2018-09-26

EFFECT OF UNTREATED AND UREA MOLASSES TREATED FINGER MILLET STRAW AND LOWLAND BAMBOO LEAF AS BASAL DIET ON NUTRIENT UTILIZATION, GROWTH AND CARCASS CHARACTERISTICS OF LOCAL SHEEP IN BENISHANGUL GUMUZ REGIONAL STATE, ETHIOPIA

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BAHIR DAR UNIVERSITY COLLEGE OF AGRICULTURE AND ENVIRONMENTAL SCIENCES

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M.Sc. Thesis

By

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June, 2018

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M.Sc. THESIS

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SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE (M.Sc.) IN “ANIMAL PRODUCTION”

June, 2018

Bahir Dar, Ethiopia

APPROVAL SHEET

As member of Board of Examiner of the Master of Science (M.Sc.) thesis Open Defense examination, we have read and evaluated this thesis prepared by **Ms. Behiwot Adugna Dessie** entitled **"EFFECT OF UNTREATED AND UREA MOLASSES TREATED FINGER MILLET STRAW AND LOWLAND BAMBOO LEAF AS BASAL DIET ON NUTRIENT UTILIZATION, GROWTH AND CARCASS CHARACTERISTICS OF LOCAL SHEEP IN BENISHANGUL GUMUZ REGIONAL STATE, ETHIOPIA**". We hereby certify that, the Thesis is accepted for fulfilling the requirement for the award of the Degree of Master of Science (M.Sc.) in **Animal Production.**

Board of Examiners

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Name of Chair Person	Date	Signature

DECLARATION

This is to certify that this thesis entitled "**EFFECT OF UNTREATED AND UREA MOLASSES TREATED FINGER MILLET STRAW AND LOWLAND BAMBOO LEAF AS BASAL DIET ON NUTRIENT UTILIZATION, GROWTH AND CARCASS CHARACTERISTICS OF LOCAL SHEEP IN BENISHANGUL GUMUZ REGIONAL STATE, ETHIOPIA**" submitted in partial fulfillment of the requirements for the award of the degree of Master of Science in "**Animal Production**" to the Graduate program of college of Agriculture and Environmental Sciences, Bahir Dar University by Ms. **Behiwot Adugna Dessie**, (ID. No. BDU 07021118PS) is an authentic work carried out by her under our guidance. The matter embodied in this project work has not been submitted earlier for award of any degree or diploma to the best of our knowledge and belief.

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ACKNOWLEDGEMENTS

First and foremost, I would like to thank the almighty God for giving health, strength and patience so as to accomplish this study.

Special thanks and heart-felt appreciation goes to my advisors Yeshambel Mekuriaw (PhD) and Bimrew Asmare (PhD), for their unreserved support and guidance during my research work. Special thanks to the Bahir Dar University college of Agriculture and Environmental Sciences for allowing me the chance of studying this M.Sc. program. And special thanks to Debire Birhan animal nutrition laboratory for their support in the laboratory analysis.

I would like to pass my great indebtedness to Assosa ATVET College staffs for allowing me financial, resource and time support in this work so that my study came to success. I wish to express deep appreciation to my family for their continuous encouragement and moral support throughout the study period.

I wish to express my deepest appreciation to Mr. Demelash Ayichile, Mr. Mulisa Faji and Ms. Lamrot Tekiliye for their support and encouragement till this time.

.

STATEMENT OF THE AUTHOR

I hereby, declare that this thesis is my authentic work and that all sources of materials used for this thesis have been appropriately acknowledged. This thesis has been submitted in partial fulfillment of the requirements for an advanced M.Sc. degree at Bahir Dar University. I soberly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate. Brief quotations from this thesis are allowable without special permission provided that accurate acknowledgement of the source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the School of Graduate Studies when in his or her judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, per-mission must be obtained from the author.

Name: Behiwot Adugna

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Place: Bahir Dar University, Bahir Dar

Date of Submission: _____________

DEDICATION

This piece of work is dedicated to my father Ato Adugna Dessie and my mother, W/ro Tiru Abawa**,** who have paid a lot of sacrification to get me in the right track, with all their affection, love and dedication to bring me up to this point of success in my life.

ABBREVIATIONS / ACRONYMS

ADF	Acid detergent fiber
ADFD	Acid detergent fiber digestibility
ADFI	Acid detergent fiber intake
ADL	Acid detergent lignin
AOAC	Association of official analytical chemists
AsARC	Assosa Agricultural Research Center
ATVET	Agricultural Technical Vocational Educational Training
BGBA	Benshangul Gumuz Bureau of Agriculture
BW	Body weight
CP	Crude protein
CPD	Crude protein digestibility
CPI	Crude protein intake
CSA	Central Statistical Agency
DM	Dry matter
DMD	Dry matter digestibility
DMI	Dry matter intake
FAO	Food and Agriculture Organization of the United Nations
FCE	Feed conversion efficiency
IBC	Institute of Biodiversity Conservation
ILRI	International Livestock Research Institute
m.a.s.l	Meters Above Sea Level
MOA	Ministry of Agriculture
NDF	Neutral detergent fiber
NDFD	Neutral detergent fiber digestibility
NDFI	Neutral detergent fiber intake
NSC	Noug seed cake
OM	Organic matter

OMD	Organic matter digestibility
OMI	Organic matter intake
SAS	Statistical Analysis Soft-ware
TDM	Total dry matter
TLBLH	Urea molasses treated lowland bamboo leaf hay
TFMS	Urea molasses treated finger millet straw
ULBLH	Un treated lowland bamboo leaf hay
UFMS	Un treated finger millet straw
WB	Wheat bran

Effect of Untreated and Urea Molasses Treated Finger Millet (*Eleusine coracana*) Straw and Lowland Bamboo (*Oxytenanthera abyssinica*) Leaf as Basal Diet on Nutirent Utilization, Growth and Carcass Characteristics of Local Sheep In Benishangul Gumuz Regional State, Ethiopia

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ABSTRACT

The experiment was conducted at Assosa ATVET College to evaluate the effect of untreated and urea molasses treated finger millet straw and lowland bamboo leaf hay as basal diet on nutrient utilization, growth and carcass characteristics of local sheep; in Benishangul Gumz. Twenty yearling intact male local sheep with initial body weight before the 21.6 ± 1.31 kg (mean ± SD) were purchased from local market and were used for 10 days digestibility study and 90 days feeding trial. The sheep were grouped into five blocks of four animals and randomly assigned to four dietary treatments. The four experimental feeds were untreated finger millet straw (UFMS) + 150 g wheat bran (WB) and noug Seed (NSC) mixture (T1), untreated lowland bamboo leaf hay (ULBLH) + 150 g WB and NSC mixture (T2), urea molasses (UM) treated finger millet straw (TFMS) + 150 g WB and NSC (T3) and UM treated lowland bamboo leaf hay (TLBLH) + 150 g WB and NSC mixture (T4), the basal diet was weighed with sensitive balance and offered. Water and salt were available all times throughout the experimental period. Data were analyzed using General Linear Model (GLM) procedure of SAS software version (9.1). The crude protein (CP) content of UFMS, ULBLH, TFMS and TLBLH were 6.74, 15.87, 12.66 and 21.8 % respectively. The DM intake was higher ($P < 0.001$) for T2 and T4 than T1 and T3. Urea molasses treatment results higher improvement on intake of CP. The apparent CP digestibility were higher ($P<0.001$) for T4 than T3, and T2 and T1. (T4>T3=T2>T1). The apparent DM, OM and NDF digestibility was lower ($P < 0.05$) for T1 than other treatment (T4=T2=T3>T1). Average daily gain (ADG), body weight change (BWC) and final body weight gain (FBWG) were higher ($P < 0.001$) for T2 and T4 than T1. Moreover, ADG, BWC and FBWC for T4 were higher ($P < 0.001$) than T3. Slaughter BW was significantly different ($P < 0.001$) among treatments (T1<T3=T2=T4). The empty BW, hot carcass weight and rib eye area were significantly higher ($P < 0.05$) for T2, T3 and T4 than T1. Dressing percentage on the basis of EBW and SW were higher ($P < 0.05$) for treated group than untreated group (T4=T3>T2=T1). The total edible offal components, total non-edible offal components and total edible products were significantly higher ($P < 0.05$) for T4 than T1, while similar with T2 and T3. In conclusion urea molasses treatment could be taken as an option to improve nutritive value of lowland bamboo leaf hay and finger millet straw. Interims of CP content, finger millet straw responded more to urea molasses treatment

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Key words: *Effect, finger millet straw,* lowland *Bamboo leaf, sheep, urea molasses.*

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1. INTRODUCTION

The livestock population of Ethiopia is estimated to be 57.83 million cattle, 28.89 million sheep and 29.70 million goats (CSA, 2016). In Ethiopia, sheep are the major source of food security serving a diverse function including cash income, savings, and fertilizer and for socio-cultural functions. Sheep are also important foreign currency earners accounting for 34% of the live animal exports (ILRI, 2013). In general the productivity of sheep in Ethiopia is low even compared to neighboring countries because of poor feed quality and insufficient supply of feed. In addition to these seasonal variation in feed quantity or poor feed quality and quantity causes periods of weight loss and gain, unimproved genetic resources and prevalence of diseases and parasites are the reason for poor productive animals (FAO, 2010).

The total annual meat production comes from cattle (63%), sheep (25%) and goats (12%) and at the national level, sheep and goat account for about 90% of the live animal/meat and 92% of skin and hide (FAO, 2010). The same source also confirmed that local sheep are slaughtered at about 12 months of age with live weight of 18-20 kg with carcass weight of 8-10 kg /sheep. Meat production is estimated at about 3.5 kg per sheep per year in the population and 10 kg per sheep slaughtered. Both values are very low when compared with those in neighboring countries that have small ruminant population’s 50–75% less than Ethiopia, such as Sudan, Somalia, Djibouti and Kenya, which respectively produce 13, 13, 12, and 13 kg/head (Amha Sebsibe, 2008). Increasing the current level of productivity of sheep is essential to meet the demands of the ever-increasing human population. In order to satisfy the demand for meat the quality and quantity of meat, should be increased by improving the feeding and management system (Kasahun Birhanu, 2009). Small ruminants by virtue of their small size provide an opportunity to increase meat production, because of their ability to succeed on locally available and low quality and quantity feeds as well as for possessing high reproductive performance (ESGPIP, 2011).

In Ethiopia, the sources of feeds are natural grazing land, crop residues, improved pasture forage crops and agro-industrial by-products. Green fodder (grazing) is the major type of feed (about 55.33 percent) followed by crops residue that is 31.29 percent. From the present feed shortage point of view sheep production is relatively better suited in the area as compared large ruminants. Moreover, biomass yield and land size of natural pasture is decreasing because of poor management and conversion to crop land respectively (CSA, 2016).

Most dry forages and roughages found in Ethiopia have a crude protein (CP) content of less than 7% and these do not satisfy the requirements of rumen microorganisms. When fed alone, such feeds are unable to provide even the maintenance requirement of livestock McDonald *et al.*, 2002). Therefore, inadequate nutrition is among the major constraints to limit sustainable livestock production in Ethiopia (ILRI, 2013). Supplementation of poor quality feeds with nitrogen sources and carbohydrate increases the rate and extent of digestion resulting in improved dry matter (DM) intake. (McDonald *et al.,* 2010).

Finger millet is grown almost in all the regions of Ethiopia with varying quantity (CSA, 2016). In Ethiopia, out of the total grain crop area, 79.69% (8.7million hectares) was under cereals crops. From these finger millet cover 14.01% (1.5 million hectares) of the grain crop area. Total production of finger millet in Ethiopia is estimated 9,402,463 Quntal per year, from this 0.39% of the production is utilized for animal feed (CSA, 2016). In Benishangul Gumuz, finger millet is the dominant cereal crop, covering an estimated area of 23,784 ha, followed by maize. Finger millet straw is used for livestock feed in the area (CSA, 2016)**.**

Bamboo is a major non-timber forest product whose exploitation should provide local people with sufficient food and fodder for their livestock and contribute to the development of herbal medicine as well as generate income (Denbeshu Debeko, 2010 and Yeshambel Mekuriaw *et al*., 2012). The same source reported that two indigenous species of bamboo are predominant in Ethiopia. These are highland (*Yushania alpinia*) and lowland (*Oxythenanthera abyssinica*) bamboo. Lowland bamboo (*Oxythenanthera abyssinica*) forest of Ethiopia is cover about 85% of the total bamboo forest of the country.

The potential of bamboo leaf as ruminant feed is reported by Yeshambel Mekuriaw *et al*.(2012) Therefore, huge amount of bamboo leaves are left on the ground during bamboo culm harvesting. It is essential to use this resource as livestock feed by urea molasses treatment. Conservation and processing of bamboo leaf could enhance the feeding values of bamboo foliage.

Urea treatment has most practical significance in the tropics by acting both as an alkali and as a source of nitrogen to roughages inherently low in protein, resulting in a successful improvement in digestibility and intake of these feeds (McDonald *et al*., 2010). During treating, the ammonia gas acts upon the fiber and fibrous the release of soluble carbohydrates and energy for cellulolytic Bacteria growth, enhancing efficient utilization of roughages. Moreover, urea molasses application is relatively easy, less toxic and effective (Ibrahim and Schiere 1989).

One of the constraints for sheep rearing in the study area is inadequate and poor quality of feed. As the area is known for its potential for bamboo tree, bamboo leaf is used as source of feed for sheep. Finger millet straw is also another as source of feed for sheep. But the nutritive value of finger millet straw is low feeding value for livestock Therefore, there is a need to improve the nutritive value of these feeds by treating with urea and molasses. Therefore, this study was designed to evaluate effect of untreated and urea molasses treated finger millet straw and lowland bamboo leaf as basal diet on nutrient utilization, growth and carcass characteristics of local sheep, with the following specific objectives.

- To evaluate the effect of untreated and urea molasses treated finger millet straw and lowland bamboo leaf on feed intake, digestibility, live weight change and carcass characteristics on local sheep.
- To evaluate the nutritive value of urea molasses treated finger millet straw and lowland bamboo leaf.

2. LITERATURE REVIEW

2.1 Origin and distribution of local sheep

Sheep belong to the sub-family Caprinae, family Bovidae. The genus *Ovis* include all Sheep, while domesticated sheep belong to the species *Ovis aries.* Sheep are extremely versatile and since domestication they have spread throughout the world (Devendra and McLeroy, 1982). Sheep are the first animals to be domesticated, and it was believed that most domestication took place in western Asia (FAO, 2000).

In Ethiopia, there exists a great variation in climate and topography, they distribute from tropical to temperate environments (Kasahum Awgichew, 2008). Ethiopia is believed to be one of the major gateways for domestic sheep migration from Asia to Africa. Ethiopia has a vast genetic resource of sheep. They are widely distributed across the major agro-ecological zones and geographical regions. About 75% of the sheep population inhabited the highland part of the country while the remaining 25% are distributed in the lowland (Markos Tibbo, 2006**).** The sheep types in Ethiopia are classified into four major groups based on their physical characteristics: short fat-tailed, long fat-tailed, thin-tailed and fat-rumped sheep (Solomon Gizaw, 2008). According to the report of Solomon Gizaw *et al*. (2008) there are about 14 traditionally recognized sheep populations in Ethiopia. These are Horo, Farta, Menz, Tukur, Arsi Bale, Afar, BlackHead Somalia, Gmuz, Bonga, Washera, Adilo, Slimen, Sekota, and Wollo.

2.2. Sheep production systems in Ethiopia

Production systems in Ethiopia are predominantly traditional. The prevailing sheep production systems have evolved in relation to the total availability of land, the overall pattern of crop production and farming systems, the area of uncultivated land, and the density of animal populations. In addition to the physical environment, characterizing sheep production system consists of assessing the important products and functions of livestock (Tesfaye Getachew *et al*., 2010).

According to Markos Tibbo, (2006) and Solomon Gizaw *et al*. (2008) sheep production is classified as three major different production systems; highland sheep-barely, mixed crop-livestock and pastoral and agro-pastoral production systems. Similarly Solomon Abegaz *et al*. (2008) reported that the different types of sheep production system are: mixed crop-livestock system, pastoral and agro-pastoral production system, ranching production system and Urban and peri-urban sheep production system.

Within the mixed crop-livestock system, small ruminant production systems are found associated with the different agricultural production systems which vary in potentials, intensity of the mixed farming operation, natural resources base including grazing and livestock resources (Kasahun Awgichew and Alemu Yami 2008). The pastoral and agro-pastoral systems are found in the arid and semi-arid lowlands of Afar, Somali and Oromia (Adugna Tolera *et al*., 2012). Pastoral production system is located in the arid and semi-arid lowland areas below 1500 m.a.s.l. in which livestock rearing is the mainstay of people. Pastoralists keep large flocks of sheep and goats for subsistence, income, breeding, restoring wealth and social prestige for meat (Alemayehu Mengistu, 2002). The ranching production system is a range-based system of livestock production similar to the pastoral systems but with different production parameters, livestock functions and management. Ranching can be considered as a modern land use system. It is a labor-extensive system focusing on the production of marketable commodities (Solomon Abegaz, *et al.*, 2008). The Urban and peri-urban sheep production system is an emerging component of the livestock sector, based on intensive system which includes smallholder and operations around the major towns, mainly to generate income (Adugna Tolera *et al*., 2012).

2.3. Role of sheep in Ethiopia

In Ethiopia, Sheep production provides food, cash income and manure to the smallholder farmers, Smallholder farmers rear sheep mainly for two purposes: for cash income and slaughter for home consumption during festivals (Solomon Gizaw *et al.*, 2010). Sheep production in the crop/livestock production systems of the highland areas has a very important role in contributing to the food security as well as in generating direct cash income (ILRI, 2013). Nowadays, sheep provide meat in all parts of the country contributing towards human nutrition and the economic requirements of the communities. In addition, because of the diverse sheep genetic recourse is distributed in highland and lowland areas, they play an invaluable role in smallholder farmers by supplying dung, employment, rural nutrition, prestige and investment that is significant for livelihood of the poor people and especially the vulnerable groups in less developed countries like Ethiopia. Moreover, in Ethiopian economy, live animals, mutton and skins, as a commodity group contributes important foreign currency item (CSA, 2016).

Sheep and goat contribute 25% and 12% of the total annual meat production output respectively at the national level, sheep and goat account for about 90% of the live animal/meat and 92% of skin and hide (FAO, 2010). Small ruminants provide about 48% of the cash income generated by livestock production (Kassahun Birhanu, 2009) and sheep are also important foreign currency earners accounting for 34% of the live animal exports (ILRI, 2013). Moreover, sheep production provides an opportunity for smallholder farmers that requires low initial capital and is able to use the marginal land as well as crop residues for feeding; additionally, care-taking of sheep can be carried out by any family members (Tesfaye Getachew *et al*., 2010). Opportunity to increase meat production, because of their ability to succeed on locally available and low quality and quantity feeds as well as for possessing high reproductive performance (ESGPIP, 2011).

2.4. Constraints to sheep production

Previous studies reported that major constraints to sheep production in their order of importance were as follows; feed shortage particularly in the dry and wet seasons, disease problems associated with insufficient veterinary services, lack of improved genotypes which can thrive well in the environment and bring desirable characteristics such as good growth performance, desirable wool characteristics and body conformation which were lacking in the local sheep, lack of capital to restock and build up their flock size are the constraint of sheep production in different parts of Ethiopia (Kasahun Awgechew, 2008; Kassahun Birhanu, 2009 and Solomon Gizaw *et al*., 2008). Similarly Yayneshet Tesfaye (2010) reported that, the major constraint to livestock production in Ethiopia is the scarcity and fluctuating quality and quantity of the year round feed supply.

Productivity of sheep in small holder production systems is low, this is because the local sheep breeds grow slower reach sexual maturity at old ages and produce smaller carcasses (Markos Tibbo, 2006). In Ethiopia, most sheep are slaughtered at about 12 months of age with live weights of 18-20kg. Moreover, data collected on the carcass weight of various breeds of sheep showed low (10kg/sheep) productivity potential (ILRI, 2013). Local sheep are characterized by slow growth rate, able to breed throughout the year, adapted to live and produce under harsh environment, resistant/tolerant to disease, heat tolerant, ability to use poor quality feed, ability to survive on irregular supply of feed and water (Kassahun Birhanu, 2009).

2.5. Feed resources for sheep in Ethiopia

According to CSA (2016) the major feed source in Ethiopia are natural grazing, crop residues, improved pasture forage crops and agro-industrial by-products. The availability and utilization extent of feed resource by small ruminant depends on the type of agro-eco system, cropping patterns and intensity, prevailing animal production system, farmers livestock management practice (Solomon Gizaw *et al.*, 2010).

2.5.1 Natural pastures

Natural pasture are naturally occurring grasses, legumes, herbs, shrubs and trees foliage that are used as animal feed .Grazing land is major feed type in Ethiopia and cover 53.33% of total feed recourse (CSA, 2016). Reduction of grazing land in the high land mixing farming system due to expansion of cropping to meet subsistence needs of the ever increasing human population; explanation urbanization as the expense of grazing land; and poor management and utilization system (over grazing) leading to serious land degradation (Fekede Feyisa *et al*., 2011). When sufficient quantity of forage is available, sheep can meet their nutrient requirement from forage alone with supplemental source of salt and minerals. However, the availability of natural pasture does not support growth especially during the long dry seasons due to their poor quality and less availability. According to Merhun Lamaro (2012) natural pastures are deficient in energy, protein and minerals. Therefore, for optimum production supplementation with concentrate mixture or legume fodder is important for sheep grazing on natural pasture.

2.5.2 Crop residues

Crop residues are includes harvested by-products (straw and chaff of cereals and pulses, etc.) widely used in animal feeding next to grazing, that cover 31.29%. Their use for winter or dry season feeding of livestock is long established and wide spread (CSA, 2016). The residue of cereal crops are poor quality roughage feed with 5-8% protein content and very low digestibility and they are unable to provide even the maintenance requirements of sheep and goats unless they are supplemented or treated in some way to increase the supply of protein to the animal (McDonald *et al*., 2002). Straw and other fibrous by-products are inevitably produced during cereal production. They have traditionally been used for many purposes including feeding animals. They are good sources of basal feed for ruminants in developing countries and are more important than cultivated forages because of the competition for land for human food production (Abebe Hailu *et al*., 2011).

According to McDonald *et al*. (2010), the crude protein content of the dry matter of both straws is low. The major component of the dry matter is the fiber, which contains a relatively high proportion of lignin. The dry matter of straw consists of about 400–450 g/kg of cellulose, 300–500 g/kg of hemicellulose and 80–120 g/kg of lignin. Degradability of the protein is relatively low and of the un degradable protein much is likely to be indigestible.

In cereal production, to date interest has centered mainly on grain quantity and quality. Straw value has received little attention, but there is currently worldwide interest in utilizing low quality roughages as feed for animals by upgrading their nutritive value (Alemayehu Mengistu, 2006). Straws consist of stems and leaves of plants after the removal of the ripe seeds by threshing and are produced from most cereal crops and from some legumes. (Kassahun Berhanu, 2009). Despite various limitations, crop residues provide the majority of the feed consumed by ruminant animals. When ruminants are given low quality forages, low voluntary feed intake is recognized as one of the most important constraints to animal performance. Thus, supplementation with nitrogen source feeds or treatments with alkali are effective in increasing intake and digestibility of low quality forages (McDonald *et al*., 2002)

2.5.3 Agro-industrial byproducts

Agro-Industrial by-products that are produced from food processing plants including oil seed by-product and grain by-product are now considered valuable livestock feeds (Ensiminger *et al.*, 2002). Agro industrial by products are like oil cake (rapeseed cake, nueg cake, sunflower cake, etc.), bran, and brewery residue, which cover 1.37% 0f total feed sources (CSA, 2016). They are feeds of high energy, protein, some minerals and vitamins, which are important in ruminant rations to supplement other low quality feeds particularly roughages and they contained less fiber and are generally of better in nutrient content as compared to crop residue and other roughages ((Ensiminger *et al*., 2002).

2.5.3.1 Oil seed cake

Oil seed cakes are the residues or cakes that are produced as by-products during extraction of oil from oilseeds. Noug (*Guizotia abyssinica*) seed is one of the major oilseeds grown in Ethiopia. Moreover, they are the relatively easily available concentrate feed found throughout most part of Ethiopia and can be satisfactorily used as a high protein feed if needed. Most of the noug seed is produced in the western parts of the country, particularly western Oromia and Amhara regions (Adugna Tolera, 2008). According to Abebaw Nega (2009) One of the most common agro-industrial by-products produced and used widely in Ethiopia is noug seed (Guizotia abyssinica) meal (NSM). The CP content of noug seed cake was found to be 31.1-34.9% (Worknesh Seid, 2014).

2.5.3.2. Wheat bran

Wheat bran is the coarse outer covering of the wheat kernel as separated from cleaned and scoured wheat in the usual process of commercial milling and the most common milling by product used for livestock feeding in Ethiopia (Adugna Tolera, 2008). The fiber and metabolizable energy contents of wheat bran vary slightly depending on the specification of the wheat milling and processing method. These factors affect the overall blend of bran components. It is the most popular, important livestock feeds and a good source of energy, protein, phosphorus, and vitamins (Ensiminger, 2002). Dereje Worku (2015) and Dereje Tadesse (2015) reported 91.4 14.2 and 17.9 CP; content of WB, respectively.

2.5.4 Improved forage

According to CSA (2016) improved forage is produced in very small amount (only 0.28 percent) and has less contribution as feed source. Cultivated fodder crops such as oats, vetch, alfalfa, and fodder beet are not well developed, Shortage of land in the mixed crop-livestock agriculture, technical problems such as planting and managing the seedlings, insect damage and low interest of farmers were some of the reported reasons for poor adoption of improved forage production

(Yeshmbel Mekuriyaw *et al*., 2012). Therefore, it is better looking for other feed recourse locally available, adaptable to the environment and ever green like bamboo leaf.

2.5.5 Non-conventional feed resource

Non-conventional feed resources refer to all those feeds that have not been traditionally used in animal feeding and/or are not normally used in commercially produced rations for livestock. Whereas the traditional feeds of crop origin tend to be mainly from annual crops, the non-conventional feed resources include commonly, a variety of feeds from perennial crops and feeds of animals and industrial origin. Examples of these feed sources are brewery grain, oil palm by-products, single-cell proteins, feed materials of plant and animal origin (e.g. poultry excreta), and poor quality cellulosic roughages from farm residues such as stubbles, haulms and vines (Aschalew Deribe , 2015).

Other agro-industrial by-products also exist such as slaughter-house by-products (e.g. feather meal) and those from the processing of sugar, cereal grains, citrus fruits and vegetables for human consumption. Non-conventional feed resources also include feeds like residues of local drinks coffee, *areke*, *tela chat* left over called *geraba,* fruits and vegetables reject (Yeshitila Admasu, 2008)

The importance of these feeds depends on the method of utilization because of their poorness in essential nutrients and the bioavailability of these nutrients contained in non-conventional feed resources could be improved by supplementation and treatment. A given feed stuff which is traditional in one country may be non-conventional in the other country (Aschalew Assefa *et al*., 2014).

2.6. Nutritional requirement of sheep

Energy, protein, minerals, vitamins and water are the main nutrients required by sheep. The nutrient requirements are the values considered necessary for maintenance, optimum production, and prevention of any signs of nutritional deficiency (NRC, 1981). Nutrient requirement of sheep depend on their physiological state and function and contain allowance for maintenance and production. The intake of nutritionally adequate feeds increases with animal size (growth), but it is not maintained at the same proportion of live weight. The larger animals, the more feed intake to maintain its body functions and production (Ensminger, 2002).

Energy requirements of ruminants mostly come from the fermentation of fibrous carbohydrates in the rumen and the rest comes from starch, fats and excess protein. The availability of energy is the main limiting factor in animal production for an efficient utilization of resources and for the achievement of acceptable levels of animal performance (Lachica and Aguilera, 2005). The daily maintenance requirements may range from 50 to 100% of total daily nutrient requirements, depending on whether the animal is also growing, lactating, gestating or fattening (Pinkerton, 2000). The major sources of energy for sheep are from pasture, hays, silage, by-product feeds, and grains. Energy deficiencies result in reduced growth or weight loss, reduced reproductive efficiency, reduction in resistance to infectious disease and parasites and increased mortality (Ensminger 2002).According to NRC (1981), a daily energy requirement for 20 kg sheep for maintenance is 1.17 Mcal DE. Also Alemu Yami, (2008) energy is the most limiting nutrient, limits performance more often than any other nutrient deficiency. The lowest energy level at which the sheep do not lose weight is between 8 and 10 MJ ME/kg DM.

The minimum protein level required for maintenance is about7% to 8% CP in the DM, and the most productive animals such as rapidly growing lambs and lactating ewes need about 11% CP (McDonald *et al*., 2002). Protein requirement for 20 kg growing lamb live weight gaining 0, 50, 100, and 150g/day is 21, 47, 61, and 76 g per day with daily DM intake of 0.837kg/day (McDonald *et al*., 2002). The same source reported that the CP requirements for growing and fattening lambs with 20 and 10 kg BW are 85 and 127g, respectively. The protein requirement of growing sheep is affected by growth, weight, age, body condition, rate of gain and protein to energy ratio. Protein deficiency is characterized by reduced appetite, lower feed intake, and poor feed efficiency (Ensminger 2002). Ensminger (2002) also documented that sheep with 10-20 kg body weight having moderate and rapid growth potential require 26.2-16.9% CP on DM based diet. Animal at a younger age also reduces the amount of protein required for body tissue accretion. Poor body condition animals require protein rich feeds to compensate for their growt.

Table 2.6. Energy and protein requirements of sheep for growth

Nutrient	Live weight (kg)	Gain (g/day)			Calculated requirement per kg $W^{0.75}$	
		0	50	100	Maintenance	For 1 g gain
ME (MJ/day)	20	4.1	5.1	6.2	0.43	0.02
	30	5.6	7.0	8.5	0.44	0.03
	40	7.0	8.7	10.7	0.44	0.04
Protein (g/day)	20	30	40	60	3.17	0.30
	30	45	55	65	4.76	0.20
	40	45	70	85	2.83	0.40

Source: ARC (1980).

2.7. Finger millet

Finger millet (*Eleusine coracana*) is a small seeded cereal grown in low rain fall areas of the semi-arid tropics of the world under rain fed conditions. It is hardy crop capable of providing reasonable grain yield under circumstances where other crops give negligible yield (Tafere Mulualem and Adane Melak, 2013). Also millet is a cereal crop grown in most parts of Ethiopia from mid to high altitude. This crop is endemic to Ethiopia grown for the grain and the straw (ICRISAT, 2014). In Ethiopia, finger millet is currently grown on more than 431,506 ha, from which 742,297 tons is harvested (ICRISAT, 2014). The Ethiopian agricultural crop production sub-sector is complex involving considerable in crops grown across the country's different regions and agro-ecologies. Cereals like finger millet are the core of Ethiopia's agriculture and food security accounting for about three-quarters of total area cultivated, 29% of the agricultural GDP (14% of the total GDP) and 64% of the calories consumed (IBC, 2012). CSA (2016) reported the total production of Production of finger millet in Benshangul Gumuz is estimated 518,245 quntal per year of these the utilization of finger millet as animal feed is 0.49%.

Finger millet (*Eleucine coracana*) commonly known as Raji or Mandua in India and is a staple food crop and contains 9.2% protein, 1.29% fat, 76.32% carbohydrate, 2.24% minerals and 3.90% ash and it is a good source of vitamin A and B (Rathore, 2001). The green straw of the crop is suitable for making silage. Millet grain has nutritive value very similar to that of oats, and contains high indigestible fiber owing to the presence of hulls, which are not removed by ordinary harvesting method (McDonald *et al.*, 2010). According to Tafere Mulualem and Adane Melak (2013) finger millet is indeed a versatile crop for the people of Benishangul gumuz in Ethiopia. They used finger millet for making Injera, Genfo, Kitaand cultural drinks such as Areqi, Borde and Tella.

In the area finger millet has also played a significant role in the feeding system of livestock. Most farmers used finger millet residue (straw) for animal feed which accounts 69% which is regarded benefits for farmers without expenses for their cattle **(**CSA, 2016). In local community they feed residue of finger millet straw without any treatment because of this they produce poor productive animal (AsARC un published).Human population growth in Ethiopia is forcing the conversion of many former grazing areas into croplands needed for increased food production.

2.7.1. Characteristics of millet straw and its use as animal feed

Finger millet straw could be characterized by its low and high NDF and ADF contents. Melese Gashu *et al*. (2014) and Almaz Ayenew *et al*. (2012) reported that Finger millet straw contains 93% and 92.4% DM, 88 % and 92.1% OM, 12% and 7.9% ash, 4.3% and 3.5% CP, 68.8% and73.1% NDF, 40.2% and 45.8 % ADF and 15.2% 7.6% ADL respectively. The low CP content indicating that maximal livestock performance cannot be achieved on finger millet straw alone, even if the production requirements of animals are low. Thus, finger millet straw need to be supplemented with energy, protein, mineral and vitamins depending on the nutrient needs as influenced by the production phase (growing, finishing lambs or replacement ewes) of livestock (Almaz Ayenew *et al*, 2012).

2.8. Bamboo leaf

The total area of bamboo in Ethiopia is estimated about 1 million hectares, which is equivalent to 7% percent of the world and 67 % of the African bamboo forest area. And the lowland bamboo forest of Ethiopia is cover about 85% of the total bamboo forest of the country. the rest 15 % is cover by highland bamboo forest (kasahun embaye *et al.*, 2005).

Benishangul-Gumuz has 440, 000 hectares of Shimal bamboo (*Oxytenanthera abyssinica*) of this the study area asossa covered 77,947 hectares of low land bamboo. Mainly used for subsistence uses such as housing, fencing, kitchen utensils, and agricultural implements and shoots for food for use in traditional houses. (CSA, 2007 and INBAR, 2010). Lowland bamboo is mainly used for income generation, construction and fences and present study revealed the economic importance of bamboo, which is capable of generating employment as off-farm activities for rural poor, skilled and semi-skilled farmers, particularly in the highland area where the bamboo species is suitable for making different handicrafts.(INBAR 2010 and Yeshmbel Mekuriaw *et al.*, 2012)

This increased the utilization of bamboo as animal feed, since it is drought resistant and evergreen plant throughout the dry season providing green forage to ruminants. Farmers use bamboo as forage for livestock for almost more than seven and ten months of the year in the highland and lowland districts, respectively depending on the length of the dry period throughout the year. (Denbeshu Debeko, 2010 and Yeshambel Mekuriaw *et al*., 2012)

According to yeshambel Mekuriaw *et al.* (2012), Age of plant is one important factor affecting nutritional quality of feed. Nutrient composition of bamboo decreases with age due to declining physiological function after the age of 3–4 years. Foliage biomass will increase with age, but the leaf become tough and difficult to be consumed by animals. Selection of age of bamboo culms for foliage collection is based on the foliage biomass and the quality of the culm for other purposes. Although the most preferred age of bamboo feeding is at shoot stage, between one and three years of age of the plant. This is low leaf area of culms (<1 year old).

2.8.1. Chemical composition and nutritive value of bamboo leaf

Bamboo is one of the most important renewable natural resources to provide protein-rich fodder for ruminants during the dry season. From the proximate analysis, the major components of bamboo leaves are: carbohydrates, protein and crude fiber; the three together constitute over 75% of the leaves. Bamboo leaves are a good source of carbohydrates or energy. The relatively high crude fiber content of these bamboo leaves (that is, 25.88 to 33.19%) suggests that animals will prefer them less to alternatives that have lower crude fiber (Okaraonye and Ikewuchi, 2009).

In Ethiopia bamboos are very good sources of livestock feed, especially during the dry and prolonged dry season (Embaye 2003 and Denbeshu Debeko, 2010). Bamboo leaves could be an excellent supplement to poor quality roughage feeds since they have moderate to high CP content (18-22% CP) (Eyob Gebreziabhear 2016), But Yeshambel Mekuriyaw *et al*., (2012), reported that bamboo foliage cannot be used as a supplement feed, because of its similarity to that of low-quality grass hay in terms of feeding value. The same source also recommend conservation and processing of bamboo leaf could enhance the feeding values of bamboo foliage.

2.9. Feed treatment methods

Feeding only straw does not provide enough nutrients to the ruminants to maintain high production levels due to the low nutritive value of this highly lignified material. The high level of lignification, the slow and limited ruminal degradation of the carbohydrates and the low content of nitrogen are the main deficiencies of straw, affecting its value as feed for ruminants (Van Soest, 1994). Wanapat *et al*. (2009) reported that treating straw with urea or calcium hydroxide or by supplementing straw with protein, intake and degradability can be enhanced, compared to feeding untreated straw.

Techniques such as urea treatment, chopping and mixing with high quality forages can improve the intake and dietary quality of crop residues significantly (Alemayehu Mengistu, 2005). In addition, numerous methods of physical, chemical and biological treatments have been investigated, including supplementation with other feed stuffs or components in order to improve the utilization of straw by ruminants (C. Sarnklong *et al*., 2010**).**

2.9.1. Physical treatment methods

Crop residues can be ground, soaked, pelleted or chopped to reduce particle size or can be treated with steam or X-rays or pressure cooked. (C. Sarnklong *et al.,* 2010). Authors observed that grinding and pelleting of grass hay decreased dry matter degradability in cows from 73 to 67%, which was mainly due to a decreased fermentation rate (9.4-5.1%/h) and decreased total retention time of the solids from 73 to 54 hours, resulting in an increased intake (Stensig *et al.*, 1994). C. Sarnklong *et al.,* 2010reported that the use of steam treatment in a high pressure vessel at different pressures and for a range of different treatment times increased the degradation *invitro* in rumen fluid after 24 h and the rate of degradation, but could not enhance the potential degradability of the fibrous fractions (NDF, ADF and hemicellulose).

2.9.2. Chemical treatment method

Chemicals to improve the utilization of different straw may be alkaline, acidic or oxidative agents. Among these, alkali agents have been most widely investigated and practically accepted for application on farms. Basically, these alkali agents can be absorbed into the cell wall and chemically break down the ester bonds between lignin and hemicellulose and cellulose, and physically make the structural fibers swollen (Chenost and Kayouli, 1997; Lam *et al*., 2001).Urea chemical treatments appear to be the most practical for use on-farm, as no expensive machinery is required, the chemicals are relatively cheap and the procedures to use them are relatively simple. However, the chemicals themselves are not harmless and safety precautions are needed for their use (Sundstøl and Coxworth, 1984 and C. Sarnklong *et al*., 2010).

Straw can also be treated with urea, which releases ammonia after dissolving in water. (Schiere and Ibrahim, 1989).As urine contains urea, urine can be used as a source of urea and ammonia to improve the quality of straw. Urine can be sprayed on the straw in a similar way as is done with urea solutions (Dias da Silva, 1993) and can provide a nearly equal improvement of the Degradability. Urea is a solid chemical, easy to handle and transport (Sundstøl and Coxworth, 1984), and urea can be obtained easily in many developing countries. In addition, urea is considerably cheaper than NaOH or NH3. Vadiveloo (2003) reported that straw varieties with a low degradability responded better to urea treatments than higher quality straw, increasing the *in vitro* dry matter degradability from 45 to 55-62%. Urea treatment may therefore be most suitable for small-scale farmers to improve the quality of straws, particularly varieties showing a low degradability with or without additional supplementation (Ibrahim and Schiere 1986). Ibrahim and Schiere (1986), have not observed the increase in digestibility of the treated matter that could have been expected with an increased dosage of applied urea.

The recommend use, in practice, of threshold dosages of urea of 4 kg for 100 kg of straw ,the amount of water of straw varies from as low as 0.2 litter per kg of straw to as high as 1 litter per kg (Chenost ,1995), because higher dosages have not proved that they could improve the treatment. Treatments can done in pits using polyethylene sheet in the inner linings, airtight the plastic sheet during treatment period, Polyethylene sheet is very effective for excluding air (Sundstøl and Coxworth, 1984). Chenost (1995), Lam *et al*. (2001) and C. Sarnklong *et al*. (2010) reported that the presence of urease, moisture, temperature, application rate, type and quality of straw are the major factor affecting urea treatment methods.

Lam *et al*. (2001), reported the best assessment of treatment efficiency is of course the animal's response in terms of intake and performances. However first and simplest criterion of a successful treatment is the physical aspect of the treated roughage: (a) marked change of color from clear yellow to brown or dark brown (dark yellow is not enough), (b) strong but good ammonia smell without any trace of bad fermentation, (c) smooth texture of the straw or the stalks which become easy to twist and to bend, (d) absence of any mould.

2.9.3. Biological treatment

The use of fungi and/or their enzymes that metabolize lignocelluloses is a potential biological treatment to improve the nutritional value of straw by selective delignification the (C. Sarnklong *et al*., 2010). Nevertheless, it is currently too early to apply this method in developing countries due to the difficulties and lack of technology to produce large quantities of fungi or their enzymes to meet the requirements. There are also a number of serious problems to consider and overcome (Ibrahim and Schiere, 1989)

2.10. Urea and molasses treatment

Treatment can increase digestibility of fibrous feeds. The key to improving the use of crop residues for ruminants is to overcome their inherent barriers to rumen microbial fermentation (Sharma *et al.*, 1995). Also it increases feed intake and productivity of animal, this treated feed resource is rich in nutrients like carbohydrates, proteins and minerals (FAO, 2010).

Urea is not a protein supplement, but source of non-protein nitrogen (NPN) for microbial protein synthesis in the rumen, is a chemical best known for fertilizer containing 46 percent of non-protein nitrogen. It is widely used to generate ammonia for improving poor quality fibrous feeds. This is because of its relatively easy availability compared with other chemicals used for treatment of crop residues, lower effect on environmental pollution, its added value of nitrogen over other alkalis like sodium hydroxide for rumen microorganisms and ease of application (Ibrahim and Schiere, 1989). Supplementation with urea can correct shortage of rumen degradable nitrogen in many fibrous crop residues, so urea treatment improved straw use efficiency. As a result of this, treated straw can be economically fed for longer periods of time, and hence it reduces feed shortage problems (Hirut Yirga *et al.*, 2011)..

Urea treatment increased CP content of straw from 3.5 to 14.9% and improved the digestibility of the straw and higher significance difference for CP content in urea treated than untreated straw. However, no significant changes for crude fiber nor other fiber fractions, and no change for gross energy were observed between the urea treated and untreated straw. Urea treatment also increased both *in vitro* OM digestibility (IVOMD), and *in sacco* DM and OM degradability after 48 hr incubation in the rumen (McDonald *et al.*, 2010). The processes are influenced by moisture content, ambient temperature, treatment duration, application rates, straw quality and type, and presence of urease (C. Sarnklong *et al*., 2010).

Moisture dosage of urea used, ambient temperature, type of straw, duration of treatment and their interaction affect the activities of ureolytic bacteria and hence determine the effectiveness of the treatment. According to the authors, the optimum dosage of urea required per 100 kg of air dry straw ranges from 4.5 to 6.2 kg at moisture level of 12-50% resulting in improved straw *in vitro* organic matter digestibility (IVOMD) (Chenost ,1995).

Temperature and duration of treatment are also important factors to the success of urea treatment. At high temperature, chemical reaction occurs rapidly and stimulates the dissociation of more ammonia gas. Different duration of treatment time for different ambient temperature (4 8 weeks at 5-15 ^{o}C; 1-4 weeks at 15-30 ^{o}C; <1 week, at > 30 ^{o}C). Thus, the inputs needed for effective urea treatment should not follow blanket recommendation, as this is mainly influenced by the environmental conditions under which the treatment is carried out (Sundstøl and Coxworth, 1984).

2.11. Effect of urea molasses treated feed

2.11.1. Intake

Quality of the feed determines the voluntary intake of the animals. The higher the quality of the feed offered to the animal, the higher will be the intake and performance with animal on the diet (Cheeke, 1991). Urea treatment increase acceptability and voluntary intake of the treated straws as compared to untreated straws by 25-50% when it is made on a free choice basis (Smith *et al*., 1989; Manyuchi *et al*., 1994). Depression in the voluntary intake of straws is observed mainly due to poor palatability low nitrogen and high NDF content (Preston and Leng, 1987)

Treatment improves the nutritive value of crop residues in several ways. Generally, it increases the nitrogen content of crop residues and increase intake and also improves palatability of these feed materials and that maximizing feed intake is critical to increase animals' performance (McDonald *et al.*, 2002). The low protein status of poor quality roughage limits voluntary intake in ruminants. Treatment of roughages adds more nutrients (N) to the rumen microbes. This may reduce the rumen retention time by increasing the outflow rate and stimulating the intake (Abdulrazak *et al.,* 2005). Those protein and energy are the most important components of diets that are required in greater quantities by animals. Thus, when ruminants are offered with un-treated low quality roughage, there will be decreased voluntary intake loss in body weight because of inability to meet both energy and protein requirements (McDonald *et al.* 2010).

2.11.2. Digestibility

Digestibility of feeds refers to the percentage of the whole feed or any single nutrient in the feed, which is not excreted and thus assumed to be available to animal for absorption from the gastro intestinal tract. Digestibility of a feed is determined largely by chemical composition of the feed. For instance, the digestibility of one feed is believed to be different from that of a similar feed because each feed may contain different chemical entities some of these constituents diminish the opportunity for the digestive enzymes to be exposed to their respective substrates (Khan *et al*., 2003).

Urea treatment of poor quality roughages increases the nitrogen content of the stover or straws (Smith *et al*., 1989; Manyuchi *et al*., 1994). The effect of urea treatment is to increase digestibility often by 5-10% units, to increase the nitrogen content of the straw Masimbiti, (2001) reported that urea treatment increase the digestibility of low quality roughages through its effects on plant cell walls and increase *in vitro* DM digestibility, and higher digestibility indicates the effectiveness of the treatment process proper treatment of straw with ammonia increased OM digestibility and nitrogen content by 10-12 percentage and 0.8-1.0 units, respectevily (Sundstøl and Coxworth 1984).

Protein deficiency is a constraint of practical significance in limiting animals' productivity ,that maximization of livestock productivity in the tropics largely depends up on the efficiency of utilization of local protein resources, as protein supplementation tends to improve the digestibility of diets consumed (Allen and Bradford, 2009).

The primary chemical composition of feeds that determines the rate of digestion is neutral detergent fiber (NDF), which is itself a measure of cell-wall content; thus there is a negative relationship between the NDF content of feeds and the rate at which they are digested (McDonald *et al*., 2002). Low NDF content 20-30% has been shown to result in high digestibility, while lignification of the plant cell wall decreases the digestibility of plant material in the rumen. Van Soest (1994) mentioned that consumption of low quality diets would be determined by the digestibility of their components. Digestibility of a feed is influenced not only by its composition, but also by the composition of others feeds consumed with it.

2.11.3. Weight gain

Nutrition is one of the environmental factors that affect live weight gain, but the degree of response varies with breed type. When feed is sufficiently available, all tissue of the body will receive sufficient nutrients for maintenance, normal growth and fattening. FAO (2002) reported that urea treated straw improved feed intake, animal performance and feed utilization efficiency as compared to untreated straw. When ruminants are offered with un-treated low quality roughage, they lost their body weight because of their inability to meet both the energy and protein requirements (McDonald *et al*., 2010). Nutrition is perhaps the most important consideration in livestock management as it has much influence on growth rate and body composition (Sayed A.B.N. 2009). Young animals fed high concentrate diets generally have higher daily BW gains, dressing percentage and carcass quality than those fed poor quality roughages (Kosum *et al*., 2003). Inadequate nutrition, particularly protein and energy are the main nutritional factors limiting the productivity of sheep (Adugna Tolera *et al.*, 2000). Increasing protein and energy levels in the diet improves average daily BW gain and feed conversion efficiency of animals (Ebrahimi, *et al*., 2007).

2.12. Carcass characteristics of sheep

Fat is deposited only if surplus nutrients are available, the more fat is deposited in lambs at any given age and body weight. The aim of controlling growth is to maximize lean tissue deposition, it is essential that the animal's protein supply should be optimal (McDonald *et al.,* 2010). Carcass represent the remaining parts after the animal has been slaughtered and bled out without skin, feet, head, internal organs, digestive tracts, udder and sexual organs (Gautsch *et al*., 1986). Carcass is made up of various proportions of muscle, bone and fat and that eventually to be sold as joint or steaks. The weight of carcass in relation to the weight of the live animal is, therefore, an important measurement of meat yield (Warriss, 2000). The rate of growth and yield of carcass determine the value of farm animal for meat production. However, nutrition has much influence on growth rate and body composition of animals. Carcass weight depends on the rate of gain, weight at slaughter and dressing percentage of the animals (Rahman, 2007).

2.12.1. Hot carcass weight

The rate of growth and yield of carcass determine the value of farm animal for meat production. However, nutrition has much influence on growth rate and body composition of animals. Carcass weight depends on the rate of gain, weight at slaughter and dressing percentage of the animals (Rahman, 2007).

Hot carcass represents the portion of the animal which is left after the removal of the head, skin, feet and viscera. The main important factors used for the evaluation of carcass, regardless of species include; hot carcass weight, dressing percentage, carcass conformation and composition Khan *et al*., (2003). Hot carcass weight (immediately after slaughter) is the best estimate, but for commercial purposes cold carcass weight (24 hours post mortem) is more useful. Carcass shrinkage varies with different classes of livestock and the loss is influenced by storage conditions (Khan *et al.*, 2003 and Parish *et al*., 2009).

2.12.2. Dressing percentage

Dressing percentage is an important trait in carcass merit evaluation and affected by; age, sex, castration, and plane of nutrition (Pond *et al.*, 1995), amount of gut fill at slaughter and whether the carcass is weighed hot or cold. Young animals fed high concentrate diets generally have higher daily body weight gains, dressing percentage and carcass quality than those fed poor quality roughages (Kosum *et al*., 2003). Moreover, dressing percentage varies widely between breeds, sex and management condition (Warriss, 2000). Differences in the weight of the hide, head, feet and internal organs can also impact dressing percentage. The largest variation in dressing percentage is associated with the gut fill.

2.12.3. Rib eye muscle area

The loin is one of the most expensive carcass cuts and consumers prefer loins that possess a large longismus dorsi cross sectional area (rib eye muscle area) which accounts for 25% of the points allocated in one of the scoring systems. In this system the circumference of the cut surface of the longismus dorsi (rib eye) muscle and of the fat around it between the 12^{th} and 13^{th} ribs on the right side of each carcass is traced and the traced area of the muscle is then measured with a Plano meter (Khan *et al*., 2003).

The rib eye muscle area is directly related to the amount of muscle in the carcass, especially in the loin and around and is considered as an indicator of muscle development and yield of high valuable cuts (Williams, 2002). However, Shahjalal *et al.,* (2000) reported that lower and higher level of protein supplementation did not affect the rib-eye area of the sheep.

3. MATERIALS AND METHODS

3.1. Description of the study area

The research was conducted in Benishangul Gumuze Regional State, at Asossa Agricultural TVET College Campus. Geographically, the study site located at 10^0 02' 05'' N and 34^0 34' 09.9'' E with altitudes 1580 meters above sea level. The study area is situated east of Assosa town and west of Addis Ababa about 14 km and 653 km distance, respectively. The area has annual rainfall of about 1275 mm (AsARC, 2011).

3.2. Experimental animals and their management

Twenty intact male yearling local sheep with initial body weight of 21.6 ± 1.3 kg (mean ± SD) were used in the experiment. The animals were bought from local market in Assosa. Their age was determined by dentition and asking the owner of the animals. The animals were quarantined for fifteen days to get them used to their new environment and to observe their health condition. Moreover, they were vaccinated against foot and mouth disease. The animal were dewormed with albendazole (300 mg/sheep) for 7 day to control and prevention of internal parasite, sprayed to external parasite during the quarantine period with the consultation of veterinarian for the disease prevalence in the area.

At the end of the quarantine period, the animals were ear tagged for identification purpose, and blocked into five block of four animals based on initial live weight and randomly assigned to one of the treatment. The animals were individually penned and pens were equipped with feeding trough, plastic buckets for supplements and watering trough separately. They were adapted on the experimental diet for 15 days before beginning of the data collection.

3.3. Experimental feed preparation and feeding

3.3.1. Urea molasses treatment of finger millet straw and dried lowland bamboo leaf

Finger Millet (*Eleusine coracana*) straw was collected from the area surrounding Assosa district and molasses was purchased from Bahirdar city and transported to Assosa agricultural collage. Lowland bamboo (*Oxythenanthera abyssinica*) leaf was collected from Assosa ATVET college and area around college, and the fresh biomass was air dried until the required moisture content was attended. The collected finger millet straw and lowland bamboo leaf were stored properly on the college farm and was treated with urea molasses solution and put to plastic bags to take place natural fermentation process.

Plastic bag was prepared for finger millet straw and lowland bamboo leaf ensiling purpose. The volume of the bag was determined by assuming the estimated total finger millet straw and dried lowland bamboo leaf consumption over the experimental period. The finger millet straw and lowland bamboo leaf hay were treated with a urea molasses solution prepared from 40 g of urea per kg of straw dissolving it in 800 ml of water then 100 ml molasses was added in the solution of urea and it was stirred well (Ibrahim and Schiere, 1989). A uniform spray of urea molasses solution was applied for weighed finger millet straw and dried lowland bamboo leaf over the ground plastic sheet batch by batch. the straw and leaf was treated and compacted until filled to the bag capacity. Finally, the bag was made airtight then, left unopened for twenty-one days. By the end of treatment period, the plastic bag was opened and a portion of the finger millet straw and lowland bamboo leaf hay were taken daily and ventilated overnight to remove residual ammonia before offering to the animals. Treated finger millet straw and lowland bamboo leaf were fed *ad libitum*. Water and salt was given *ad libitum* for all experimental animal thought the experimental period. Wheat bran + noug seed meal on 50% with both on DM basis (150g DM/day) was given for all experimental animal two times a day (08:00 and 10:00).

3.4. Treatments and experimental design

The twenty sheep were randomly assigned to five blocks of four animals based on their initial live weight. The experimental design used was Randomized Complete Block Design (RCBD) with four treatments and five replications. The four treatments are indicated in table 3.4.

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Table 3.4. Treatment arrangement

Treatments	Feed type
T1	Untreated finger millet straw + 150g CM. (75g WB & 75g NSC)
T2	Untreated lowland bamboo leaf hay+ 150g CM. (75g WB & 75g NSC)
T3	Urea molasses treated millet straw + 150g CM. (75g WB & 75g NSC)
T4	Urea molasses treated lowland bamboo leaf hay+ 150g CM. (75g WB & 75g NSC)

CM=concentrate mixture, NSC= Noug seed cake, WB= Wheat bran.

3.5. Measurements

3.5.1. Feed Intake

After an acclimatization period of 15 days and digestibility trial, the feeding trial was conducted for 90 days. Daily feed offered to the experimental animals and the corresponding refusals of every treatment was recorded and measured by using sensitive balance during the experimentation period to determine daily feed intake. Samples feed offered were taken from batches of feeds and that of refusals were collected over the experimental period for each animal and finally analysis for each animal.

Daily feed intake of individual animal was calculated as following: Feed intake (g) = Amount of feed offered (g) – Amount of feed refused (g). The metabolize energy (ME) intake of experimental animals were estimated from its digestible organic matter intake (DOMI) by using the formula, ME (MJ/kg DM) = DOMI × 0.0157, Where, DOMI = g digestible OM/ kg DM (AFRC, 1993 as cited by Solomon *et al.*, 2004).

3.5.2. Digestibility

The digestibility trial was conducted before feeding trial. All experimental animals were fitted with fecal collection bags for three adaptation days, after adaptation day collection of feces was gone for seven days. Feces collected in the fecal bags was weighed, recorded and sampled for each animal every day in the morning. Twenty percent of the daily feces was sampled in plastic bags and was stored at -20 ^{o}C. After seventh days samples withdraw from freeze and dried at 60 ^{o}C for 72 hours and thawed and thoroughly mixed. Sub-sampled were taken and sent to Debre Birhan research center laboratory for chemical analysis of feed. Apparent digestibility percentage of DM, CP, Ash, NDF and ADF was determined using the following formula (McDonald *et al.*, 2002).

$$\text{Apparent nutrient digestibility} = \frac{\text{Nutrient intake} - \text{Nutrient excreted in feaces}}{\text{Nutrient intake}} * 100$$

3.5.3. Live weight gain

Initial and final body weight of the animals was measured at the beginning of the experiment after fasting period (overnight). To determine the weight change, live weight of each animal was taken at every 10 days in the morning before the daily feed is offered by using balance. Weight gain was calculated as the difference between final and initial body weight of sheep divided by number of experimental day. Feed conversion efficiency (FCE) of the animal was determined as the proportion of daily weighed gain to the total DM intake. Mean daily body weight change was calculated as;

$$\text{ADG (kg/d)} = \frac{\text{Final body weight(Kg)} - \text{Initial live weight (Kg)}}{\text{No. of feeding days}}$$

3.5.4. Carcass characteristics

After feeding trial all sheep from each treatment were slaughtered to study the carcass characteristics. Sheep are fasted overnight and the sheep were weighed and the weight was recorded as slaughter weight. On slaughtering the blood was collected in a container and weighted. The animals were then suspended with head down. The head was detached from the body and weighed. The skin was flayed and weighted with legs below the fetlock joints. The entire gastro-intestinal tract was removed with contents and weighted, then after removing the gut content. Then the viscera to divide into four sections namely esophagus, reticulo-rumen, omasum and abomasum, small and large intestine and was weighted, and then the weight of empty gut was calculated by difference and recorded.

Internal organs (lung with trachea, heart, liver with gall bladder, kidney, urinary bladder, spleen, esophagus, penis, testis, and tail) was removed and measured separately. Abdominal and internal fat depositions surrounding the stomach (channel fat) were removed and weighted. Weight of genital fat was also recorded. Finally the hot carcass weight was measured and recorded after removal of the offal components. The rib eye area of muscle was traced on the graph paper between the 12th and 13th rib of the right half carcass and the area was measured (Khan *et al*., 2003). Total edible offal component were taken as the sum of heart, tongue, small intestine, liver, blood, fat tail, empty gut, tail, small and large intestine, reticulo-rumen, omasum and abomasum, tongue, testis, kidney and fat (mesenteric, pelvic and kidney). Non-edible offal component were taken as the sum of head without tongue, penis, urinary bladder, lungs with trachea, esophagus, spleen, feet, skin, genital organs, gall bladder and gut fill. Total edible products were taken as the sum of total edible offal components and hot carcass weight. Dressing percentage was calculated as proportion of hot carcass weight to slaughter weight.

$$\text{Dressing percentage based on SW} = \left(\frac{\text{Hot carcass weight(Kg)}}{\text{Slaughter weight(Kg)}}\right)*100$$

3.6. Chemical analysis of experimental feed

Samples of feed offered and refusal such as UFMS, TFMS, ULBLH, TLBLH was collected daily from each treatment were analyzed for DM, Ash, CP, NDF, ADF, ADL at Debrebirhan Agricultural Research Center. The DM, OM and Ash were determined according to AOAC (1990). CP content was measured by the Kjeldahl method as N*6.25. The content of NDF, ADL and ADF was determined according to Van Soest and Robertson (1985).

3.7. Data analysis

Data were analyzed by using General Linear Model (GLM) procedure of Statistical Analysis System (SAS) version 2003 software. Treatment mean was calculated to determine correlation coefficients for the body weight, feed intake and digestibility. The association between nutrient intake, digestibility and body weight gain was tested by using correlation analysis. When the differences in treatment means was significant at the probability level of $P < 0.05$, the mean was separated using by Duncan's multiple range tests.

The statistical model used was:

$Y_{ij} = \mu + T_i + B_j + E_{ji}$, where:

Y_{ij} = response variable,

μ = over all mean,

T_i = treatment effect,

B_j = block effect.

E_{ij} = random error

4. RESULTS AND DISCUSSION

4.1 Chemical composition of experimental feeds

The chemical composition of the experimental feeds is presented in Table 4.1. The CP content of the refusals feed was decreased while the content of NDF, ADF and ADL were increased as compared to the offered feed, indicating selectivity by animals for nutritious parts of the feed, although there was an attempt to decrease selectivity by chopping and chemical treatment (Dereje Worku, 2015, Mulisa Faji, 2017 and Worknesh Seid, 2014). The CP content of untreated dried lowland bamboo leaf (ULBLH), urea molasses treated finger millet straw (TFMS) and urea molasses treated lowland bamboo leaf hay (TLBLH) with the value 15.8%, 12.66% and 21.8% respectively were higher than CP required for microbial protein synthesis in the rumen (above 8%) that can support at least the maintenance requirement of ruminants (McDonald *et al*., 2010 and Van Soset, 1994). However, the CP content of untreated finger millet straw (6.74) was lower than CP required for microbial protein synthesis in the rumen.

The application of urea molasses treatment in the current study reduced the fiber (NDF,ADF and ADL) while increase the CP content of finger millet straw and lowland bamboo leaf hay, due to binding of ammonia to the straw (McDonald *et al*., 2010). The result of this study showed that organic matter content of the treated lowland bamboo leaf and finger millet straw was lower than untreated lowland bamboo leaf and finger millet straw.

The DM content of finger millet straw obtained in this study was 90 %, comparable with the values 90 % noted by Degitu Alemu (2015). This result was slightly lower than the value 93.0% reported by Melese Gashu *et al*., (2014). The OM content of finger millet straw used in this study was 91.02% comparable with the values 92.6 and 94 % reported by Almaz Ayenew *et al*., (2012), and Degitu Alemu (2015).

The CP value of finger millet straw in present study was higher than the values 2.13 and 4.3% reported by Degitu Alemu (2015) and Melese Gashu *et al*., (2014) respectively. But, the CP value of finger millet straw in the present study was slightly comparable with value 7.8% reported by Maha *et al*., (2016). This variation among studies might be due to environmental factors (including location, climate, soil fertility and soil type), agronomic practice used, length and condition of storage time, It might also involve variety differences of finger millet (Maha *et al.*, 2016).

The current study showed that application of urea molasses treatment resulted in doubling the percentage units of CP value from 6.74% (untreated) to 12.66% (treated) of the millet straw. The increased CP value of millet straw due to urea molasses treatment was highly comparable with the increased CP content of millet straw more than doubling in percentage units from 2.13% (untreated) to 9.70% (treated) and that states urea molasses treatment numerically reduced ADF and ADL content of finger millet straw (Degitu Alemu, 2015). Similarly Melese Gashu *et al*.,(2014) reported that application of urea treatment doubling the percentage of CP value from 4.3% (untreated) to 7.4% (treated) and decrease the fiber content. Also in these study urea molasses treatment increase the CP value from 15.87% (ULBLH) to 21.8 %(TLBLH). Although not more responsive like to finger millet straw. The CP content of ULBLH obtained in this study is comparable with the values reported by (Denbeshu Debeko, 2010, Eyob Gebregziabhear, 2016 and Yeshambel Mekuriyaw *et al.*, 2012). Misra *et al*., (2006) indicates that cell wall components was affected by urea treatment by reducing the NDF and hemicelluloses content of straw due to binding of ammonia with straw and solublization of hemicelluloses by the action of ammonia evolved from urea. According to the current study, urea molasses treatment increase the ash content of treated feed (TFMS and TLBLH) than un treated feed (UFMS and TLBLH). And in this study the refusal from all treatment group were lower in CP and higher in fiber content (NDF,ADF and ADL).

The NDF content of finger millet straw in current study was 72.2 %, which is comparable with 73.2% reported by Almaz Ayenew *et al*., (2012) and lower the values 77.7% reported by Degitu Alemu (2015) and. However, this result was higher than the value 68.8 and 69.5% reported by Melese Gashu *et al. (*2014) and Firew Tegege and Getnet Asefa (2010). The ADF and ADL contents of finger millet in current study were higher than the values 40.2% and 15.2% (Melese Gashu *et al*. 2014) and 45.8% and 7.6% (Almaz Ayenew *et al*. 2012),. On the other hand, the ADF and ADL contents of finger millet were lower than the values 62.22% and 26.60% reported by Degitu Alemu (2015). These differences might be due to variant of finger millet straw, climatic factor, soil fertility, storage time and condition, because plant maturation and storage increases the cell wall constituent and therefore, the structural carbohydrates (cellulose and hemicelluloses), and lignin contents increase and reduce nutritive value (Maha *et al.,* 2016).

The DM content of ULBLH used in the current study was highly comparable with the values 91.1% reported by Eyob Geberegziabhear (2016), and 91.4% reported by Yeshambel Mekuriaw *et al*.,(2012) which was harvested in dry season (February and April). The OM and CP contents of ULBLH in this study were comparable to the results 80.7% and 20.5% (Eyob Gebregziabhear, 2016), and 81.5% and 11.1% (Yeshambel Mekuriaw *et al.*, 2012).

The NDF content of ULBLH in the current study was comparable with the value 73% reported by Eyob Gebregziabhear (2016) and lower than the value 77.0% reported by Yeshambel Mekuriaw *et al*.,(2012). The ADF content of ULBLH in this study was 50.5, higher than the value 40.8% reported by (Eyob Gebregziabhear, 2016) and comparable to 50.7% reported by Yeshambel Mekuriaw *et al.*, (2012).The ADL content of ULBLH was higher than the result 8.7% reported by Eyob Gebregziabhear (2016) and 8.3% noted by Yeshambel Mekuriaw *et al.*, (2012), the difference might be due to climatic factor, soil fertility, storage condition and season of harvesting.

Table 4.1. Chemical composition of experimental feed offered and refused.

	Chemical Composition, %DM						
Feeds offered	DM(%)	OM	Ash	CP	NDF	ADF	ADL
UFMS	90	91.02	8.98	6.74	72.22	57.4	18.88
ULBLH	90	87.7	12.3	15.87	71.1	50.5	15.55
TFMS	90	91	9	12.66	66.3	53.3	17.77
TLBLH	90	82.78	17.22	21.8	65.55	45.5	14.77
50%NSC & 50%WB	89	91.01	8.98	26.52	38.77	21.1	8.1
Feed Refusal							
T1	90	90.02	9.98	6.36	78.66	61.5	19.8
T2	91	88.87	11.13	13.2	77.5	55.5	16.66
T3	90	92.14	7.86	9.06	74.77	57.7	18.77
T4	91	84.27	15.73	17.52	73.11	48.8	14.88

DM= dry matter; OM= organic matter ; CP= crude protein; ADF= acid detergent fiber;NDF= neutral detergent fiber; ADL= acid detergent lignin; UFMS= un treated finger millet straw ;TFMS=urea molasses treated finger millet straw; ULBLH= un treated lowland bamboo leaf hay ; TLBLH=urea molasses treated lowland bamboo leaf hay; WB= wheat bran; NSC= noug seed cake; T1 =UFMS *ad libitum*+ 75gNSC 75gWB: T2= ULBLH *ad libitum* + 75gNSC75gWB; T3 = TFMS *ad libitum* + 75gNSC 75gWB; T4= TLBLH *ad libitum* + 75gNSC75gWB.

The CP content of concentrate mix, WB: NSC, (1:1) in the present study was higher than 15.59% reported by Eyob Gebregziabhear (2016), but comparable with 20.1% reported by Merhun Lamaro (2012). The NDF content of concentrate mix in the current study concides with 38.1% reported by Merhun Lamaro (2012), and lower than 51.1% reported by Eyob Gebregziabhear (2016). The ADF content was in agreement with 21.43% reported by Eyob Gebregziabhear (2016), and highly comparable to 20.5 reported by Merhun Lamaro (2012). The ADL content was higher on the previous results 5.92% and 5.7% reported by Eyob Gebregziabhear (2016) and Merhun Lamaro (2012), respectively.

4.2. Feed and nutrients intake

The mean daily feed and nutrients intake of local sheep fed basal diets of untreated and treated finger millet straw and lowland bamboo leaf hay supplemented with equal amount of concentrate mix (wheat bran and noug seed cake) is presented in Table 4.2. The result of this study indicated basal feed, total dry matter, organic matter, crude protein, neutral detergent fiber (NDF) and DM intake (% BW) were different among treatments, while the supplement, ADF and ADL intake were not different ($P>0.05$) among the treatments. Total DM intake was higher ($P < 0.001$) for T4 than T3 and T2 than T1 (T4=T2>T3>T1). This might be related with difference in nutrient content and variety. The fiber and CP content of the basal feed for T3 and T1 in this study was higher and lower than T4 and T2 respectively. The CP and fiber content of feed can influence the intake of animals (McDonald *et al*., 2010).

The total DM intake were higher ($P < 0.001$) for the sheep fed urea molasses treated finger millet straw than untreated finger millet straw and urea molasses treated lowland bamboo leaf hay than untreated lowland bamboo leaf hay. This might be due to urea treatment improves softness of feed and this improves the intake of feed as it makes it more accessible to the rumen microorganisms (McDonald *et al.*, 2010). This could be attributed to fermentable protein which might have enhanced the efficiency of rumen micro-organisms resulting in improved feed intake (Almaz Ayenew *et al*., 2012). Organic matter intake was higher ($P < 0.001$) for T2 and T4 than T3. Moreover, T2 OM intake was higher ($P < 0.001$) than T1. This might be attributed to the basal feed OM content difference among the treatments.

Significant difference ($P < 0.001$) was observed among treatments in CP intake. CP intake was higher ($P < 0.001$) for T4 than other treatments (T4>T2>T3>T1) and this result was consistent with the CP content of basal feed used in this experiment and Total DM intake and CP intake were significantly ($P<0.001$) higher for T2 than T3.TDMI and CP content were higher for T4 than other treatments and were lower for T1(UFMS) than other treatments. This might be due to relatively low CP content and poor digestibility of UFMS used in the study. CP intake was significantly higher (P< 0.001) for the sheep fed urea molasses treated feeds (T3 and T4) than untreated feeds (T1 and T2). This might be due to treating straw with urea or calcium hydroxide or by supplementing straw with protein, intake and degradability can be enhanced, compared to feeding untreated straw (Wanapat *et al*., 2009). This study was in agreement with the findings reported by Degitu Alemu (2015) who stated that lambs fed urea molasses treated millet straw based diet consumed significantly higher total DM and CP than the rest groups.

Table 4.2. Daily feed intake of local sheep fed basal diet of treated and untreated finger millet straw and lowland bamboo leaf hay supplemented with noug seed cake and wheat bran mixture.

Feed and nutrients intake(g /day)	T1	T2	T3	T4	SE	SL
Basal feed (g/day) intake	383.91^{c}	566.7^{a}	551.2^{b}	579.2^{a}	7.1	***
Supplement DM intake	150	150	150	150		Ns
Total DM intake	533.91^{c}	716.91^{a}	701.41^{b}	729.27^{a}	7.1	***
DM intake (% BW)	2.4^{b}	2.8^{a}	2.7^{a}	3.1^{a}	1.0	*
OM intake	485.93^{c}	633.49^{a}	638.09^{b}	615.9^{ab}	2.7	***
CP intake	65.65^{d}	129.68^{b}	109.5^{c}	165.9^{a}	0.3	***
NDF intake	335.51^{b}	461.94^{a}	423.23^{a}	437.64^{a}	2.0	**
ADF intake	252.39	317.8	325.43	295.18	1.7	Ns
ADL intake	84.56	100.27	110.1	97.66	1.7	Ns

$^{a, b, c}$ = means with a different superscript letter in row are significantly differ.*= (P<0.05) ** = (P<0.01), ***= (P<0.001), DM= dry matter; OM= organic matter; CP= crude protein; NDF= neutral detergent fiber; ADF= acid detergent fiber; ADL= acid detergent lignin; ns = not significant; T1 = UFMS + 150 g S; T2=ULBLH + 150 g S ;T3 = TFMS + 150g S; T4 = TLBLH + 150 g S; SL significance level.

The result of the current study showed that urea molasses treatment results higher improvement on intake of total DM, CP and nutrient intake. The current study was in agreement with the finding of Degitu Alemu (2015) who stated that urea treatment improves softness of millet straw and this improves the intake of millet straw as it makes it more accessible to the rumen micro organisms. Improvement in intake through dietary protein supplementation is due to an increase rumen microorganism. This could lead to an increase in microbial population and efficiency, thereby facilitating the rate of breakdown of the digesta which eventually lead to increment in feed intake (Van Soest, 1994).

4.3. Digestibility of nutrients

The apparent nutrient digestibility of local sheep fed basal diet of treated and untreated finger millet straw and lowland bamboo leaf hay supplemented with equal amount of concentrate mix (wheat bran and noug seed cake) is presented in Table 4.3. The result of this study showed that apparent digestibility of DM, OM and CP were different among treatments and this might be due to variation of feeding and the primary chemical composition of feeds that determines the rate of digestion of ADF and NDF, which is a measure of cell-wall content; thus there is a negative relationship between the ADF and NDF content of feeds and the rate at which they are digested (McDonald *et al.,* 2002).

In this study the apparent CP digestibility was higher ($P<0.001$) for T4 than T3, T2 and T1 (T4>T3=T2>T1). The apparent DM, OM and NDF digestibility were lower ($P < 0.05$) for T1 than other treatments (T4=T2=T3>T1). While the apparent ADF digestibility was non significant among treatments.

The CP digestibility was higher for T4 than T3. This might be due to high CP and low fiber content of treated lowland bamboo leaf hay (T4) as compared to treated finger millet straw (T3). This was in agreement with the finding of Eyob Gebregziabher (2016), that showed better digestibility of CP for sheep in T2 (Tef straw + 300 g/head/d bamboo leaf hay) compared to T1 (Tef straw alone) and this could be attributed to better CP content in dry bamboo leaves since higher CP content usually results in better CP digestibility.

The DM, OM , CP and NDF digestibility of urea molasses treated millet straw(T3) was higher than the DM, OM, CP and NDF digestibility in untreated millet straw(T1). The result of this study coincides with the results of Degitu Alemu (2015), who reported that the DM,OM,CP,NDF and ADF digestibility was higher for urea molasses treated millet straw than untreated straw. The result of the current study was also in line with the finding of Maha *et al*. (2016), who reported dry matter digestibility of urea treated millet straw was higher compared with that of untreated straw. The improvement in digestibility could be attributed to an enhancement of rumen microbial activity as a result of increased nitrogen (Maha *et al.,* 2016). The current study was also agrees with previous study reported by Melese Gashu *et al.*,(2014), who stated that urea treatment of finger millet straw improved the digestibility of DM, OM, NDF and ADF when compared with the digestibility in local lambs fed sole untreated finger millet straw basal diet. The increase in digestibility of treated straw than untreated could be explained by the fact that the lingo-cellulose bonds in the cell walls might have been broken down by the alkali which made more cellulose and hemi-cellulose available for digestion by rumen microbes.

Table 4.3. Nutrient apparent digestibility of local sheep fed basal diet of treated and untreated finger millet straw and lowland bamboo leaf hay supplemented with noug seed cake and wheat bran mixture.

Digestibility Coefficient%	Treatments					
	T 1	T 2	T 3	T 4	SE	SL
DM	49.3^{c}	74.3^{ab}	74.9^{ab}	76.7^{a}	1.0	*
OM	44.8^{c}	71.6^{b}	73.3^{b}	74^{b}	0.8	*
CP	36.3^{c}	72.2^{b}	71.1^{b}	75.8^{a}	1.6	***
NDF	36.8^{c}	51.68^{ab}	51.11^{ab}	53.08^{a}	1.4	*
ADF	38.3	45.52	45.60	46.04	1.3	Ns

$^{a, b, c}$ = means with a different superscript letter in row are significantly differ. *= (P<0.05) ;***(P<0.001) DM= dry matter; OM= organic matter; CP= crude protein; ADF= acid detergent fiber; NDF= neutral detergent fiber; ns=non-significant; T1= UFMS+150Gs; T2= UBLH +150Gs; T3= TFMS+150gS; T4= TBLH+ 150gS.

The CP digestibility in urea molasses treated bamboo leaf hay (T4) observed in this study was higher than CP digestibility in untreated bamboo leaf hay (T2). This study result was in line with the study result reported by Eyob Gebregziabhear (2016), who stated that the low DM and OM digestibility of tef straw and dry bamboo leaves observed could be attributed to their high cell wall constituents. Another coinciding study result was reported by Yeshambel Mekuriaw *et al*., (2012), who found that although inclusion of low land bamboo leaf hay significantly improved CP digestibility as compared to natural pasture grass hay, digestibility was not significantly increased with increasing level of low land bamboo leaf hay.

In the current study the experimental animals assigned in the controls (T1) had lower coefficient of digestibility in DM, OM, CP and NDF than the rest treatment groups. This result coincided with the same study result reported by Degitu Alemu (2015). This difference might be due to lower CPI which has a positive correlation with DM, OM, CP, NDF and ADF digestibility.While the apparent ADF digestibility was non-significant among treatments. In line with this result Yeshambel Mekuriaw *et al*. (2012) found that no significant difference was observed for NDF and ADF digestibility on lowland bamboo leaf hay and natural pasture grass hay.

4.4. Body weight gain

The Body weight change of local sheep fed basal diet of treated and untreated finger millet straw and lowland bamboo leaf hay supplemented with equal amount of concentrate mix (wheat bran and noug seed cake) is presented in Table 4.4. The result of this study indicated that there was significant difference in final BW, body weight (BW) change, feed conversion efficiency (FCE) and average daily gain (ADG) among treatments. Final BW, BW change and ADG were higher ($P < 0.001$) for T4 than T1 and T3, while similar with T2. This might be attributed to the high CP and low fiber contents of treated lowland bamboo leaf hay (T4) than both untreated (T1) and treated millet straw (T3). On the other hand sheep in the fed treated finger millet straw (T3) had higher ($P < 0.001$) mean daily BW gain, final BW and BW change compared to sheep fed untreated finger millet fed treatment (T1), which actually underwent BW loss. This was might be due to higher crude protein intake of the treated straw that resulted a better performance of lambs.

Weight loss during the experimental period for sheep offered untreated finger millet straw and this might be due to the straw failed to meet the maintenance requirements (McDonald *et al.* 2002). Because of low nitrogen, high cell wall and slow digestion, animals kept on sole straw or hay diet may not be able to maintain their nitrogen balance and growing animals could lose body weight (Maha, 2012). FCE was higher for T4 than T1 while similar with T2 and T3 (T4=T3=T2>T1). The low FCE for T1 was because of lower CP and energy intake and higher fiber content of diet that might have caused the use of net efficiency of metabolic energy to be depressed (Maha, *et al*., 2012).

Table 4.4. Body weight change of local sheep fed basal diet of treated and untreated finger millet straw and lowland bamboo leaf hay supplemented with noug seed cake and wheat bran mixture.

Parameters	T 1	T 2	T 3	T 4	SE	SL
Initial body weight (kg)	21.1	21.8	21.8	21.7	0.7	Ns
Final body weight (kg)	18.3^{c}	27.3^{ab}	26.3^{b}	30.0^{a}	2.6	***
BW Change (Kg)	-2^{c}	5.4^{ab}	4.5^{b}	8.2^{a}	2.6	***
ADG (g/d)	-32^{c}	60.2^{ab}	50.0^{b}	91.7^{a}	2.9	***
FCE	-0.06^{b}	0.08^{ab}	0.07^{ab}	0.13^{a}	0.1	***

$^{a, b, c}$ = means with a different superscript letter in row are significantly differ. ***(P<0.001); BW= body weight; ADG= average daily gain; FCE= Feed conversion efficiency; ns =non-significant; SL= significance level; T1= UFMS+150gCM; T2= ULBLH +150gCM; T3= TFMS+150gCM; T4= TLBLH+ 150gCM. SL= significance level.

The result of this study coincides with the study report of Eyob Gebregziabhear (2016), sheep fed Tef straw + 300 g/head/d 2BLH:1CM and sheep feed Tef straw +300 g/head/d 1BLH had significantly higher (P<0.001) BW change, average daily gain (ADG) and feed conversion efficiency. In the current study ADG and body weight change were higher in T4 (TLBLH) than T3 (TFMS). This can be attributed to the high CP and low fiber contents of bamboo leaf hay than both treated and untreated millet straw. The result was in agreement with the report of Yeshambel Mekuriaw *et al*. (2012), who stated that improved FCE for sheep fed with higher proportion of LBLH. This might be presumably due to higher CP concentration and intake.

The current study showed that significantly higher average daily gain (ADG), body weight change and feed conversion efficiency were observed when sheep were fed on urea molasses treated finger millet than un treated finger millet straw and treated bamboo leaf hay than untreated bamboo leaf hay. This was in line with the report of Degitu Alemu (2015), who noted that significantly higher average daily gain (ADG), body weight change and feed conversion efficiency were observed when sheep were fed on urea molasses and effective microorganism (EM) treated straw.This was mainly due to higher CPI of the treated straw that resulted a better performance of lambs.

The body weight loss observed in this study for T1 was -32g/d ,coinciding with the report of Almaz Ayenew *et al*. (2012) who reported that weight loss of -23.3g/d was recorded in sheep fed sole finger millet straw as the sheep fed with finger millet straw alone could not get the amount of CP needed to meet their maintenance requirements. Similarly, Eyob Gebregziabhear (2016) reported that body weight loss of -37.8g/d was recorded in sheep feed tef straw alone which indicated that the tef straw used in this study was not capable of providing enough nutrients even for maintenance requirements.

The average daily body weight gain obtained for T4 by this study was in line with the value 91.06 for the local Benshagul-sheep fed on groundnut straw reported by Mezgebu Getinet (2017). In general, the optimum BW change, ADG and FCE was relatively recorded for sheep fed on urea molasses treated lowland bamboo leaf hay than when sheep feed urea molasses treated finger millet straw due to increasing total DM and CP intake. This could be due to high TDMI and CP intake lead to increasing feed conversion efficiency.

4.5. Carcass characteristics

The carcass parameters of local sheep fed treated and untreated finger millet straw and lowland bamboo leaf hay supplemented with equal amount of concentrate mix (wheat bran and noug seed cake) is presented in Table 4.5. In this study the mean slaughter weight (SW), empty BW, hot carcass weight (HCW), dressing percentage on the basis of slaughter BW and empty BW and rib eye area (REA) were significantly different among the treatments. Slaughter BW higher ($P < 0.001$) for T2, T3 and T4 than T1 (T4=T2=T3>T1). Dressing percentage on the basis of SW and empty BW and REA was higher ($P<0.05$) for T4, T3 and T2 than T1 (T4=T3=T2>T1), this might be due to nutrient intake of sheep. In this study hot carcass weight (HCW) and empty body weight (EBW) were significantly higher ($P < 0.05$) for urea molasses treated lowland bamboo leaf (T4) than urea molasses treated finger millet straw (T3). And higher ($P < 0.05$) HCW and EBW were observed for untreated lowland bamboo leaf (T2) than untreated finger millet straw (T1). The variation in different carcass traits in this study may be due to nutrition, age, sex, genetics, season and other related factors affect the growth and carcass traits of animal (McDonald *et al.* 2010).The difference between treatments in EBW in this study coincides with the report of Eyob Gebregziabhear (2016), who stated significant ($P<0.05$) difference between supplemented and non-supplemented sheep was observed in empty BW, this may be due to nutritional content of different feed type.

Table 4.5 Effects of treated and untreated finger millet straw and lowland bamboo leaf hay supplemented with noug seed cake and wheat bran mixture on carcass characteristics of local sheep.

Parameter	T1	T2	T3	T4	SE	SL
Slaughter BW (kg)	18.16^{b}	26.8^{a}	25.8^{ab}	29.87^{a}	0.8	***
Empty BW (kg)	14.86^{d}	21.2^{ab}	21.7^{bc}	24.5^{a}	0.6	*
Hot carcass weight (kg)	6.88^{c}	12.7^{ab}	11.4^{b}	14.0^{a}	0.7	*
Dressing percentage (%)						
Slaughter BW base	37.9^{b}	47.4^{b}	44.2^{ab}	46.9^{a}	0.6	*
Empty BW base	39.7^{b}	55.9^{b}	58.2^{ab}	55.8^{a}	0.6	*
REA (cm^2)	8.1^{b}	11.7^{a}	9.9^{ab}	12.6^{a}	0.6	*

a, b, c Means with different superscripts in rows are significantly differ.*= (P<0.05) ;***(P<0.001); SL= significance level; REA = rib-eye area; BW= body weight T1 = UFMS + 150gCM T2 = ULBLH + 150gCM ; T3 = TFMS + 150gCM and T4 = TLBLH +150gCM.

The current study showed that hot carcass weight was also significantly higher (P<0.01) for urea molasses treated finger millet straw and bamboo leaf hay than the control group of sheep. Awet Estifanos and Solomon Melaku (2009) reported that hot carcass weight was significantly higher (P<0.01) at high, medium and low level of wheat bran supplementation than for the control treatment. Similarly, Eyob Gebregziabhear (2016) noted that hot carcass weight was higher for supplemented treatments compared to non-supplemented ones.

Dressing percentage on slaughter basis were 60.3, 57.2, 55.0 and 53.6 for treatments T4, T3, T2, and T1, respectively. There was significant difference ($P<0.05$) between treatments with higher ($P<0.05$) dressing percentage for sheep in T4 and T3 compared to those in T2 and T1. According to Awet Estifanos and Solomon Melaku (2009), the control treatments had significantly lower ($P<0.01$) dressing percentage than wheat bran supplemented treatments. Dressing percentage on empty BW and SW basis was higher ($P<0.05$) for T4 and T3 (treated) compared to T2 and T1(untreated).

All treated feed offered sheep had higher ($P<0.05$) rib eye area than the control groups. Eyob Gebregziabhear (2016) reported that all supplemented sheep had higher ($P<0.05$) rib eye area than those fed the tef straw alone. Awet Estifanos and Solomon Melaku (2009) also reported sheep in the control treatment had smaller ($P<0.001$) rib-eye muscle area compared to those supplemented with wheat bran. Greater rib eye muscle area is associated with a higher production of lean in the carcass and higher lean/bone ratio.

4.6. Edible offal components

The edible offal components of local sheep fed basal diet of treated and untreated finger millet straw and lowland bamboo leaf hay supplemented with equal amount of concentrate mix (wheat bran and noug seed cake) is presented in Table 4.6. in these study, total edible offal component(TEOC) were significantly different among the treatments. TEOC were significantly higher ($P < 0.05$) for T4, T2 and T3 than T1(T4=T2=T3 > T1). In the current study testis and tail was higher ($P < 0.001$) for T2 and T4 than T1. The abdominal fat were significantly higher ($P < 0.05$) for T2 and T4 than T1 and T3. Also, stomach fat were significantly higher ($P < 0.05$) for T1, T2, T4 than T1. And genitals fat were significantly higher ($P < 0.05$) for T2, T3 and T4 than T1.

In the current study, the sizes of edible offal components were significantly ($p < 0.05$) affected by treatment of feeds. Edible offal components of treated feed offered sheep were heavier ($P < 0.05$) than untreated feed offered sheep. The higher TEOC for treated group sheep indicating in increased live weight might be related with energy and protein content of feed. Michael Yirdaw and Yayneshet Tesfaye (2014) indicated that lamb carcass fatness is closely associated with BW and differences in their energy or dietary protein level intake when lambs. This observation agree with Lamirot Tekiliye (2017) who stated that higher weight of TEOC in the supplement sheep indicated the supplementation has positive effect on weight of TEOC. Abebe Hailu (2011) indicated that there is significant difference in TEOC for wahera sheep feed UTRS supplement with concentrate mix. Similarly, Feleke Assefa *et al.*, (2015) reported that edible offal of supplemented sheep were heavier ($P<0.05$) than non-supplemented ones.

Table 4.6. Edible offal components of local sheep fed basal diet of treated and un treated finger millet straw and lowland bamboo leaf hay supplemented with noug seed cake and wheat bran mixture.

Parameters	T1	T2	T3	T4	SE	S.L
Blood (g)	883	1081	1035.8	1043.2	20.2	Ns
Tongue (g)	50.1	63.1	63.5	64.2	1.9	Ns
Kidneys (g)	70.8	79.2	72.9	66.5	1.6	Ns
Heart (g)	119.1	128	122.1	129.7	1.5	Ns
Liver with gall bladder (g)	374.7	372.5	341.1	367.8	11.3	ns
Kidney fat (g)	47.1	41.5	41.1	89.7	0.9	ns
Testis (g)	145.2[b]	346.2[a]	196.6[b]	323.2[a]	6.1	***
Abdominal fat(g)	92.6[b]	174.4[a]	99.1[b]	180.2[a]	4.8	*
Tail (g)	465.9[b]	721.4[ab]	519.1[ab]	854.7[a]	1.2	***
Rumen-Reticu(g)	433.4	434.9	579.5	564.7	12.8	ns
Omasum-Abo(g)	187.2	198.4	200.1	194.7	3.4	ns
SI and LI (g)	669.3	873.7	891.0	858.8	14.3	ns
Stomach Fat (g)	291.3[ab]	293.9[ab]	260.0[b]	356.0[a]	8.8	*
Genitals Fat (g)	41.9[b]	56.2[ab]	95.2[a]	82.9[a]	1.0	*
TEOC (kg)	3.8[b]	4.8[ab]	4.5[ab]	5.1[a]	0.1	*
TEP(kg)	10.7[b]	12.7[ab]	15.4[ab]	19.2[a]	0.2	*

[a, b, c] Means with different superscripts in rows are significantly different *= (P<0.05); ***=(P<0.001); LI=large intestine; SI=small intestine; ns=non-significant; SL= significance level; TEOC=total edible offal component; TEP= total edible product; T1 = UFMS + 150gCM; T2= ULBLH + 150gCM; T3 = TFMS + 150gCM; T4 = TLBLH + 150gCM.

The total edible product (TEP) was significantly lower ($p<0.05$) for the control (T1) as compared to treatments fed with treated lowland bamboo leaf hay diets (T4). this might be the highest weight of slaughter BW and HCS for T4 than T1. Michael Yirdaw and Yaynshet Tesfay (2014) noted that the total usable product were also significantly lower ($p<0.05$) for the control as compared to supplemented treatment. The significant difference observed in the total usable product was mainly due to the higher value of dressing percentage which is affected by level of nutrition among the other factors.

4.7. Non-edible offal components

The non-edible offal components of local sheep fed basal diet of treated and un treated finger millet straw and lowland bamboo leaf hay supplemented with equal amount of concentrate mix (wheat bran and noug seed cake) is presented in Table 4.7. The total non-edible offal components (TNEOC) was significantly ($p<0.05$) higher for T2 and T4 than T1 (T4=T3=T2>T1). In the current study head without tongue were significantly higher ($P < 0.05$) for T4 and T3 than T1 and T2 and esophagus were significantly higher ($P < 0.05$) for T1, T3 and T4 than T2. TNEOC was relatively good for TLBLH treatment than TFMS but not significantly different, this might be due to high CP content of T4, increase BW of sheep. The difference in slaughter weight also reflected in weight of non-edible offal (Lamirot Tekilye, 2017). But the total non-edible offal components (TNEOC) of sheep fed with untreated LBLH was significantly ($P<0.05$) higher than group of sheep fed with untreated finger millet straw.

In the current study TNEOC were higher ($P< 0.05$) for sheep feed treated feed (TLBLH and TFMS) than untreated feed (ULBLH and UFMS).Similarly, Eyob Gedregziabhear (2016) reported that total non-edible offal components were higher ($P<0.001$) for sheep supplemented with the concentrate mix alone compared to those in the control treatment. Michael Yirdaw and Yaynshet Tesfay (2014) also reported that there was a significant difference ($p<0.05$) due to supplementation on blood, spleen and pancreas, skin and feet and TNEOC % .The report of Feleke Assefa *et al.* (2015) showed that total non-edible offal components (TNEO) were higher ($P<0.05$) for supplemented sheep than non-supplemented sheep. Similar to this Mulu Moges *et al*.,(2008) reported higher TNEOC for supplemented Wegera sheep than non-supplemented sheep fed basal diet of grass hay.

Table 4.7. Non-edible offal components of local sheep fed basal diet of treated and untreated finger millet straw and lowland bamboo leaf hay supplemented with noug seed cake and wheat bran mixture.

Parameters	T1	T2	T3	T4	SE	S.L
Head without tongue (g)	1228.9[c]	1328.9[bc]	1401.4[ab]	1538.4[a]	21.5	*
Skin + Feet (g)	2069.5	2980.8	2887.2	3015.6	46.1	ns
Lungswith trachea (g)	420.5	368.6	399.5	339.4	7.2	ns
Spleen (g)	40.8	45.8	36.3	48.5	1.8	ns
Esophagus (g)	45.9[a]	29.3[b]	39.3[ab]	45.0[a]	1.0	*
Penis (g)	42.7	41.4	48.8	56.9	0.9	ns
Gut fill (g)	3343.9[b]	5649.6[a]	4118.9[b]	5259.2[a]	124.5	**
TNEOC (kg)	7.1[b]	10.4[a]	8.9[ab]	10.3[a]	0.2	*

[a, b, c] Means with different superscripts in rows are significantly different *= (P<0.05); **=(P<0.01);; ns=non-significant; SL= significance level; TNEOC= total non-edible offal component; T1 = UFMS + 150gCM; T2= ULBLH + 150gCM; T3 = TFMS + 150gCM; T4 = TLBLH + 15

5. CONCLUSION AND RECOMMENDATIONS

The CP content of untreated dried lowland bamboo leaf (ULBLH), urea molasses treated finger millet straw (TFMS) and urea molasses treated lowland bamboo leaf hay (TLBLH) were slightly above the 8% CP that can support at least the maintenance requirement. The chemical analysis of feed samples showed that finger millet straw had relatively lower CP content and higher fiber content than lowland bamboo leaf hay. The application of urea molasses treatment resulted in doubling in the percentage units of CP value of the millet straw and reduced the fiber content of the straw. The study also showed that untreated bamboo leaf hay had higher CP and lower fiber contents than both untreated and urea molasses treated finger millet straw.

The current study indicated that basal feed, total dry matter, organic matter, crude protein, neutral detergent fiber (NDF) and DM intake (% BW) were different among treatments, while the ADF, supplement and ADL intake were not among the treatments. Total DM intake were higher for ULBLH and TLBLH than TFMS and UFMS. The apparent CP digestibility was higher for TLBLH than TFMS, ULBLH and UFMS, while the CP digestibility for ULBLH and TFMS was similar. The apparent DM, OM and NDF digestibility were lower for UFMS than other treatments. While the apparent ADF digestibility was non significant among treatments.

In this study final BW, BW change and ADG were higher for TLBLH than TFMS and UFMS, while similar with ULBLH. This might be attributed to the high CP and low fiber contents of treated lowland bamboo leaf hay than both untreated and treated millet straw . Generally FBW, BWC and ADG were higher for TLBLH than TFMS.The mean slaughter weight , empty BW, hot carcass weight , dressing percentage on the basis of slaughter BW and empty BW and rib eye area (REA) were significantly different among the treatments.

The total edible offal component (TEOC) were significantly different among the treatments. The total edible offal components (TEOC) were higher in the treated feed offered treatments compared to the control treatments. The total edible product (TEP) was lower for the UFMS as compared to other treatments. The total non-edible offal components (TNEOC) of sheep offered with urea molasses treated LBLH was higher than other treatments offered with urea molasses treated finger millet. Similarly, the total non-edible offal components (TNEOC) of sheep fed with untreated LBLH was higher than group of sheep fed with untreated finger millet straw.

Based on the above conclusion the following recommendations are forwarded:

- Untreated lowland bamboo is better than treated finger millet straw as ruminant feed.
- Bamboo should be taken as conventional source of feed and development strategies need to be designed as being done for other forages.

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7. APPENDIX

7.1. Appendix tables

Appendix Table 1. Summary of ANOVA for DM and nutrient intake of local sheepfed on basal diets of untreated or treated finger Millet straw and bamboo leaf hay supplemented with equal amount of concentrates mix (wheat bran and/ noug seed cake).

Parameters	TrDF	TDF	EDF	Trms	Ems	F-v	P>F	Cv	Mean
TDMI	3	19	12	47105.9138	12888.3782	3.65	0.0443	17.00573	667.5808
TOMI	3	19	12	31091.74519	10027.783	3.1	0.0673	17.19951	582.2191
TCPI	3	19	12	13776.65442	112.85173	122.08	<.0001	9.264151	114.6696
TNDFI	3	19	12	47803.7034	4948.1877	9.66	0.0016	15.67175	448.8545
TADFI	3	19	12	5709.54816	3618.4438	1.58	0.2461	19.27364	312.1025
TADLI	3	19	12	636.535066	545.42634	1.17	0.3628	19.08787	122.3518

TDMI= Total of Dry Matter Intake; TOMI= Total Organic Matter Intake; TCPI= Total Crude Protein Intake; TNDFI= Total Neutral Detergent Fiber Intake; TADFI= Total Acid Detergent Fiber Intake; TDF=Total Degree Freedom; TrMS= Treatment Sum Square; EMS=Error Mean Square; F-V=F-Value; CV%=Coefficient of Variation Percentage.;TDF=Total Degree Freedom

Appendix Table 2. Summary of ANOVA for apparent digestibility of dry matter and nutrients of local sheepfed on basal diets of untreated or treated finger millet straw and bamboo leaf hay supplemented with equal amount of concentrates mix (wheat bran and/ noug seed cake).

Parameter	TrDF	TDF	Trms	EDF	Ems	F-v	P > F	Cv	Mean
DMD	3	19	847.860507	12	623.95511	1.02	0.0302	36.28656	68.83842
OMD	3	19	993.976305	12	724.95291	1.03	0.0298	40.81549	65.96748
CPD	3	19	1810.984963	12	702.7414	1.01	<.0001	40.98013	64.68811
NDFD	3	19	1765.101368	12	1170.08628	1.02	0.0262	52.65338	64.96549

DDM= Digestibility of Dry Matter; DOM=Digestibility of Organic Matter; DCP= Digestibility of Crude Protein; DNDF=Digestibility of Neutral Detergent Fiber; DADF=Digestibility of Acid Detergent Fiber; TDF=Total Degree Freedom; TrMS= Treatment Sum Square; EMS=Error Mean Square; F-V=F-Value; CV%=Coefficient of Variation Percentage.

Appendix Table 3. Summary of ANOVA for body weight parameters of local sheepfed on basal diets of untreated or treated finger millet straw and bamboo leaf hay supplemented with equal amount of concentrates mix (wheat bran and/ noug seed cake).

Parameter	TrDF	TDF	EDF	Trms	Ems	F-v	P>F	Cv	Mean
INITIAL	3	19	12	0.55533333	0.52408333	1.06	0.4023	3.340729	21.67
FINAL	3	19	12	126.8405	6.2000833	2.02	<.0001	9.766608	25.495
BWC	3	19	12	112.7098333	6.0994167	1.43	<.0001	64.56731	3.825
ADG	3	19	12	13914.79658	753.01831	1.43	<.0001	64.56748	42.5
FCE	3	19	12	0.08989233	0.02552183	1.04	0.0488	593.8868	0.0269

BW= body weight; DMI= dry matter intake; FCE= Feed conversion efficiency; ns=non-significant;PCE=Protein Conversion Effeciency; SL= significance level; TDF=Total Degree Freedom; TrSS=Treatment Sum Square; RepSS= Replication Sum Square; ESS=Error Sum Square; TSS=Total Sum Square; TrMS= Treatment Sum Square; Rep MS= Replication Mean Square; EMS=Error Mean Square; F-V=F-Value; CV%=Coefficient of Variation Percentage.

Appendix Table 4. Summary of ANOVA for carcass characteristics of local sheepfed on basal diets of untreated or treated finger millet straw and bamboo leaf hay supplemented with equal amount of concentrates mix (wheat bran and/ noug seed cake).

Parameter	TrDF	TDF	EDF	Trms	Ems	F-v	P>F	Cv	Mean
SBW	3	19	12	49.1033333	8.9241667	1.32	0.0001	11.57134	25.81667
EBW	3	19	12	35.4042	6.8708333	0.91	0.0425	12.35069	21.22333
HCW	3	19	12	13.43312222	2.41145556	0.75	0.0361	13.32759	11.65167
DP (%)									
SBWB	3	19	12	28.00077778	30.9637361	1.54	0.0423	11.84694	46.97
EBWB	3	19	12	22.6618083	42.6965417	1.65	0.0476	11.44103	57.1125
REA (cm^2)	3	19	12	10.71583333	1.7825	4.62	0.0307	12.68908	10.52167

BW= Body Weight; HCW=Hot Carcass Weight EBW=Embty Body Weight; SW=Slaughter Weight; ns=non-significant (P>0.05); TrDF= Treatment Degree Freedom; EDF=Error Degree Freedom; TDF=Total Degree Freedom; TrMS= Treatment Sum Square; EMS=Error Mean Square; F-V=F-Value; CV%=Coefficient of Variation Percentage.

Appendix Table 5. Summary of ANOVA for non- carcass components of local sheepfed on basal diets of untreated or treated finger millet straw and bamboo leaf hay supplemented with equal amount of concentrates mix (wheat bran and/ noug seed cake).

Parameter	TrDF	TDF	EDF	Trms	Ems	F-v	P>F	Cv	Mean
Blood	3	19	12	22924.2089	12881.9832	2.42	0.2509	11.22852	1010.808
Tongue	3	19	12	138.4788083	51.6503917	1.17	0.1404	11.92421	60.27083
Kidneys	3	19	12	83.0873639	114.818947	0.99	0.5737	14.79835	72.40917
Heart	3	19	12	74.3347222	294.944056	1.09	0.8573	13.76466	124.7683
Liver	3	19	12	695.529586	1864.02842	1.5	0.7758	12.08326	128.7312
Kidney Fat	3	19	12	1641.306233	344.892233	0.31	0.05	33.84492	252.8533
Testis	3	19	12	28416.59353	681.9437	7.59	0.0002	10.32775	128.7683
AF	3	19	12	8481.29534	1089.67968	0.25	0.0172	25.0854	333.3075
Tail	3	19	12	97657.4127	31006.9934	1.11	0.1077	27.50226	357.3075
RR	3	19	12	19142.26847	10002.1513	0.48	0.2285	19.87587	54.87167
OA	3	19	12	103.485608	469.599525	2.36	0.8789	11.09678	252.8533
Genital Fat	3	19	12	1778.056764	478.185431	0.08	0.0803	31.64342	131.5917

Stomach Fat	3	19	12	4842.82572	5037.07822	0.51	0.4694	23.6295	640.2675
SI+LI	3	19	12	29429.23462	12963.2826	0.85	0.1806	14.58327	503.1767
TEOC	3	19	12	0.8706	0.37536667	1.15	0.1751	13.45546	195.2842
Skin +feet	3	19	12	583344.257	78400.728	1.31		10.51344	69.10583
L+T	3	19	12	3782.61579	3185.80312	1.88		14.77286	300.355
Spleen	3	19	12	87.610875	46.3712083	0.84		15.87792	780.7333
Esophagus	3	19	12	175.7348083	59.7230583	0.53		19.35041	4.553333
Penis	3	19	12	150.2780556	149.256056	1.84		25.71738	2663.271
Gut fill	3	19	12	3345201.38	264851.35	4.84		11.20505	382.0717
TNEOC	3	19	12	6.09276389	0.92694722	2.81		10.53083	42.8875
TEP	3	19	12	20.82885556	4.46892222	0.89		13.04525	39.9375

LI=large intestine; ns=non-significant; SI=small intestine; TEOC=total edible offals component; TNEOC=total non-edible offals component; TEP= Total Edible Products; HWT=Head without Tongue; UB= Urinary Bladder; OA=Omasum-Abomasum; RR=Reticulo-rumen;TrDF= Treatment Degree Freedom; EDF=Error Degree Freedom; TDF=Total Degree Freedom; TrSS=Treatment Sum Square; EMS=Error Mean Square; F-V=F-Value; CV%=Coefficient of Variation Percentage.

7.2. Appendix figures

Appendix figure 1. Weight of animal during experiment.

Appendix figure 2. Feces collection during experiment

Appendix figure 3. Ventilation of treated feed for fermentation

Appendix figure 4. Putting of treated feed

Appendix figure 5. preparation of urea molasses treated straw.

Appendix figure 6. Sheep during flaying

Biographical Sketch

The author, Behiwot Adugna , was born to her father Ato Adugna Dessie and her mother W/ro Tiru Abawa on September , 1992 at Bahir Dar, Amhara National Regional State. After completing her high school education, she joined to Debire Birhan University in November 2010 and graduated with BSc in Animal Science in June 2012. Following her graduation, she was employed in Assosa ATVET College in 2013 and serving as an instructor. In July 2015 she joined Bahir Dar University, Faculty of Agricultural and Environmental Science, Department of Animal Sciences for her post graduate study.