was three weeks (47.88%) after 48 hours incubation period. Dry matter disappearances (%) of sugarcane bagasse treated with yeast Fig 4 revealed that sugarcane bagasse treated with yeast at 7 weeks had the highest DM disappearance followed by 5 weeks and the least was recorded at 3 weeks ensiling period after 48 hours incubation time.

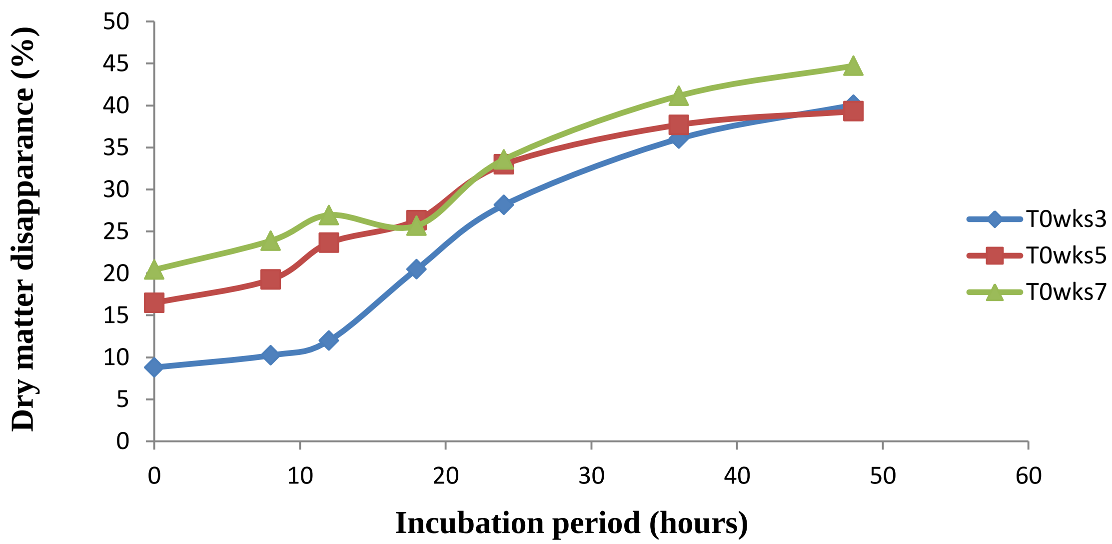

Figure 1: Effect of Sugarcane Bagasse (control) on dry matter disappearance

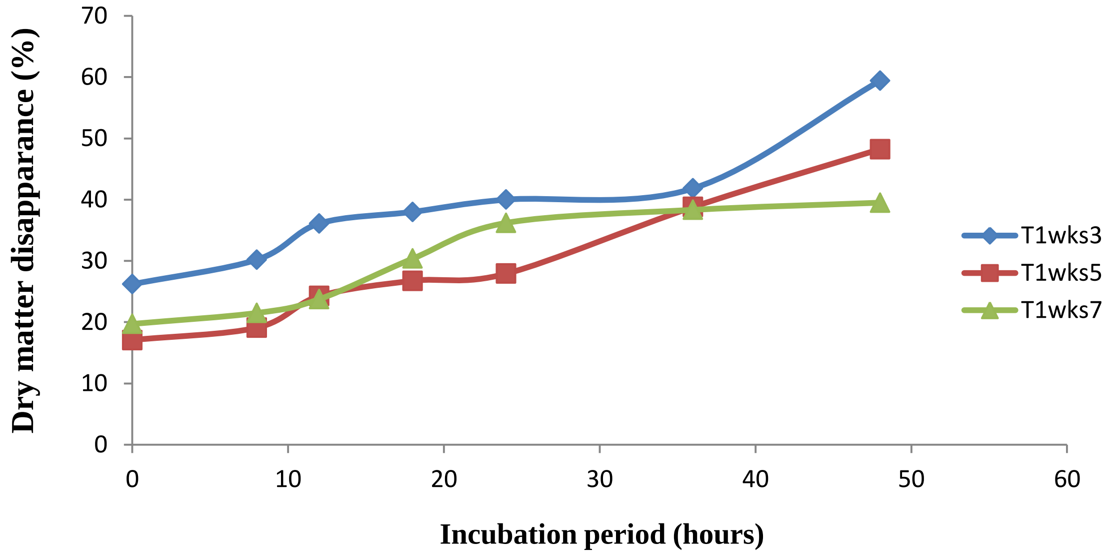

Figure 2: Effect of Sugarcane Bagasse (urea) on dry matter disappearance

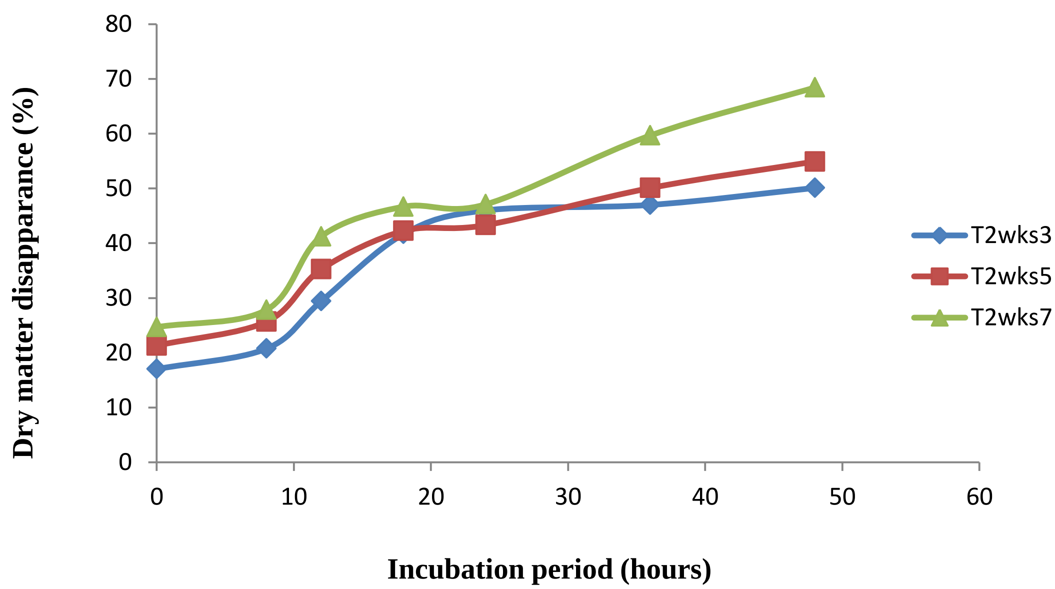

Figure 3: Effect of Sugarcane Bagasse (molasses) on dry matter disappearance

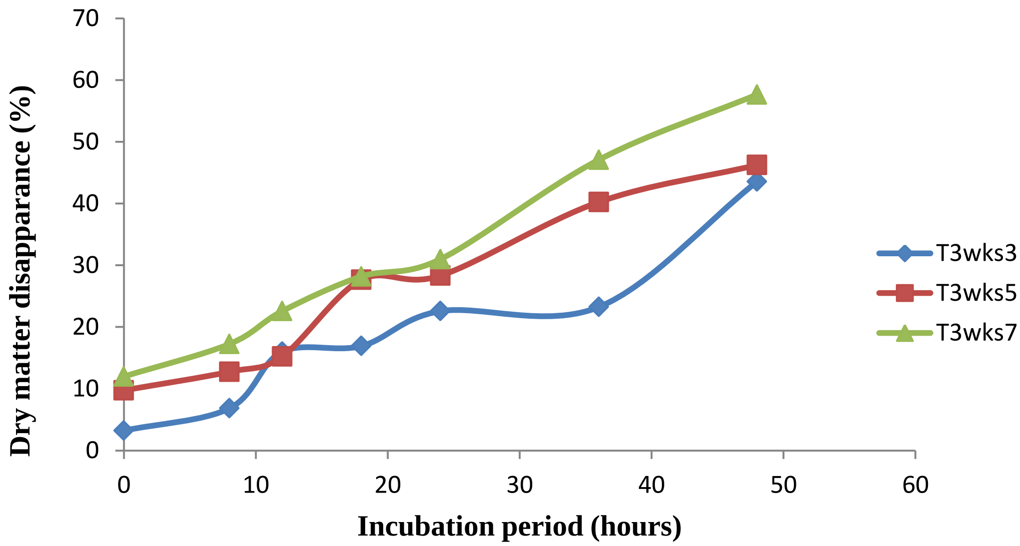

Figure 4: Effect of Sugarcane Bagasse (yeast) on dry matter disappearance

4.1.8 Organic Matter Disappearance of Sugarcane Bagasse Silage Over Incubation Time

These figures below shows the pattern of organic matter disappearance of sugarcane bagasse silage SBS with the treatment and period of ensiling, the pattern increased as the incubation time increased. The organic matter OM disappearance of sugarcane bagasse were almost up to 60% disappear after 36hr of incubation, since there were no significant (p>0.05) difference between disappearance after 24, 36 and 48hr of incubation. However, at the end of the incubation (urea and molasses) with period of ensiled has higher value of disappearance.

The results of organic matter of untreated sugarcane bagasse ensiled at different period are shown in Fig 5. The curve revealed that silage produced at 7 weeks recorded highest OM disappearances values during 48 hours (43.29%) followed by 3 weeks and the least was recorded at 5 week ensiling period (39.17%) after 48 hours. Figure 6 show the results of organic matter disappearance of urea treated sugarcane bagasse ensiled at different period the curve revealed that 7 weeks silage recorded the highest OM disappearance of (59.94%), followed by 5 weeks and 3 weeks ensiling period after 48 hours of incubation period.

Figure 7 shown the results of organic matter disappearances of sugarcane bagasse treated with molasses at different ensiling period. The OM disappearance of sugarcane bagasse treated with molasses revealed that 7 and 3 weeks ensiling period produced highest OM disappearance during 48 hours (69.59 and 69.50 %) followed by 5 weeks (60.63%) after 48 hours. Figure 8 show organic matter disappearance. The curve revealed that, silage produced after 7 weeks had the highest organic matter disappearance values during 48 hours (44.67 %). The trends indicated that there is increased in the disappearance values as the ensiling period increase.

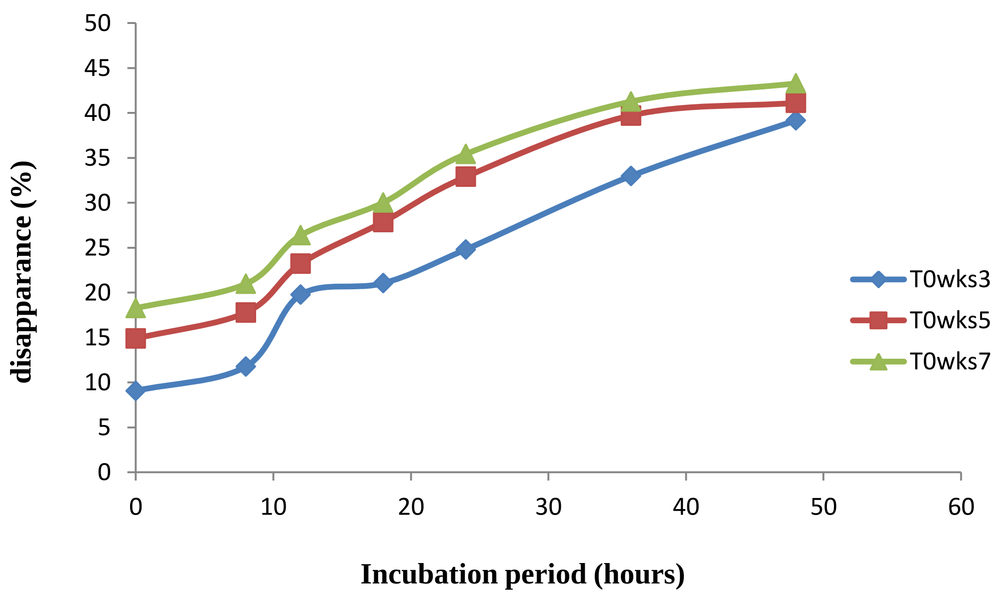

Figure 5: Effect of Sugarcane Bagasse (control) on Organic matter disappearance

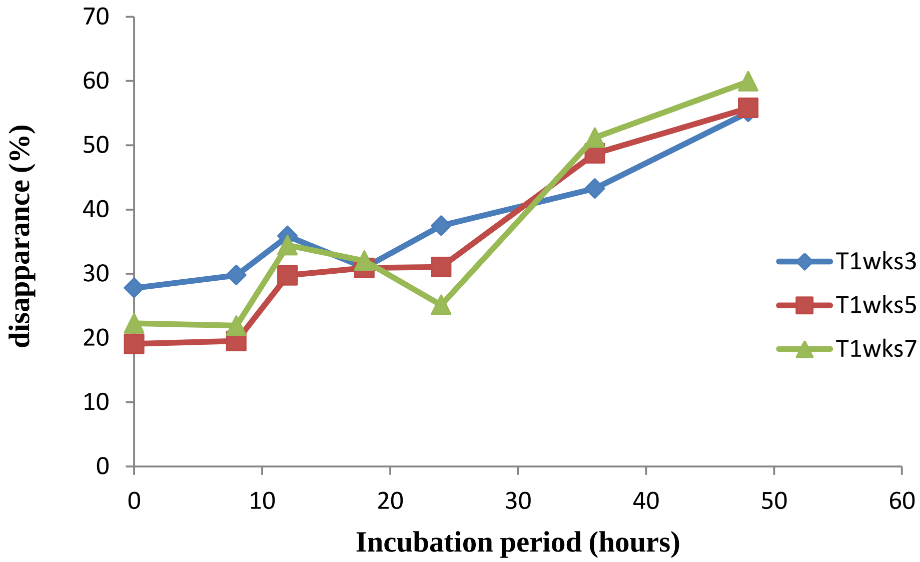

Figure 6: Effect of Sugarcane Bagasse (urea) on Organic matter disappearance

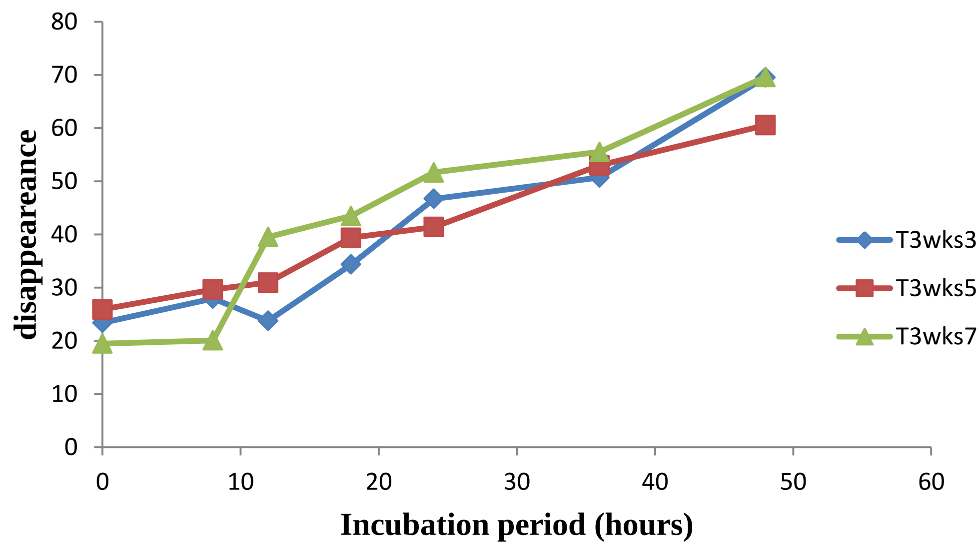

Figure 7: Effect of Sugarcane Bagasse (molasses) on Organic matter disappearance

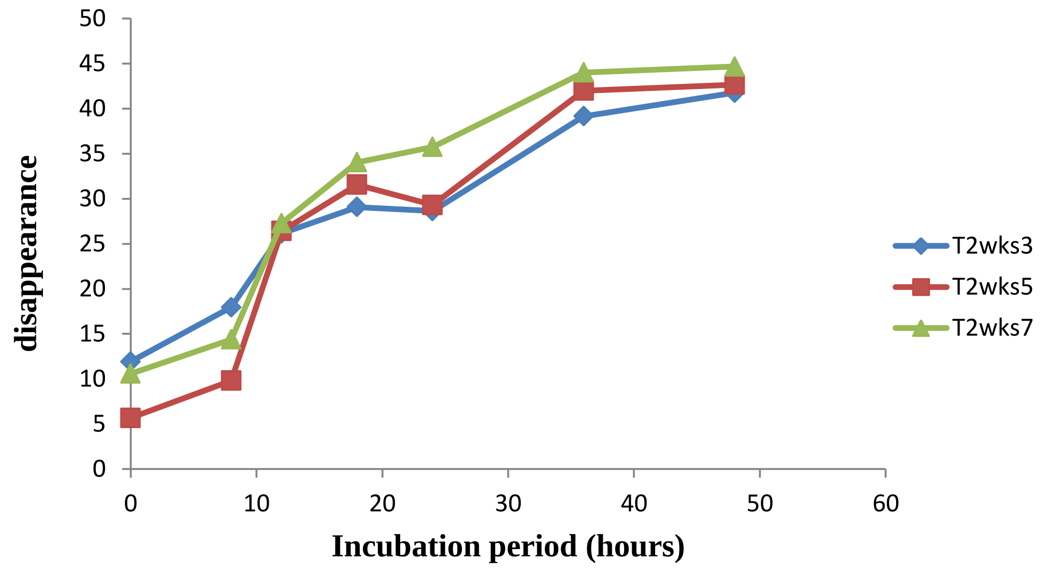

Figure 8: Effect of Sugarcane Bagasse (yeast) on Organic matter disappearance

4.2 Effect of Additives on Dry Matter Degradability of Sugarcane Bagasse Silage

The effect of sugarcane bagasse silage on dry matter *in sacco* degradability is shown in Table 8. Sugarcane bagasse no has significant effect on the *in sacco* DM degradability parameters except in ‘a’ quickly soluble fraction and effective degradability (ED), from the result obtained (yeast) has higher quickly soluble fraction ‘a’ (17.30%) and (molasses) has higher ‘b’ slowly degradable fraction with (control) having the lower value. Treatments (control and molasses) has significantly ($p<0.05$) higher degradation rate constant ‘c’ when compared with (urea and yeast). But no significant ($p>0.05$) difference was observed between treatments on quickly soluble fraction ‘a’ and ‘b’ slowly degradable fraction with the (control) having lower PD (59.16%). Moreover, (urea and molasses) recorded highest dry matter *in sacco* effective degradability ED.

Table 8: Effect of Additives on Dry matter Degradation Characteristics of Sugarcane Bagasse Silage

	Parameters							
Treatments	a	b	c	A	B	PD	ED	Lt
Control	5.60	54.16	0.03	15.24^{b}	44.16^{b}	59.16^{b}	25.72^{c}	1.94^{a}
Urea	16.80	65.96	0.01	20.32^{a}	62.44^{ab}	82.76^{a}	30.46^{b}	0.00^{b}
Molasses	-16.20	84.50	0.02	21.02^{a}	47.27^{b}	68.30^{a}	38.02^{a}	0.00^{b}
Yeast	17.30	63.68	0.02	8.33^{c}	72.67^{a}	80.98^{a}	23.60^{d}	0.00^{b}
SEM	0.16	0.15	0.01	0.85	3.88	4.08	0.70	0.25

Means with different superscripts within the same column are significantly different (P<0.05). a- quickly soluble fraction; b- slowly degradable fraction; c- degradation rate constant (fraction/hour); A- washing lost, B- rumen degradability fraction, PD- potential degradability; ED- effective degradability (%); LT- lag time

4.2.1 Effect of Silage Period on Dry Matter Degradation Characteristics of Sugarcane Bagasse Silage

The effect of silage period on dry matter *in sacco* degradation characterisitics of sugarcane bagasse silage are presented in Table 9. From the result obtained period 7 has higher value of ‘a’ quickly soluble fraction, ‘b’ slowly degradable fraction and ‘c’ degradation rate constant. There was no significant ($p>0.05$) in ‘a’ quickly soluble fraction and ‘b’ slowly degradable fraction while significantly ($p<0.05$) difference exist ‘c’ degradation rate constant within the period of silage. Week 7 has significantly ($p<0.05$) higher PD and ED (88.07 and 31.31%) when compared with period 3rd (64.80%) having the lowest value.

Table 9: Effect of Silage Period on Dry matter Degradation Characteristics of Sugarcane Bagasse Silage

	Parameters							
Period	a	b	c	A	B	PD	ED	Lt
Week 3	-12.70	77.50	0.07^{a}	14.87	48.07^{b}	64.80^{b}	26.95^{b}	0.63
Week 5	12.23	55.18	0.03^{a}	16.73	50.68^{b}	67.41^{b}	30.09^{a}	0.82
Week 7	12.97	75.10	0.01^{b}	17.08	71.16^{a}	88.07^{a}	31.31^{a}	0.00
SEM	1.70	3.00	0.020	1.20	3.93	3.93	1.14	0.28

Means with different superscripts within the same column are significantly different ($P<0.05$). a- quickly soluble fraction; b- slowly degradable fraction; c- degradation rate constant (fraction/hour); A- washing lost, B- rumen degradability fraction, PD- potential degradability; ED- effective degradability (%); LT- lag time

4.2.2 <u>Interaction Effect between Additives and Ensiling Period on Dry Matter Degradation Characteristics of Sugarcane Bagasse Silage</u>

Interaction effect between additives and ensiling period on dry matter degradation characteristics of sugarcane bagasse silage is presented in Table 10. The result obtained shown that there was no significant ($p>0.05$) difference in PD and lag time Lt while significantly ($p<0.05$) exist in others parameters. Molasses has the highest value of ‘a’ quickly soluble fraction and the lower value recorded at (yeast) within treatments and ensiling period of silage. The higher PD was obtained at sugarcane bagasse silage of (urea and molasses) when compared with (control) having the lowest value at 5 week.

Table 10: Interaction Effect of Additives and Silage Period on Dry matter Degradation Characteristics of Sugarcane Bagasse Silage

		Parameters							
Treatment	Period	a	b	c	A	B	PD	ED	Lt
Control	3	-5.14	58.10	0.03	8.80	44.20	52.30	20.46	2.53
	5	8.77	38.29	0.04	16.50	30.60	47.06	26.23	3.30
	7	13.26	64.87	0.03	20.43	57.70	78.13	30.46	0.00
Urea	3	4.24	60.90	0.02	9.76	55.43	65.16	36.53	0.00
	5	-3.16	80.91	0.03	3.23	74.60	77.80	37.13	0.00
	7	19.52	80.48	0.01	21.33	78.66	100	40.40	0.00
Molasses	3	20.15	45.77	0.02	19.70	48.73	68.43	36.86	0.00
	5	20.76	59.10	0.02	15.06	64.80	79.86	37.36	0.00
	7	21.02	78.98	0.01	26.20	73.80	100	39.03	0.00
Yeast	3	20.85	26.61	0.02	17.03	30.43	47.46	17.56	0.00

	5	16.50	40.92	0.06	24.70	32.73	57.43	23.86	0.00
	7	8.70	91.30	0.01	12.00	88.00	100	29.36	0.00
SEM		3.53	26.3	0.01	0.52	3.28	3.32	0.31	0.25
T x P		*	*	*	*	NS	NS	*	NS

Means with different superscripts within the same column are significantly different ($P<0.05$). a= quickly soluble fraction; b= slowly degradable fraction; c= degradation rate constant (fraction/hour); A- washing lost, B- rumen degradability fraction, PD= potential degradability; ED= effective degradability (%); LT= lag time

4.2.3 <u>Effect of Additives on Organic Matter Degradation Characteristics of Sugarcane Bagasse Silage</u>

Table 11 shows the effect of additives on organic matter *in sacco* degradability of sugarcane bagasse. The result revealed that there was no significant ($p>0.05$) difference among parameters except in potential degradability PD and effective degradability ED. The higher value of 'a' quickly soluble fraction is obtained in (urea and molasses), similarly with 'b' slowly degradable fraction having the least value recorded at (control). The potential degradability PD and effective degradability ED of (urea and molasses) has significantly ($p<0.05$) higher (98.07 and 96.83%) with the lower values obtained at (control and yeast) with (58.02 and 57.15%).

Table 11: Effect of Additives on Organic Matter Degradation Characteristics of Sugarcane Bagasse Silage

	Parameter							
Treatment	a	b	c	A	B	PD	ED	Lt
Control	14.24	42.91	0.04^{ab}	15.02^{b}	42.06	57.15^{b}	25.74^{c}	0.66
Urea	17.00	81.07	0.01^{b}	23.36^{a}	74.71	98.07^{a}	39.74^{a}	0.00
Molasses	23.00	73.83	0.01^{b}	22.92^{a}	73.92	96.83^{b}	34.52^{b}	0.00
Yeast	-24.70	82.72	0.02^{a}	10.08^{c}	47.96	58.02^{b}	26.22^{c}	0.00
SEM	1.70	0.13	0.028	0.50	19.55	3.12	0.27	0.16

Means with different superscripts within the same column are significantly different (P<0.05). a- quickly soluble fraction; b- slowly degradable fraction; c- degradation rate constant (fraction/hour); A- washing lost, B- rumen degradability fraction, PD- potential degradability; ED- effective degradability (%); LT- lag time

4.2.4 Effect of Ensiling Period on Organic Matter Degradation Characterisitcs of Sugarcane Bagasse Silage

The effect of ensiling period on organic matter degradation characteristics of sugarcane bagasse silage is presented in Table 12. From the result obtained there was no significant (p>0.05) difference among the parameters and within the period, but significant (p<0.05) effect exist in effective degradability ED with higher value obtained at 7 week (32.83%). The higher value of potential degradability PD was obtained at 7 week (84.35%) and the least value was obtained at 5 week (73.80%).

Table 12: Effect of Silage Period on Organic Matter Degradation Characteristics of Sugarcane Bagasse Silage

	Parameters							
Period	a	b	c	A	B	PD	ED	Lt
3	-27.50	100.58	0.07	17.11	56.71	74.40	30.71^{b}	0.50
5	5.00	69.40	0.04	17.70	56.70	73.80	31.12^{b}	0.00
7	10.50	73.85	0.08	18.74	65.57	84.35	32.83^{a}	0.00
SEM	0.12	0.09	0.02	1.23	3.93	4.55	1.10	0.16

Means with different superscripts within the same column are significantly different ($P<0.05$). a- quickly soluble fraction; b- slowly degradable fraction; c- degradation rate constant (fraction/hour); A- washing lost, B- rumen degradability fraction, PD- potential degradability; ED- effective degradability (%); LT- lag time

4.2.5 Interaction Effect between Additives and Ensiling Period on Organic Matter Degradation of Sugarcane Bagasse Silage

The effect of interaction between additives and ensiling period of sugarcane bagasse on organic matter degradation are shown in Table 13. The result shows that there were no significant ($p>0.05$) difference at all parameters except effective degradability ED. The soluble fraction (a) was highest in yeast 3 weeks (27.63%) and lowest was recorded in control 3 weeks (-3.45%). Fraction degraded in the rumen (b) fraction was highest in molasses 7 weeks (84.44%) and lowest was obtained in yeast 5 weeks (33.57%). The values of potential degradability (PD) values were highest for urea and molasses at 7 weeks ensiling period and the lowest was recorded in control at 3 weeks (43.76%). The effective degradability (ED) of OM was highest in urea 7 weeks (41.60%) and lowest in control 3 weeks (21.26%).

Table 13: Interaction Effect of Additives and Ensiling Period on Organic Matter Degradation Characteristics of Sugarcane Bagasse Silage

		Parameter							
Treatment	Period	a	b	c	A	B	PD	ED	Lt
Control	3	-3.45	43.80	0.02	17.80	26.00	43.76	21.26	2.00
	5	5.61	41.52	0.06	10.60	36.53	47.13	26.23	0.00
	7	6.38	44.12	0.04	18.43	32.06	50.50	29.06	0.00
Urea	3	24.68	65.82	0.01	25.90	64.63	100	38.43	0.00
	5	21.17	78.29	0.01	23.40	76.60	90.50	39.20	0.00
	7	21.69	78.31	0.01	19.50	80.53	100	41.60	0.00
Molasses	3	12.57	81.23	0.01	19.06	75.16	94.23	32.30	0.00
	5	24.22	75.78	0.01	28.76	71.26	100	34.43	0.00
	7	15.56	84.44	0.01	22.26	77.74	100	36.83	0.00
Yeast	3	27.63	33.57	0.02	13.96	46.30	60.20	27.96	0.00

	5	11.75	54.98	0.02	5.70	61.03	66.73	24.46	0.00
	7	-11.61	58.74	0.09	10.60	36.53	47.13	26.23	0.00
SEM		5.33	5.31	0.02	0.50	19.55	3.12	0.27	0.16
T x P		NS	NS	NS	*	NS	NS	*	NS

Means with different superscripts within the same column are significantly different (P<0.05). a= quickly soluble fraction; b= slowly degradable fraction; c= degradation rate constant (fraction/hour); A- washing lost, B- rumen degradability fraction, PD= potential degradability; ED= effective degradability (%); LT= lag time

4.3 DISCUSSION

4.3.1 Effect of Additives, Silage Period and Interaction on Physical Characteristics of Sugarcane Bagasse Silage

Generally, pH is one of the quickest and simples ways of evaluating silage quality. Silage that has been properly fermented will have a much lower pH. (Kung & shaver, 2002) in their interpretation of silage analysis stated that a good quality grass and legume silage pH value in the tropics ranges between 4.3 – 4.7 Most of the pH value of the ensiled sugarcane bagasse silage reduce with increasing days of ensiling. The pH value also showed a trend increasing with inclusion of additives and the time period. Untreated sugarcane bagasse (control) had a higher pH value of 4.70 with the list value of 4.12 after 3, 5 and 7 weeks period of ensiling, respectively.

Other silages on interaction between additives and ensiling weeks had low pH varying from 3.76 – 4.10, 4.48 – 4.59 and 3.98 – 4.32 after 3, 5 and 7 weeks of ensiling, respectively. This pH was acidic to moderately acidic and indicates proper fermentation and good keeping quality. Using a similar procedure and higher period of fermentation, though with a different material (Water Hyacinth) (Akinwande, Mako & Babayemi, 2011) obtained a low pH range 4.3 – 4.66 while (Babayemi, Ekokoto, & Inyan, 2009) obtained a pH range of 3.38 – 4.61 when cassava peels was ensiled together with Albiza saman pod. The result of the present study fall within the range of 4.0 – 5.5 reported by (Menenses *et al.*, 2007) which are classified to be pH for good silage, pH levels higher than the normal stipulated range might be an indication of lack of organic acid generation during fermentation.

Silage can be evaluated physically through color and smell (Aroma) by chemical analysis (Wattiaus, 2000). The colors obtained in the present study were close to the original color of the materials used for the silage. This observation coincides with the findings of (Oduguwa, Jolaosho, Akinola & Aniwe, 2007; Ashiru, Maigandi, Muhammad & Abdulhamid, 2007; Babayemi, Ifut, Inyang & Isaac, 2010) using similar procedure though with different feed materials. Silage of urea and yeast were lighter in color than that silage with molasses. Good silage must present a pleasing taste; the color should be light brown, pale yellow and greenish yellow and must be without moulds (Amodu & Abubakar, 2004).

The aroma was generally pleasant and sweet for silage with urea, molasses and yeast. (Oduguwa, Jolaosho & Ayankoso, 2007) stated that the most important physical characteristics in terms of acceptability of silage to animal is odour, but other physical properties helped to determined well preserved silage. The result for aroma obtained in this study compares with the result of several authors (Menenses *et al.,* 2007; Oduguwa, Jolaosho & Ayankoso, 2007; Muhammad, Abdu, Iyeghe & Sulaiman, 2009; Baba, Uba & Halim, 2010; Inyang, Ifut, Eyoh & Ndehedehe, 2012) all reported that the end product of good silage had a pleasant or fruity smell. Olurunnisomo & Dada (2011) however observed a pleasant smell in all their treatments when Elephant grass was ensiled with cassava peels. Amodu & Abubakar (2004) stated that good silage usually has an acceptable aroma (clean and not putrid odor).

4.3.2 Effect of Additives, Silage Period and Interaction on Nutrient composition of Sugarcane Bagasse Silage

Results of the proximate composition of the sugarcane bagasse SCB of this study showed very slight variations among the treatments which could be attributed to several factors like variations in the type of additives to be included, type of variety, cultivation practices and environmental conditions which are in agreement with the earlier reports by (Larbi *et al*., 2007; Tesfaye & Chali, 2008; Lebot, 2009; Abonyi, Iyi & Machebe, 2012) who all reported that there were variations in chemical composition of different Agricultural by products.

The dry matter values of silage made from treatments and their period of ensiling are comparable. The DM percent of untreated silage was significantly higher than any of the treatment this was as a result of reduction in DM loss in silage during fermentation (Patterson *et al.*, 1998). It was revealed from the result that urea and yeast treated sugarcane bagasse silage have the high crude protein which was due to ammonization of the sugarcane bagasse during the silage production phase and this supports the findings of (Saenger, Lemenager & Hendrix, 198; Ali, Fontenot & Allen, 2012; Tesfaye, 2005; Cloete, Villiers & Kritzinger, 1983) who reported increased crude protein of various crop residues when ammoniated. The present study revealed that, CF has the higher value in treatment (control) and increased with the increasing of ensiling period. The NDF content of treated sugarcane bagasse with urea decreased as the treatment period increased. The ADF and NDF of sugarcane bagasse treated with urea shows significant ($p<0.05$) decreased when compared to others treatment while with increasing period of ensiling. The findings by (Atta, Elmnan, Fadel & Salih, 2007; Kraidees, 2005) showed the same trend in bagasse and that ADF decreased when urea treated and ensiled for seven weeks.

4.3.3 <u>Dry matter Disappearance of Sugarcane Bagasse Silage at Different Ensiling Period</u>

The *in sacco* nutrients disappearance results indicated the disappearance features of sugarcane bagasse with additives which differed slightly among themselves from the trend. The *in sacco* dry matter disappearance of sugarcane bagasse revealed the possible degradation of sample incubated *in sacco* after certain period of time which extended from 0 to 48 hours. There was an increase in DM disappearance associated with increasing incubation time.

Figure 4 showed DM disappearance of SCB (control) with period of ensiling during *in sacco* rumen incubation. The disappearance pattern shows significant increase as the time of incubation with period of ensiling of 48 hours having the higher value of disappearance followed by 36, 24, 18, 12 and 8hrs of incubation. Figure 5 shows pattern of DM disappearance of SCB (urea), the pattern shows significant effects among treatments due to the presence of urea which increase microbial population, hence increased the potential degradability PD. This in line with the findings of (Smith, Idou, Asaolu & Odunlami, 1991) that maximum value of PD was recorded by ration A and the value of potential degradability PD is due to higher content of readily degradable soluble carbohydrate and urea. Figure 6 and 7 the result of the pattern shows that there is an effect within the treatments and ensiling period. The value of DM disappearance of tested treatment are within the range of moderate to high level of disappearance this is an agreement with the finding of (Elmnan, Atta & Ismeal, 2019).

4.3.4 Organic Matter Disappearance of Sugarcane Bagasse Silage at Different Ensiling Period

Figure 8, 9, 10 and 11 showed the result of organic matter disappearance of the tested treatment with ensiling period of (control, urea, molasses,yeast and 3, 5, and 7 weeks), during incubation time which extended from 0 – 48 hours. There was an increase in organic matter OM disappearance associated with increasing incubation time. In general the disappearance rate of SCB on organic matter was slow for the first 8 hour of rumen incubation when only 30% of the incubated sample has disappeared. Thereafter, disappearance rapidly increased and was apparently complete after 48 hours. The result of the present study is line with the finding of

(Ben salem, Nefzaoui, Salem & Tisserand, 1993) on effect of lipid supply on in situ degradation in cow: comparison of hay and corn silage diets.

Figure 9 organic matter disappearance was higher for urea than control which has the lower disappearance figure 8. The increase of sugarcane bagasse on organic matter with increasing level of ensiling period and incubation time observed in this study agree with the findings of (Elmnan, Atta & Ismeal, 2019) in an experiment to study the effect of sugarcane bagassse treated with urea as energy source in total mixed ration for goat *In* vitro digestibility and In situ degradability study.

4.3.5 Effect of Additives, Ensiling Period and their Interaction on Dry Matter Degradability of Sugarcane Bagasse Silage

Dry matter degradability has significant effect on *in sacco* parameters. The higher value observed for the immediately soluble DM fraction from the result obtained (urea) and period 3 has higher quickly soluble fraction 'a' while (molasses) and period 3 has higher 'b' slowly degradable fraction with (yeast) having the lower value. The DM slowly degradable fraction 'b' of the present study was greater than those reported by (Phesatcha & Wanapat, 2012; Khorshidi, Abedi, Kioumarsi & Sheriman, 2013; Yacout, Khayal, Shwerab & Khalel, 2016).

The DM degradation rate constant 'c' obtained in this study were in disagreement with the one recorded by (Kariuki *et al.,* 2001) were higher value of degradation rate constant 'c' observed. The maximum value of potential degradability (PD) was recorded by treatments (urea) followed by (yeast, molasses and control) with their ensiling period of 3, 5 and 7. The maximum value of PD for (urea) due to its high content of readily degraded of soluble carbohydrates and N and low content of CF. Consequently the low value of PD recorded by (control) rations could be explained by their high CF.

According to (Turki & Atcham, 2011) effective degradability of feed in the rumen depended on the length of retention of the feed in the rumen, which is also a function of the quantity and quality of the feed given to the animals. The effective degradability recorded in the present study were within the range reported by (Nasiru, Badamasi & Hakimi, 2016) but lower than those reported (Phesatcha & Wanapat, 2012; Yacout, Khayyal, Shwerab & Khalel, 2016). The low DM effective degradability contents of the treatments and ensiling period in this study, despite high potential degradability values are most likely as a result of the slow rate of degradation.

4.3.6 Effects of Additives, Ensiling Period and their Interaction on Organic Matter Degradability of Sugarcane Bagasse Silage

The organic matter degradation of treatments and ensiling period was found to be comparable. The readily degradable fraction ‘a’ and slowly degradable fraction ‘b’ was found to be higher at (urea and molasses) this is due to the presence of nitrogen and molasses, these provides fermentable carbohydrate and increased soluble carbohydrate. Thus, fermentation with urea and molasses could increase the nutritive value of sugarcane bagasse. This result was consistent with (Ahmed *et al.*, 2013) who reported that urea treatment raised CP from 2.2% of raw bagasse to 10.4%. The effective degradability ED of organic matter OM was found to be higher due to readily degradable and the rate of degradation. Feedstuffs with higher effective degradability are those which are more degradable in the rumen of goats. Therefore the effective degradability of the present study was higher than those recorded by (Yacout, Khayyal, Shwerab & Khalel, 2016).

The maximum value of potential degradability (PD) was recorded by urea followed by (molasses, yeast and control). The maximum value of PD for (urea and molasses) due to its high content of readily degraded of soluble carbohydrates and nitrogen and low content of CF. Consequently the low value of PD recorded by (control) could be explained by their high CF. Urea treatment was reported to cause partial break down of the bond between the lignin and other cell wall components that lead rumen bacteria to degrade fibrous material in the rumen (Ngyuen, Dan, Ly & Sandsle, 2002). High supply of nitrogen immediately after incubation might result in increasing degradation rate of fibrous by-products up to 48 hrs than that in the late time.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

The research was conducted at the Laboratory and Research farm Department of Animal Science, Bayero University Kano state, to evaluate effect silage additives and ensiling period on *In sacco* rumen degradability of sugarcane bagasse silage SBS using fistulated Kano brown bucks. Two experiments were carried out to achieve the objectives; the first one was to determine the effect of silage additives and ensiling period on physical quality, nutritive value of sugarcane bagasse silage SBS. The second was to determine the effect of first experiment on disappearance and *in sacco* degradability. The experimental design was a 3 x 4 factorial arrangements in randomize completely block design (RCBD). The treatments were four un ensiled SCB (contol), SCB + urea, SCB + molasses and SCB + yeast with three period of ensiling (3, 5 and 7 weeks). The result and degradability parameters were subjected to analysis of variance (ANOVA) using SAS package (1999), significant difference between individual means were identified using Duncan Multiple Range Test (DMRT).

The result of study revealed that, the pH of all silage was significant ($p<0.05$) affected by treatment and ensiling period and the value of pH are within the range which are classified to be good silage. The colour was light brown and pale yellow with acceptable aroma. The result of proximate composition shows that there were significant ($p<0.05$) difference among all parameters evaluated. The result of *in sacco* dry matter and organic matter disappearance of sugarcane bagasse SCB revealed the possible disappearance of sample incubated after certain period of time. There was significant ($p<0.05$) difference among the treatment and ensiling period of both DM and OM disappearance on SCB, after 48hrs of incubation time almost 50 – 80% of the feed ingredients have disappeared. However, at the end of incubation time (urea and molasses) with ensiling period has higher value of disappearance.

The degradation kinetics value obtained in this study did not vary significantly ($p>0.05$) in ‘a’ quickly soluble fraction and ‘b’ slowly degradable fraction. There was significant ($p<0.05$) difference between silage additives and ensiling period on potential degradability PD and effective degradability ED of (urea and molasses) having the higher value when compared with other additives.

5.2 CONCLUSION

Based on the experiments it can be concluded that silage additives (urea and molasses) at period 7 weeks ensiling period were proven to be excellent in terms of

1. Physical, nutritional and degradation characteristics of sugarcane bagasse.
1. Disappearance of urea and molasses at 7 weeks ensiling period had the highest percentage dry matter and organic matter disappearence at 48 hours incubation time.
2. *In sacco* degradability of urea and molasses at 7 weeks ensiling period had the greatest dry matter and organic matter rumen degradability, indicating that additives and ensiling period had a positive effect on *in sacco* degradability of sugarcane bagasse silage.

5.3 RECOMMENDATION

The following recommendations are made

1. Silage made from urea or molasses ensiled at 7 week period is recommended during ensilage and degradability studies.
2. Further investigation need to be conduct in vivo feeding trial with sugarcane bagasse ensiled with urea or molasses as to justify the present finding.

REFERENCE

A.O.A.C. (2005). Association of Official Analytical Chemists. Official Methods of Analysis 18th Edition AOAC Inc, Arlingon, Virginia USA. 1094pp.

Abonyi, F.O., Iyi, E.O. and Machebe, N.S. (2012). Effect of Feeding Sweet Potato (Ipomoea batatas) Leaves on Growth Performance and Nutrient Digestibility of Rabbits. *African Journal of Biotechnology* II (15): pp 3709-3712

Abdel-Aziz, N.A., Salem, A.Z.M., Mounir, M.E., Diaz, L.M., Kholif, A.E., Elghandour Mona M.M. and Borham, E.B. (2014). Biological Treatments as a Mean to Improve Feed Utilization in Agriculture Animals-An Overview. *Journal of Integrative Agriculture.* 14. 534–543. 10.1016/S2095-3119(14)60829-7.

Adebowale, L.O.A. (2010). Dynamics of Ruminant Livestock Management in the Context of Nigerian Agricultural System. http://dx.doi.org/10.5772/52923

Adebowale, O.A. (2012). Dynamics of Ruminant Livestock Management in the Context of Nigerian Agricultural System, Livestock Production, Khalid Javed, IntechOpen, DOI: Available from: http://www.intechopen.com/books/livestock-production/dynamic-of-ruminant-livestock-management-in-the-contex-of-the-nigeria-aricultural-system.

Agbor, V.B., Cicek, N., Sparking, R., Berlin, A. and Levin, D.B. (2011). Biomass Pre treatment Fundamentals Toward application *Biotechnology Advance.* Volume (29):675-851.

Ahamefule, F.O. and Udo, M.D. (2010). Performance of West African Dwarf Goats Fed Raw or Processed Pigeon Pea (Cajanus cajan) Seed Meal Based Diets. *Nigerian Journal of Animal Science Production*, 37: 227-236.

Ahmed, A. and Egwu, G.O. (2014). Management Practices and Constraints of Sheep Nigerian *Journal of Animal Production*, 18(2): 108-110.

Ahmed, M.H., Babiker, S.A., Elnasir, F., Fadeel Elseed M.A. and Mohammed I.T. (2013). Effect of Urea Treatment on Nutritive Value of Sugarcane Bagasse. *ARPN Journal Science and Technology*.Vol. 3(8): 2225-7217.

Akinwande, V.O., Mako, A.A. and Babayemi, O.J. (2011). Silage Quality, Voluntary Feed Intake (VFI), Nutrient Digestibility and Nitrogen Balance in West Africa Dwarf Sheep Fed Ensiled Water Hyacinth (WH) in Nigeria. Proceeding of the 36th Annual conference of the Nigerian Society for Animal Production (NSAP), University of Abuja. Pp 509 – 512.

Alberto, G., Portella, J.S. and De Oliverira, O.L.P. (1993) . Effect of Addition of Ground Sorghum Grain and of Wilting on Elephant Grass. *Grassland and Forage Abstracts*. 65 (2): 203-204

Ali, I., Fontenot, P. and Allen, V.J. (2012). Effects of Feeding Corn Stover Treated With Different Nitrogen Sources on Palatability and Dry Matter Intake in Sheep. *Journal of Veterinary and Animal Science.* 2: 11-15

Amodu, J.T. and Abubakar, S.A. (2004). Forage Conservation Practices. In: Gefu, J.O and Amodu, J.T. (eds), Forage Production and Management in Nigeria. Proceedings of a Training Workshop on Forage Production and Management held at NAPRI, Shika. 10-14 Oct, 2004. App 60 – 67

Anandan, S., Khan, A.A., Ravi, D., Jeethander R. and Blummel, M. (2010). A Comparison of Sorghum Stover Based Complete Feed Blocks With a Conventional Feeding Practice in a Peri-Urban Dairy. *Animal Nutrition and Feed Technology*, 10: 23-28.

Ashiru, R.M. (2014). Quality Assessment and Utilization of Sugarcane Waste Ensiled With Non-Protein Nitrogen Sources and Soybean Meal by Yankasa Sheep. Ph.D Thesis, Bayero University, Kano.

Ashiru, R.M., Maigandi, S.A., Muhammad, I.R. and Abdulhamid, S. U. (2007). Ensiling Quality of Sugarcane Waste Enhanced With Non-Protien Nitrogen Source and Suyabean Meal Residue for Dry Season Ruminants Feeding.

Atta, R.G. Elmnan, A.B., Fadel Elseed A.M.A. and Salih A.M. (2007). Effect of Ammonia and Urea Treatments on the Chemical Composition and Rumen Degradability of Bagasse. *Journal of Applied Sciences Research*, 3: 1359-1362.

Ayoola, G.B. and Ayoede, J.A. (2004). Socio-economic and Policy Aspects of Using Crop Residues and Agro-industrial by-products as Alternative Livestock Feed Resources in Nigeria. In: Stares, J.E.S., A.N. Said and J.A., Kategile (eds) African Feeds Research Work, Addis Ababa, Ethiopia. The Complementarity of Feed Resource for Animal Production in Africa. Proceedings of the joint Feed Resources Networks workshop Held in Gaborone, Botswana, 1-7.

Baba, M., Uba, T. and Halim, A.R. (2010). Nutritive Value of Kyasuwa Hay (*pennisetum pedicellatum)* Ensiled With Poultry Litter at Varying Proportion. Research *Journal of Animal Science*, 4(5): 117 – 120.

Babayemi, O.J., Ekokoto, O.A. and Inyang, U.A. (2009). Evaluation of Ensiled Cassava Peels together With Albiza Samon pods. Proceeding of the 34th Annual Conference of the Nigerian Society for Animal Production (NSAP), Uyo 544 – 546

Babayemi, O.J. and Igbekoyi, J.A. (2008). In Eric Tielkes (Eds.), Competition for a Resource in a Changing World: New Drive for Rural Development. Conference of the International Research on Food Security, Natural Resources Management and Rural Development, Tropentag, 7-9th October 2008.

Babayemi, O.J., Ifut, O.J., Inyang, U.A. and Isaac, L.J. (2010). Quality and Chemical Composition of Cassava Waste Ensiled With Different Additives. Proceeding of the 34th Annual Conference of the Nigerian Society for Animal Production (NSAP), Uyo 654 – 657

Beauchemin, K.A., Colombatto, D., Morgavi, D.P. and Yang, W.Z. (2003). Use of Exogenous Fibrolytic Enzymes to Improve Feed Utilization by Ruminants. *Journal of Animal Science.* 81(E Suppl. 2): E37-E47.

Ben Salem, H., Nefzaoui, A., Ben Salem, L. and Tisserand, J.L. (1993). Different Means of Administering Polyethylene Glycol to Sheep: Effect on the Nutritive Value of *Acacia Cyanophylla* Lindl. Foliage. *Animal Science.* 68, 809-818.

Blaxter, K.L. (1986). An Historical Perspective: The Development of Methods for Assessing Nutrients Requirements. *Proceedings of the Nutrition Society.* (45): pp. 177-183

Blumer, S.A.G. (2002). Enriquecimento Com Ferro em levedura Saccharomyces Cerevisae. 2002. 53f. Dissertação (Mestrado em Agronomia) - Escola Superior de Agricultura “Luiz de Queiroz”Universidade de São Paulo, Piracicaba.

Blummel, M. and Ørskov, E.R. (1993). Comparison of *In vitro* Gas Production and Nylon Bag Degradability of Roughage in Predicting Feed Intake in Cattle. *Animal Feed Science Technology*, 40: 109-119.

Blummel, M., Makkar, H.P.S., Chisanga, G., Mtimum, J. and Becker, K. (1997). The Prediction of Dry Matter Intake of Temperate and Tropical Roughages from *In vitro* Digestibility/ Gas Production of African Roughages in Relation to Ruminant Live Weight Gain. *Animal Science and Technology* (69) pp.131-141

Blümmel, M., Steingass, H., Becker, K. and Soller, H. (1993). Production of SCFA, CO2, CH4 and Microbial Cells *in vitro*. Proceedings of the Society of Nutrition Physiology, 1: 9-11

Bolsen, K.K ., Ashb, G. and Wilkinson, J.M. (1995) Silage Additives . in (Eds. A. chesson and R.J. Wallace) Biotechnology in Animal feeds and Animal feeding. VCH press, weinhein, Germany. Pp 33-54

Bolsen, K.K. (1999). Silage Management in North America in the 1990s : in (Eds . T.P. Lyons and K.A. Jaques) Biotechnology in the Feed Industry . Proc . Alltechs 15th Ann. Symp . Nottingham University press, Nottingham, UK. pp 233-244

Boucque, C.V. and Fiems, L.O. (1988). Vegetable By-products of Agroindustrial Origin. *Livestock Production Sceince.* 19(1):97-135. Buffalo Calves Fed Urea-Ammoniated Wheat Straw and Hydrochloric Acid Plus Urea Treated

Brownell, H.H and Saddler, J.N. (1987). Steam Pre-treatment of Lignocellulosic Material for Enhanced Enzymatic Hydrolysis. Biotechnology Bioengineering Symposium. P29: 228-235.

Bulle, M.L.M., Ribeiro F.G. and Leme P.R. (2002). Performance of Young Bulls Fed High Concentrate Diets With Sugarcane Bagasse as Roughage Source. *Rev. Bras. Zootec*. 31(1):444-450.

Cloete, S.W.P., de Villiers, T.T. and Kritzinger, N.M. (1983). The Effect of Ammoniation by Urea on the Nutritive Value of Wheat Straw for Sheep. *South Africa Journal of Anim*al *Science*. 3: 143- 146.

Costa, D.A, Souza de L.C., Saliba, S. Ode E., and Carneiro Da C.J. (2015) By-products of Sugarcane Industry in Ruminant Nutrition. *International Journal of Advance Agricultural Research.* Vol. (3)1-9.

Dawfang, I.I., Ikani, E.J. Chikwondu, D.O., Adesheinwa, A.O.K., Annate, A.I. and Iwuayanwu, I.E.I. (2001*) An Assessment of Adoption of non Conventional Feedstuff by Poultry and Pigs Farmer in Nigeria.*

De La Cruz, H.O. (1990). Steam Treated Bagasse for Fattening Cattle. Effect of Supplementation with Gliricidia Sepium and Urea/molasses. Livestock Research for Rural Development. 2(2): 345-348

Dennis, S. (2007). Personal communication. Pioneer microbiologist.

Elkhidir, I.A. (2004). Utilization of Sugarcane Bagasse for Fattening Cattle. Ph.D Thesis. University of Khartoum.

Elmnan, B.A. Atta and Ismeal, R.A. (2019). In Vitro Digestibilty and in situ Degradability of Sugarcane BagasseTtreated With Urea as Energy Source in Total Mixed Ration for Goat. *Online Jounal. Animal Science. Feed Resource*. 9(2): 86-91. www.ojafr.ir

EMBRAPA. (2015) Suplementação mineral do rebanho de corte. Disponível em: <http://www.cnpgc.embrapa.br>Acesso em: 21/01/ 2015. Federal Institute of Education, Science and Technology of Acre - IFAC. Sena Madureira, Acre, Brazil. University of Grande Dourados

Fajemisin, A.N., Fadiyamu, C.M., Fajemisin, A.A. and Alokan, J.A. (2012). Dietary Effect of Ensiled Corncorbs Treated With or Without Water, Iye and Urea on Performance of West African Dwarf sheep. *In:* Akpa, G.N., Dairo, F.A.S., Bawa, G.S., Solomon, I.P., Amaefuele, K.U., Odunsi, A.A. and Ladokon, A.O. (eds.) *Agricultural Transformation: Strategies and Policies for Livestock Development in Nigeria.* Proceedings of the 17th Annual Conference of the Animal Science Association in Nigeria (ASAN), 9th -13th September held at international conference Center opposite Radio House Area 8 AAbuja, Nigeria. PP 575-578.

Falcon, M.A., Rodriguez, A., Carnicero, A., Regalado, V., Perestelo, F., Milstein, O. and Fuente, G.L. (1995). Isolation of Microorganisms with Lignin Transformation Potential from Soil of Tenerife Island. *Soil Biology and Biochemistry*. 27: 121-126

Fan, F.T., Lee, T.H. and Beardmore, D.R. (1981). The Influence of Major Structural Features of Cellulose on Rate of Enzymatic Hydrolysis. *Journal of biotechnology and Bioengineering* Vol (28):419-424.

FAOSTAT, (2008). FAOSTAT Database. Accessible via FAO home page at http://faostat.fao.org/default.aspx. Food and Agriculture Organization.

Flatt, W.P. (1988). Feed Evaluation System: Historical Background In Oskov, E.R. (Ed.) World Animal Science; *BA Feed Science* pp 1-22 Elsevier, Amsterdam.

Freitas, A.W.P., Rocha, F.C. and Zonta, A. (2008). Consume de Nutrients e Desempenho de Ovinos Alimentados com Dietas a Base de Cana-de-Acucar Hidrolisada. Pesquisa Agropecuaria Brasileira, Brasilia. Vol. 43(11): 1569-1574.

Gattass, C.B A., Morais, M.G., Abreu U.G.P., Franco G.L., Stein J. and Lempp, B. (2008). Effect of Yeast Culture Supplementation on Ruminal Fermentation of Beef Cattle. R. Bras. Zootec. 37(4):711-716

Granzin, B.C. and Dryden, G.M. (2003). Effects of Alkalis, Oxidants and Urea on the Nutritive Value of Rhodes Grass (*Chloris gayana* cv. Callide). *Animal Feed Science Technology Journal* 103: 113-122.

Grohmann, K., Torget, R. and Himmel, M. (1985). Optimization of Dilute acid Pre-treatment of Biomass. *Biotechnology and Bioengineering Symposium*. Vol. (15):59-80.

Hartley, R.D. and Jones, E.C. (1978). Phenolic Components and Degradability of the Cell Walls of the Brown Mibrid Mutant, bm3, of Zea mays. *Journal of Science Food Agriculture.* (29) 777-789.

Henderson, N. (1993). Silage Additives. *Journal of Animal Feed Science and technology* 45:35 – 56

Hendriks, A.T.W. Zeeman, M.G. (2009). Pre Treatments to Enhance the Digestibility of Lignocellulosic Biomass. *Journal of Bioresource Technology*, Vol. 100(1):113-129.

Hvelplund, T. and Weisbjerg, M.R. (2000). *In situ* Techniques For The Estimation of Protein Degradability and Post-Ruminal Availability**.** In: Givens, D.I., Owen, E., Axford, R.F.E. and Omed, H.M. (Eds.), *Forage Evaluation in Ruminant Nutrition*, CAB International. Pp 233-257.

Inyang, U.A., Ifut, O.J., Eyoh, G.D. and Ndehedehe, M.E. (2012). Quality, Microbial and Proximate Composition of Cassava Peels Ensiled With Brewers Spent Grains. Proceeding of the 37th Annual conference of the Nigerian Society for Animal Production (NSAP), Makurdi. Pp 626 – 628.

Jackson, M.G. (1977). Treating Straw for Animal Feeding. FAO Animal Production and Health Paper No. 10. FAO, Rome.

Jayasuriya, M.C.N. and Pearce, G.R. (1983). The Effect of Urease Enzyme on Treatment Time and Nutritive Value of Straw Treated with Ammonia as Urea. *Animal Feed Science Technol.* 8:272-281.

Jones, R.O. (1994). The Impact of Regulating the UK Silage Additive Market. B.sc. Dissertation, Harper Aolams Agricultural College, Center for Agriculture Food Marketing Studies, Newport, UK.

Kaitho, R.J., Tegegne, A., Umunna, N.N., Nsahlai I.V., Tamminga, S., Bruchem, J.V., and Arts, J.M. (1998): Effect of *Leucaena* and *Sesbania* supplementation on Body Growth and Scrotal Circumference of Ethiopian Highland Sheep and Goats Fed Teff Straw Basal Diet. *Livestock Production Science,* 54 173–181

Kamalak, A., Canbolat, O., Gurbuz, Y. and Ozay, O. (2005): Comparison of *in vitro* Gas Production Technique With *in situ* Nylon Bag Technique to Estimate Dry Matter Degradation. Czech *Journal of Animal Science,* 50:60–67.

Karuiki, J.N., Tamminga, S., Gachuiri, C.K., Gitau, G.K. and Muia J.M.K. (2001). Intake and Rumen Degradation in Cattle Fed Napier Grass Supplement With Various Levels of Desmodium Inbortum and Ipomoea Batatas. *South African Journal of Animal Science,* (31): 3.

Kewalramani, N., Kamra, D.N., Lall, D. and Pathak, N.N. (1988). Bioconversion of Sugarcane Bagasse With White Rot Fungi. *Biotechnology letters*. 10 (5): 369-372.

Khan, M.A., Nisa, U.M. and Sarwar, M. (2003). Review: Techniques Measuring Digestibility for the Nutritional Evaluation of Feeds. *International Journal of Agriculture and Biology,* 5(1): 1560-8530.

Khorshidi, J. K., Abedi, S.C., Kioumarsi, H. and Sheriman, Z.Y. (2013). Ruminal Degradation of Soy Bean, Canola and Cotton Seed Mealusing *In sacco* Procedure in Sheep. *Pakistan Journal of Biological Sciences:* 16 (17) 898 -900.

Khorvash, M., Kargar, S., Yalchi, T. and Ghorbani G.R. (2010). Effects of Hydrogen Peroxide and Sodium Hypochlorite on the Chemical Composition and *in vitro* Digestibility of Soybean Straw. *Journal of Food Agriculture and Environment.* 8(3 and 4): 848-851.

KNARDA, (2001). Kano Agricultural and Rural Development Authority. Meteorological Station Reports Temperature Record Book and Management 11: 1 – 3.

Kraidees, M.S. (2005). Influence of Urea Treated and Soybean Meal (urease) Addition on the Utilization of Wheat Straw by Sheep. Asian-Aust. *Journal. Animal. Science*. 18(7): 957-965.

Kubkomawa, H., Olawuye, H.U., Krumah, L.J., Etuk, E.B. and Okoli, I.C. (2015). Nutrient requirements and feed resource availability for pastoral cattle in the tropical Africa: A review. *Journal of Agricultural and Crop Research* Vol. 3(7), pp. 100-116, November 2015.

Kung, I. and Shaver, R. (2002). Interpretation and Use of Silage Fermentation Analyses Reports. Department of Animal and Food Science, University of Delaware, New Yolk, D.C. 19717.

Larbi, A., Etela l., Nwokocha, H.N., Orji U.I Anyanwu, N.J, Gbaranch, L.D., Anioke, S.C., Balogun, R.O. and Muhammad, I.R. (2007). Fodder and Tuber Yields and Fodder Quality of Sweet Potato Cultivars at Different Maturity Stages in the West African Humid Forest and Savannah Zones. *Animal feed Science and Technology* 35 (1 – 2), 126 – 138.

Lebot, V. (2009). Trpical root and tuber crops: Cassava, Sweet potato, Yams and Aroids/MPG Biddle ltd, Kings Lynn, UK

Leng, R.A. (1990). Factors Affecting the Utilization of Poor Quality Forage by Ruminant Particularly Under Tropical Condition. Natural Resource Rev. 3: 227303.

Liu, J.X., Orskov, E.R. and Chen, X.B. (1999). Optimization of Steam Treatment as a Method for Upgrading Rice Straw as Feeds. *Animal Feed Science Technology* 76: 345-357.

Mahanna, B. (2007). Primer provided on feeding silage yeasts. Department of Biochemistry, Ahmadu Bello University,Zaria, Nigeria.

Mason, V.C., Cook, J.E., Dhanoa, M.S., Keene, A.S., Hoadley, C.J. and Hartley, R.D. (1990). Chemical composition, digestibility *in vitro* and bio degradability of grass hay oven-treated with different amounts of ammonia. Anim. Feed Sci. Technol. 29: 237-249.

Matthew, J.T., Ndamitso, M.M., Shaba, E.Y., Inobeme, A. and Adamu, A. (2014). Proximate and Mineral Compositions of Seeds of Some Conventional and Non-Conventional Fruits in Niger State, Nigeria. *Academic Resource International* Vol. 5(2):113-118.

McDonald, I. (1981). A Revised Model for the Estimation of Protein Degradability in the Rumen. *Journal of Agricultural Science* (Cambridge) 96: 251-252.

Mehrez, A.Z. and Orskov, E.R. (1977). A study of the artificial fibre bag technique for determining the digestibility of feeds in the rumen. *Journal of Agricultural Science,* (88):645 -650.

Mekonnen, K., Glatzel, G. and Sieghardt, M. (2006). Evaluation of Common Indigenous Tree and Shrub Species for Soil Fertility Improvement and Fodder Production in the Great Land Areas of Western Shewa, Ethiopia. In: Glatzel G., Habermann B. (eds): Gemeinsam Forschen gemeinsam Lernen-Forschungspartnerschaften in der Entwicklungszusammenarbeit. Verlag der Österreichischen Akademie der Wissenschaften, Vienna, Austria. 99–106.

Mekoya, A., Oosting, S.J., Fernandez-Rivera, S. and Van der Zijpp, A.J. (2008). Multipurpose Fodder Trees in The Ethiopian Greatlands: Farmers' Preference and Relationship of Indigenous Knowledge of Feed Value with Laboratory Indicators. *Agricultural Systems*, 96: 184–194.

Menesses, M.D., Megias, J., Madrid, A., Martinez -Teruel, F., Hemandez., J. and Oliva, J. (2007) Evaluation of the Phytosanitary, Fermentative and Nutritive Characteristics of the Silage Made Form Crude Artichoke (Cynarascolymus L.) By Product Feeding for Ruminant. *Small Ruminant Resources.*70: 292 – 296

Menke, K.H., Raab, L., Salewski, A., Steingass, H., Fritz, D. and Scheider. W. (1979) The Estimation of The Digestibility and Metabolizable Energy Content of Ruminant Feeding Stuffs From The Gas Production When They are Incubated with Rumen Liquor in vitro. *Journal of Agricultural Science*, 93: 217-222.

Michalet, A,E., Doreau, B. and Ould Bah, M.Y. (1993). *In vitro* and *In sacco* methods for estimation of dietary nitrogen degradability in the rumen: a review. Animal Science and Technology, 40:57-86

Minson, J.D. (1990). Forage in Ruminant Nutrition. San Diego. Academic press

Morduch, J. (1961). Making and feeding Silage. Published by Dairy farmer (Books) Limited, Lloyd`s chambers, Ipswich, UK.

Moreira I., Marcos Júnior M., Furlan A.C., Patricio V.M.I. and Oliveira G. C. (2002). Use of sugar cane yeast (*Saccharomyces* spp.) dried by spray-dryer as protein source on growing-finishing pigs feeding. R. Bras. Zootec. 31(2):962-969.

Morris, E.J. and Bacon, J.S.D. (1977). The fate of Acetyl Groups and Sugar Components During the Digestion of Grass Cell Walls in the Sheep. *Journal of Agriculture Science* 89:327-340.

Muhammad, H.A. (2017). Genetic Evaluation of Cross Bred Boer X Red Sokoto Goat for Growth and Lactation in Semi-Arid Region. PhD thesis, Department of Animal science, Bayero University, Kano. (Unpublished).

Muhammad, I.R., Abdu, M.I., Iyeghe-Erakpotobor, G.T. and Sulaiman, K.A. (2009). Ensiling Quality of Gamba Fortified With Tropical Legumes and its Preference By Rabbits. *Research Journal of Applied Sciences* 4(1): 20-25

Musa, A.H., Hossain, M.A., Mushtak, M.J., Yusuf, S.B. and Dada, G.F. (2011). Better Utilization of Crop Residues and By-Products in Animal Feeding: Research Guidelines Crop Production in Semiarid West Africa, pp. 149-169. *Livestock and Sustainable Nutrient Cycling in Mixed Farming Systems in SubSaharan Africa. Proceedings of an International Conference*

Nagadi, S., Herrero, M. and Jessop, N.S. (2000). The Effect of Fermentable Nitrogen Availability on *in vitro* Gas Production and Degradability of NDF. Animal Feed Science and Technology. (87): 241-251.

Nair, P.V., Verma, A.K., Dass, R.S. and Mehra, U.R. (2002). Growth and Nutrient Utilization in Buffalo Calves Fed Urea-ammoniated Wheat Straw and Hydrochloric Acid Plus Urea Treated Wheat Straw. Asian-Aust. *Journal of Animal Science* 15(5): 682-686.

Najafpour, G.D. and Shan C.P. (2003). Enzymatic Hydrolysis of Molasses. Bio Resource Technol. 86(1):91-94.

Nasiru, A., Badamasi, M and Hakimi, M.I. (2016). *In sacco* Nutrients Disappearance of Rice Straw Supplemented with Cattle Manure Vermicast. In: Okoli, I.C., Ogbuewu, I. P., Emenalom, O.O and Esonu, B.O (Eds). Exploring Science and Technology Innovations for Sustainable Livestock Development. Proceedings of the 43rd annual conference of the Nigerian Society for Animal Production held at Federal University of Technology Owerri: 1247-1250.

Ngele, M.B., Adegbola, T.A., Bogoro, S., Abubakar, M. and Kalla, D. (2010). Nutrient Intake, Digestibility and Growth Performance of Yankasa Sheep Fed Urea Treated or Untreated Rice Straw with Supplement. *Nigerian Journal Animal Production.* 37(1): 61-70.

Ngyuen, X.T., Dan, C.X., Ly, L.V. and Sandsle, F. (2002). Effect of Urea Concentration Moisture Content and Duration of Treatment on Chemical Composition of Alkali Treated Rice Straw. *Livestock Resource Rural Development.* 10(1).

Nicholson, J.W.G. (1984). Digestibility, Nutritive Values and Intake. In: Sundstol F, Owen E (eds), Straw and Other Fibrous Feeds, pp. 85-90, Elsevier Publishers, Amsterdam, Netherlands.

Nocek, J.E. (1985). Evaluation of Specific Variables Affecting in situ Estimation of Ruminal Dry Matter and Protein Digestion. *Journal. Animal. Science*. 60, 1347-1358.

NPC, (2006) National Population Commission, Abuja. Head Count retrieved from http://www.population.gov.ng/index.php/publications/140-population-distribution-by-sex-state-lgas-and-senatorial-district-2006-census-priority-tables-vol-3 on 07/07/2013

NRC, (2001). National Research Council. Nutrient Requirements of Beef Cattle, 7th Edition, Washington, DC. National Academic Press. 381 pp.

Obi, F.O., Ugwuishiwu, B.O. and Nwakaire, J.N. (2016) Agricultural Waste Concept, Generation, Utilization and Management. *Nigerian Journal of Technology* Vol. (35) No. 4 October 2016

Oduguwa, B.O., Jolaosho, A.O. and Ayankoso, M.T. (2007). Effect of Ensiled on Physical Properties, Chemical Composition and Minerals Content of Guinea Grass and Cassava Top Silage. *Nigeria Journal of Animal Production.* 34:100 – 106.

Ogunlolu, B.T., Jolaosho, A.O., Akinola, T.O. and Aniwe, P.O. (2010). Effects of Length of Storage and Mixture of Cassava Peel, Pineapple Residues and Guinea Grass on Mineral Content of Silage. Proceedings of the 35th Annual Conference of the Nigerian Society of Animal Production 14th – 17th March, 2010, University of Ibadan.Pp 489-490.

Oji, U.I., Etim, H.E. and Okoye, F.C. (2007). Effects of Urea and Aqueous Ammonia Treatment on the Composition and Nutritive Value of Maize Residues. *Small Ruminant. Resources*. 69: 232-236.

Olagunju. A., Muhammad, A., Aimola, I.A., Abdullahi, M.S. and Danhassan, A.H. (2014). Effect of *Lachnocladium Spp.* Fermentation on Nutritive value of Pretreated Sugarcane Bagasse. *International Journal of Modern Biology and Medicine*. Vol.5(1):24-32.

Oliveira, M.D., Mido, S.B. Mota, J.C., Moreal, J.D. Fernando, A. and Marquez, R.O. (2002). Feito da hidrolise com cal virgem sobre a composicao bromotologica da canade-acucar-vet.Noticias, Vol. (14):19-27.

Olofin, E.A. (2007). Some Aspect of Physical Geography of Kano Region and Related Human Resources.

Olonrunnisomo, O.A. and Dada, O.A. (2011). Digestibility and Intake of Elephant Grass Ensiled with Cassava Feels by Red Sokoto Goats in Ibadan. In: A. A. Adeniji, E.A. Olatunji and

E.S. Gana (eds.) *Value Re – Orientation in Animal Production: A Key to National Food Security and Stable Economy*. Proceeding of the 36th Annual Conference of the Nigerian Society for Animal Production (NSAP), 13th – 16th March, held at Merit House/Raw Materials Research and Development Council, Abuja. Pp 584 – 586.

Onselen, V.J. van and J. Lopez. (1988). Effect of Addition of Carbohydrate Sources and of a Commercial Enzymatic Product on the Chemical and Nutritional Composition of Elephant Grass (pennisetum purpureum) Silage . Revista da sociedade Brasiliera de Zootecnia .17(5) : 421-427.

Onyeonagu, C.C. (2010). Studies on Fertilizer Nitrogen and Cutting Management of Sown Grass and Legume Pastures in a Pure mixed Swards. A Ph.D Thesis Submitted to the Faculty of Agriculture, University of Nigeria, Nsukka, p. 202.

Orskov, E.R., Horvell, D. and Mould, F.L. (1980a). The Use of Nylon Bag Techniques for the Evaluation of Feedstuffs. *Tropical Animal Production* 5:195-213.

Ørskov, E.R., Hovell, F.D. and Mould, F. (1980b). The Use of Nylon bag Technique For Evaluation of Beef Stuff. *Tropical Animal Production*. 5: 195-213.

Ørskov, E.R. and McDonald, I. (1979). The Estimation of Protein Degradability in the Rumen of Incubation Measurement Weighted According to Rate of Passage. *Jouurnal Agriculture Science.*, Camb. 92:499-503.

Ørskov, E.R., Reid, G.W. and Kay, M. (1988). Prediction of Intake by Cattle from Degradation Characteristics of Roughages. *Animal Production*, 46: 29-34.

Osuji, P.O., Sibanda, S. and Nsahlai, I.V. (1993a). Supplementation of Maize Stover for Ethiopia Menz Sheep. Effect of Cotton Seed (*Ginzolia abyssinical*) or Sun Flower Cake With or Without Maize on Intake, Growth, Apparent Digestibility, Nitrogen Balance and Excretion of Purine Derivatives. *Animal Production*, 57: 429-436.

Osuji, P.O., Sibanda, S. and Nsahlai, I.V. (1993b). Supplementation of Maize Stover for Ethiopia Menz Sheep. Effect of Cotton Seed (*Ginzolia abyssinical*) or Sun Flower Cake With or Without Maize on Intake, Growth, Apparent Digestibility, Nitrogen Balance and Excretion of Purine Derivatives. *Animal Production*, 57: 429-436.

Otjen, L., Blanchette, R., Effland, M. and Leatham, G. (1987). Assessment of 30 white rots Basidiomycetes

Owen, O.J., Ngodigha, E.M. and Amakiri. A.O. (2008). “Proximate Composition of Heat Treated Poultry Litter (Layers)”. *International Journal of Poultry Sciences*. (7):1033-1035

Ozung, P.O., Nsa, E.E., Ebegbulem, V.N., and Ubua, J.A. (2011) The Potentials of Small Ruminant Production in Cross River Rain Forest Zone: a review. *Continental Journal of Animal and Veterinary Research* 3(1), 33–37

Pandey, A., Soccol, C.R., Nigam, P., Soccol, V.T., Vandenberghe, L.P.S. and Mohan, R. (2000). Biotechnological Potential of Agro-industrial Residues.II: Cassava Bagasse. *Bioresource Technology symposium.*Vol.74(1):81-87.

Panditharane, S., Allen, V.G. Fontenot, J.P. and Jayasuriya. M.C.N. (1986). Ensiling Characteristics of Tropical Grass as Influenced by Stage of Growth, Additives and Chopping Length .*Journal of Animal Science*. 63 (1): 197-207.

Pereira R.A.N., Ferreira W.M. and Garcia S.K. (2008). Digestibility of Sugarcane Bagasse After a NaOH Treatment in Growing Rabbit diets. Ciênc. Agrotec. 32(2):573-577.

Phesatcha, K. and Wanapat, M. (2012). Study on Ruminal Degradability of Local Feeds Using Nylon Bag Technique. *Khonkaen Agricultural Journal 40 supplement* 2:123 -127.

Possenti, R.A., Franzolin R., Schammas E.A., Demarchi, J.J.A.A., Frighetto, R.T.S. and Lima M.A. (2008). Efeitos de dietas contendo Leucaena leucocephala e Saccharomyces Cerevisiae sobre a Fermentação Ruminal e a emissão de gás metano em bovinos. R. Bras. Zootec. 37(8):1509-1516.

Preston, T.R and Leng, R.A. (1987). Manipulation of Feeding and Rumen Ecosystem: In Matching Ruminant Production System with Available Resources in the Tropics and Sub-tropics. Penanbul books, 4 Mandela Aust.

Quins, J.I., Vanderwath, J.G. and Mayburgh, S. (1939). Studies on the Alimentary Tract of Merino Sheep in South Africa. IV. Description of Experimental Technique. *Onderstepoort Jounal Veterinary Science Animal Ind.,* II. Pp. 341 –360.

Quinn, J.I., Wath, J.G., Vander and Myburgh, S. (1938). Studies on the alimentary tract of Merino Sheep in South Africa: Description of Experimental Technique. *Journal of Veterinary Science Animal Indian, Ondersteport*, 11(2): 341-360.

Ramli, M.N., Imura, Y., Takayama, K. and Nakanishi, Y. (2005). Bioconversion of Sugarcane Bagasse with Japanese Koji by Solid-State Fermentation and its Effects on Nutritive Value and Preference in Goats. Asian-Aust. *Journal of Animal Science* 18 (9): 1279-1284.

Rezende, A.C., Marisa de L.A., Maziero, P., Ribeirode E., Warious G. and Polikarpov, I. (2011). *Journal of Biotechnology biofuels* Publlished online.

Rocha, G.J.M., Martin, C., Soares, I.B., Maior, A.M.S., Baudel.H M., de Abreu (2011). CAM. Dilute Mixed Acid Pretreatment of Sugarcane Bagasse for Ethanol Production. *Journal of Biomass Bioenergy.* Vol(35):663-670.

Rodrigues, M.A.M., Pinto, P., Bezerra, R.M.F., Dias, A.A., Guedes, C.V.M., Cardoso, V.M.G., Cone, J.W., Ferreira, L.M.M., Colaco, J. and Sequeria, C.A. (2008). Effect of Enzyme Extract Isolated from White-rot Fungi on Chemical Composition and *in vitro* Digestibility of Wheat straw. *Animal Feed Science and Technology*. 141: 326-338

Rodriguez-Vazquez.R.,Villanuevaventura.,G., Riosleal E, (1992a) Sugarcane Pith Dry Pretreatment for Single Cell Protein Production. *Journal of Bioresource Technology*. Vol.(39):17-22.

Rodriquez-Vazquez, R. and Diazcervantes, D. (1994b). Effect of Chemical Solutions Sprayed on Sugarcane Bagasse Pith to Produce Single Cell Protein: Physical and Chemical Analysis of Pith. *Journal of Bioresource Technology.* Vol.(47):159-164.

Roy, S. and Rangneker, D.V. (2006). Farmer Adoption of Urea Treatment of Cereal Straws for Feeding Animal in Mithila milk shed, India *Livestock Research and development* 18(8)

Saenger, P.F., Lemenager, R.P. and Hendrix, K.S. (1982). Anhydrous Ammonia Treatment of Corn Stover and its Effects on Digestibility, Intake and Performance of Beef Cattle. *Journal ofAnimal Science.* (54): 419-425

Saewar, M., Nisa, M., Khan, M. A. and Mushtaque, M. (2006). Chemical Composition, Herbage Yield and Nutritive Value of Panicum Antidotale and Pennisetum Orientale for Nili Buffaloes at Different Clipping Intervals. Asian-Aust. *Journal of Animal Science* (19): 176-184.

Salami, S.O., Makinde, F. A. and Garba, G. M. (2010). Foetal wastage in goats slaughter in Zaria abattoir, Northern Guinea Savarnia Zone . *Nig. Animal Production* 37(1): 117-122.

Salem- Ben, S. and Smith, T. (2008). Feeding Strategies to increase small ruminant production in dry environment. *Small Ruminant Research, 77 92-3).*

Salman, F.M., Salama, R., Khattab, A.E., Soliman, S.M. and El-Nomeary, Y.A. (2011). Chemical, Biological and Biochemical Treatments to Improve the Nutritive Value of Sugarcane Bagasse(SCB):1-Chemical Composition, Scanning Electron Microscopy, in *Vitro* Evaluation, Nutrients Digestibility and Nitrogen Utilization of Untreated and Treated Sugarcane Bagasse.

Santos, C.M., Nussio, G.L., Mourao, B.G., Schimidt, P., Mari, J.L., Ribeiro, L.J. and Queiroz, M. (2009). J*ournal of Animal Science,* C.O., Zopollatto, M., Sousa.de P.D., Sarturi, O.J., Filho.de T.G.S. Nutritive value of Sugarcane Silage Treated with Chemical Additives.

Sarkar, N., Ghosh, S.K. and Bannerjee, S.A.K. (2012). Bioethanol Production from Agricultural Wastes: an Overview of Renewable Energy. Vol. (27):19-27.

Sarklong, C., Cone, J.W., Pellikaan, W. and Hendriks, W.H. (2010) Utilization of Rice Straw and Different Treatments to Improve the it`s Feed Value for Ruminants: a review. *Asian Australias Journal of Animal Science.* Vol.(23):68-92.

SAS, (1999). Statistical Analytical Systems. SAS/STAT User’s Guide Statistical Analysis Institute Inc. ,Version 6, 3rd Edition, Cary, North Carolina, USA. 943 pp.

Scalbert, A., Monties, B., Lallemand, J.Y., Guitte, E.R. and olando, C. (1985). Ether Linkages Between Phenolic Acids and Lignin Fractions for Wheatstraw. Phytochemistry. Vol. (24): 1359-1362.

Schwab, C.G., Tylutki, T.P. and Ordway, R.S. (2003). Characterization of Proteins in Feeds. *Journal of Dairy Science*, 6(E Supplement): 88-103.

Shittu, A., Chafe, U.M., Buhari, S., Junaidu, A.U., Magaji, A.A., Salihu, M.D. and Jibril, A. (2008). Farmers in Sokoto state, Northwestern. *International journal of science, environment and technology,* vol. (3) no 2, 2014, 735 – 748.

Sindhu, R. and Gnansounou, E.B.P.P.A. (2016). Bioconversion of Sugarcane Crop Residue for Value Added Products-An Overview.

Smith, O.B., Idou, O.A., Asaolu, V.O. and Odunlami, O. (1991). Comparative Rumen Degradability for Forage Browse, Crop Residues, Agricultural by Products. Livestock Research for Rural Development, 3:2.

Soeharto, M. (2004). Dukungan teknologi pakan dalam usaha sapi potong berbasis sumber daya lokal. Dalam: Setiadi B, Priyanti A, Handiwirawan E, Diwyanto K, Wijono DB, penyunting. Strategi Pengembangan Sapi Potong dengan Pendekatan Agribisnis dan Berkelanjutan. Prosiding Lokakarya Nasional Sapi Potong. Yogyakarta, 8-9 Oktober 2004. Bogor (Indonesia): Puslitbangnak. hlm. 14-21.

Suksumbat, W. (2004a). Comparison of Different Alkali Treatment of Bagasse and Rice Straw. School of Animal production Technology, Institute of Agricultural Technology, Suranaree University of Technology, Nakorn Ratchasima, Thailand. Vol. 17(10):1430-1433.

Suksumbat. W. (2004b). Comparison of Different Alkali Treatment of Bagasse and Rice Straw. School of Animal production Technology, Institute of Agricultural Technology, Suranaree University of Technology, Nakorn Ratchasima, Thailand. Vol. 17(10):1430-1433.

Sundstol, F. and Coxworth, E.M., (1988). Ammonia treatment. In: F. Sundstel and E. Owen (eds.) Straw and Other Fibrous by Products as Feed. *Elsevier Applie. Science*. Publication. Amsterdam, the Netherlands. Pp 196-239.

Tesfaye, A.A. (2005). The Potential of Urea Treated Maize Stover For Growth Performance of Weaned Calves. *Kasetsart Journal. Nat. Science.* 39(4).

Tesfaye, K. and Chali, A. (2008). Effect of Variety and Plant Part on Chemical Composition of Sweet Potato (Ipomoea batatas) vines. In: Tesfaye, A., Bedru, B., Lemma, D., Wole, K. T., Maki, N., Berhanu, S., Kiyoshi, S., Nege, t. AND Mohammed, Y (Editions) FRG completed report project, MelkassaAgricultural Research Centre,pp 82 -89

Theodorou, M.K., Willians, B.A., Dhaona, M.S., Mc Ailan, A.B. and France, J. (1994). A Simple Gas Production Method Using a Pressure Transducer to Determined the

Fermentation Kinetics of Ruminants Feeds. *Animal Feed Science and Technology* (48): 185-195.

Thomas, C. and Thomas. P.C. (1985). Factors Affecting the Nutritive Value of Grass Silage .in (Eds .D.j. Cole and W Haresign) Recent Advances in Animal Nutrition . Butterworths, London . Pp 223-256.

Torres. B.L. Ferreira A.M. Verasa S.C. Melo. A.A.S. and Andrade D.K.B(2003). Sugarcane Bagasse and Urea Replacement of Soybean Meal in the Growing Dairy Cattle Diets. Revista Brasileira de zootechnia. Vol. 32(3):760-767. Urea on the Nutritive Value of Wheat Straw for Sheep. *South Africa Journal of Anim*al *Science*. (3): 143- 146.

Turki, I.Y. and Atcham, A.A. (2011). Study on Chemical Composition, Degradation and Protein Characterization of Oil Seed Cakes Available in Sudan. Research Opinion in Animal Veterinary Science. 1:9, 587 -592. www.roavs.com

Valadares, E.O., Filho, S.C., Mendez, F.N., Rocha Junior, V.R. and Cappelle E.R. (2002). Tabelas Brasileiras de composição de Alimentos para Bovinos. CQBAL 2.0. Viçosa, MG: UFV. 297p.

Van Hao, N. and Ledin, I. (2001). Performance of Growing Goats Fed Gliricidia Maculata, Small Ruminant Resources. (39): 113–119.

Van Soest, P.J. and Robertson, J.B. (1985). Analysis of Forages and Fibrous Foods. A Laboratory Manual for Animal Science 613. Report of Research of the Cornell University Agricultural Experiment Station. pp. 2(3): 35.

Van Soest, P.J. and Robertson, J.B. (1988). Analysis of Forages and Fibrous Foods. A Laboratory Manual for Animal Science 613. Report of Research of the Cornell University Agricultural Experiment Station. pp. 2(3): 35.

Van Soest, P.J. (1967). Development of a Comprehensive System of Feed Analysis and its Application to Forages. *Journal of Animal Science*. 26:119.

Van Soest, P.J., Mertens, D.R. and Deimum, B. (1978). Preharvest Factor Influencing the Voluntary Feed Intake of Forages. *Journal of Animal Science*. (47) 712-721.

Van Soest, P.J., Robertson, J. and Lewis, B. (1991). Method for Dietry Fibre, Neutral Detergent Fibre, and Nonstarch Polysaccharides in Relation to Animal Nutrition Dairy Science 74(10):3583-3597 Wheat Straw. *Asian-Aust. Journal of Animal Science*. 15(5): 682-686.

Van Vuuren, A.M., Tamminga, S. and Ketelaar R.S. (1991). *In sacco* Degradation of Organic Matter and Crude Protein of Fresh Grass (*Lolium perenne*) in The Rumen of Grazing Dairy Cows. *Journal of Agricultural Science*, 116, 429–436.

Wattiaux, M. (2000). Introduction to Silage Making. The Babcock Instute University of Wisconsin. www.badcock.cals.wisc.edu/downloads/du/du-502.en.pdf

Woolford, M.K. (1984). Silage Fermentation. Marcel Dekker, NewYork . USA

Yacout, M.H., Khayyal, A.A., Shwerab, A.M. and Khalel, M.S. (2016). Introduce Sweet Potato Vines as Good Roughage for Small Ruminants. *Ecronicon Vetrinary Scencei.,* (4): 104-204

Yalchi, T., Seif-Davati, J. and Seyed Sharifi, R. (2010). Chemical Composition and Digestibility of Urea Treated Triticale (x *Triticosecale*) Straw. *Journal of Food, Agriculture and Environment*. 8(2): 618-622.

Zadrazil, F. (1985). Screening of Fungi for Lignin Decomposition and Conversion of Straw ton Feed. Angew. *Botany*. 59: 433-452

Zhang, Y.P. and Lynd, L.R. (2007). Toward an Aggregated Understanding of Enzymatic Hydrolysis of Cellulose; Non Complexed Cellulose Systems. *Biotechnologybioengineering symposium;* 38-797-824.