EFFECT OF GRADED LEVELS OF TAGASASTE (*CHAMAECYTISUS PALMENSIS*) LEAVES SUPPLEMENTATION ON PERFORMANCE OF YEARLING MENZ SHEEP IN ETHIOPIAN HIGHLANDS

M.SC. THESIS

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EFFECT OF GRADED LEVELS OF TAGASASTE (*CHAMAECYTISUS PALMENSIS*) LEAVES SUPPLEMENTATION ON PERFORMANCE OF YEARLING MENZ SHEEP IN ETHIOPIAN HIGHLANDS

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A THESIS SUBMITTED TO THE SCHOOL OF ANIMAL AND RANGE SCIENCES, COLLEGE OF AGRICUTURE, SCHOOL OF GRADUATE STUDIES

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ADVISORS' APPROVAL SHEET

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This is to certify that the thesis titled ñEffect of Graded Levels of Tagasaste (*Chamaecytisus palmensis*) Leaves Supplementation on Performance of Yearling Menz Sheep in Ethiopian Highlandsò is submitted in partial fulfillment of the requirements for the degree of Master of Science in Animal Sciences with a specialization of Animal Nutrition of the Graduate Program of the School of Animal and Range Sciences, College of Agriculture, and is a record of original research carried out by Meron Mengesha Kosiso ID.No SGS/010/06 under our supervision, and no part of the thesis has been submitted for any other degree or diploma.

The assistance and the help received during the course of this investigation have been duly acknowledged. Therefore, we recommend that it will be accepted as fulfilling the thesis requirements.

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We, the undersigned, members of the board of examiners of the final open defense by MERON MENGESHA have read and evaluated her thesis entitled ñEffect of Graded Levels of Tagasaste (*Chamaecytisus palmensis*) Leaves Supplementation on Performance of Yearling Menz Sheep in Ethiopian Highlandsò, and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirements for the degree of Master of Science in Animal and Range Sciences (specialization: Animal Nutrition).

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DEDICATION

I dedicate this thesis manuscript to my father Mengesha Kosiso and my mother Yeshi Zeleke for nursing me with great affection and for their dedicated partnership in the success of my life.

STATEMENT OF THE AUTHOR

I declare that this thesis is my own work and it has been submitted in partial fulfillment of the requirements for M.Sc. degree at Hawassa University and is deposited at the University library to be made available to borrowers under rules of the library. I also solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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LIST OF ABBREVIATIONS

ADF	Acid detergent fiber
ADFD	Acid detergent fiber digestibility
ADG	Average daily gain
ADL	Acid detergent lignin
ANOVA	Analysis of variance
BWG	Body weight gain
BW	Body weight
CP	Crude protein
CPD	Crude protein digestibility
CPI	Crude protein intake
CSA	Central Statistical Authority
DM	Dry matter
DMD	Dry matter digestibility
DP	Dressing percentage
EBW	Empty body weight
FCE	Feed conversion efficiency
GDP	Gross domestic product
GLM	General leaner model
HCW	Hot carcass weight
IVOMO	*Invitro* organic matter digestibility
LSD	Least significant difference

ME	Metabolizable energy
NDF	Neutral detergent fiber
NDFD	Neutral detergent fiber digestibility
OM	Organic Matter
OMD	Organic matter digestibility
P	Probability
RCBD	Randomized complete blocked design
REA	Rib eye area
SEM	Standard error of mean
SL	Significance level
SW	Slaughtering weight
TEOC	Total edible offal component
TNEOC	Total non edible offal component
TLU	Tropical livestock unit

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TABLE OF CONTENTS

Contents Page

ADVISORSô APPROVAL SHEET.. iii

EXAMINERSô APPROVAL SHEET.. iv

DEDCATION v

STATEMENT OF THE AUTHOR vi

LIST OF ABBREVIATIONS.. vii

ACKNOWLEDGEMENTS é ix

TABLE OF CONTENTS xi

LIST OF TABLES xiv

LIST OF TABLES IN APPENDIX...xv

LIST OF FIGURES xvi

ABSTRACTé .xvii

1. INTRODUCTION 1

2. LITERATURE REVIEW...4

2.1 Production of sheep in Ethiopia 4

2.2. Factors affecting sheep production 5

2.2.1 Nutritional constraints of fattening sheep...5

2.3 Available feed resources and status of livestock in highlands of Ethiopia 6

2.3.1 Grazing on natural pastures 7

2.3.2 Crop residues...8

2.3.3 Agro- industrial by-products...9

TABLE OF CONTENTS (CONTINUED)

2.3.4 Fodder trees and browse species 9

2.3.4.1 Supplementary value of fodder tree foliage for small ruminants....................................10

2.4 Origin, distribution and adaptations of tagasaste 11

2.5 Tagasaste as a multipurpose tree in the highlandsé é é é é é é é é é é é é é é ...11

2.6 Nutritional qualities of tagasaste...12

2.7 Feeding value of tagasaste 13

3. MATERIALS AND METHODS..14

3.1 Description of study area 14

3.2 Experimental feeds preparation and feeding procedure 14

3.3 Experimental animals and management 15

3.4 Experimental design and treatment 15

3.5 Feeding management..16

3.6 Measurements and observation...16

3.6.1 Feed intake...17

3.6.2. Digestibility trial 17

3.6.3. Body weight change 17

3.6.4. Evaluation of carcass parameters 18

3.6.5 Chemical analysis...19

3.6.6 Statistical analysis 19

4. RESULTS...20

4.1 Chemical composition of experimental diets...20

4.2 Feed intake..20

4.3 Digestibility of nutreints..23

TABLE OF CONTENTS (CONTINUED)

4.4 Body weight change 21

4.5 Carcass parameters..26

4.4.1 Edible offal components...27

4.5.2 Non-edible offal components...29

5. DISCUSSION..30

5.1 Nutrient composition of feeds during growth and digestibility experiment...........................30

5.2 Feed intake, body weight change and feed conversion efficiency..31

5.3 Apparent digestibility of nutrients 33

5.4 Carcass parameters..34

6. CONCLUSION AND RECOMMENDATION..36

REFERENCE 37

APPENDICES 52

BIBLIOGRAPHY SCHAECHé é é é é é é é é é é é é é .é é é é é é é é é é é é é ..59

LIST OF TABLES

Table		Page
Table 1	Experimental design of feeding trial uses tagasaste leaf supplementationé é	6
Table 2	Chemical compositions of barley straw and tagasaste leaf fed to yearling Menz sheepé ...	20
Table 3	The nutrient intake of Menz sheep fed barley straw supplemented with graded levels of tagasaste leafé é é é é é é é é é é é é é é é é é .	21
Table 4	Apparent digestibility in sheep fed basal diet of barley straw supplemented with different levels of tagasaste leafé é é é é é é é é é é é	22
Table 5	Effect of level of tagasaste leaf on live weight change of sheep fed a basal diet of barley strawé ..	24
Table 6	Carcass parameters of Menz sheep fed barley straw supplemented with different levels of tagasaste leafé é é é é é é é é é é é é é é é é é ..	27
Table 7	Edible offal component of Menz sheep fed barley straw supplemented with different levels of tagasaste leafé é é é é é é é é é é é é é é é é é ..	28
Table 8	Effects by dietary treatments containing different amount of tagasaste leaf on non-edible offal component of carcass from yearling Menz ramsé é é é ...	29

LIST OF TABLES IN APPENDIX

Table Page

Table 1 ANOVA for the nutrient intake of yearling Menz sheep fed barley straw supplemented with different levels of tagasaste leafé é é é é é é é é . 55

Table 2 ANOVA for body weight change of yearling Menz sheep fed a basal diet of barley straw supplemented with different levels of tagasaste leafé é é é é ... 56

Table 3 ANOVA for apparent digestibility of sheep fed basal diet of barley straw supplemented with tagasasateé é é é é é é é é é é é é é é é é é é . 57

Table 4 ANOVA for carcass parameters of sheep fed barley straw supplemented with tagasaste leafé 59

Table 5 ANOVA for edible offal component of sheep fed barley straw supplemented with tagasasteleafé 60

Table 6 ANOVA for non-edible offal component of sheep fed barley straw supplemented with different levels of tagasaste leafé é é é é é é é é .. 62

LIST OF FIGURES

Figure 1 Effect of supplementation level on body weight gain of experimental sheep 25

Effect of Graded Levels of Tagasaste (*Chamaecytisus palmensis*) Leaves Supplementation on Performance of Yearling Menz Sheep in Ethiopian Highlands

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ABSTRACT

The effects of supplementation with graded levels of tagasaste (Chamaecytisus palmensis) leaves on feed intake, digestibility, and body weight gain (BWG) and carcass characteristics were studied using thirty yearling and intact male Menz sheep. The sheep were blocked into six blocks of five sheep based on their initial body weight and animals from each block were randomly assigned to five treatment groups with six replications per treatment in randomized complete block design (RBCD). Barley straw was fed ad libitum as a sole diet in treatment 1 (T1) and as a basal diet supplemented with 100, 200, 300 and 400g dried tagasaste leaf in the other treatments i.e. T2, T3, T4 and T5, respectively. A 90-day growth experiment and 7- day digestibility trial were conducted. Dry matter (DM), organic matter (OM), and crude protein (CP) intakes increased (P<0.05) with increasing levels of tagasaste leaf in the diets. Sheep fed T1, T2, T3, T4, and T5 diets gained (P<0.05) -5.5, 19.2, 40.7, 61.8 and 71.8 g/head/ day, respectively. The apparent digestibility of DM, OM, CP, neutral detergent fiber and acid detergent fiber significantly increased (P<0.05) with increasing levels of tagasaste leaf supplementation. The hot carcass weight showed a significant increase from T1 (6.9 kg) to T5 (11 kg) with increasing level of supplementation. Dressing percentage on slaughter weight basis and empty body weight basis did not differ (P>0.05) among treatments, but dressing percentage on empty body weight basis have higher than on slaughter weight basis this imply that the influence of digesta. Supplementing a basal diet of barley straw with tagasaste leaves improved DM intake, BWG, digestibility of nutrients and carcass. It is concluded that 400g/d/head of tagasaste leaf can serve as a protein supplement to low quality feed during dry season for efficient performance of sheep.

Key words: *Chamaecytisus palmensis,* Supplementation, Body weight, feed intake, Carcass, Menz Sheep

1. INTRODUCTION

Ethiopia has about 29.33 million sheep (CSA, 2014) and meat production is the most important function of these animals (Sebsibe, 2009). Although sheep are reared mainly for meat, skins and coarse wool production for the cottage industry of the central highlands is subsidiary product (Solomon *et al*., 2009). The indigenous sheep may be grouped into about 14 traditional sheep populations (Gizaw *et al.,* 2007). They are also found widely distributed across the different agro-ecological zones of the country (EARO, 2000). Moreover, sheep production in Ethiopia is based on indigenous breeds except Awassi-Menz cross-breeds that contribute less than 1% of the population.

Despite low level of productivity due to several technical (genotype, feeding and animal health), institutional, environmental and infrastructural constraints (Tibbo, 2006), indigenous sheep breeds have great potential of contributing more to the livelihoods of the people in low-input, small- holder crop livestock and pastoral production systems (Kosgey and Okeyo, 2007). The annual off-take rate for sheep is estimated to be 33% (EPA, 2002) with an average carcass weight of about 10 kg, which is the second lowest of the sub-Saharan African countries (FAO, 2009).

The causes for low productivity of livestock in Ethiopia are multifaceted that include poor genetic makeup and lack of appropriate breeding strategy, poor veterinary services, and inadequate quantity and quality of feed. Among these limiting factors, poor feed supply and feeding system is the most important as the feed resources in the highlands of Ethiopia are generally natural pasture and residues of different crops. Crop residues are extremely fibrous, most of them have a high content of lignin and all are of low nutritive value (McDonald *et al*., 2002). In addition most dry forages and roughages found in Ethiopia have a crude protein (CP) content of less than 7 % which indicates microbial requirement can hardly be satisfied unless supplemented with protein rich feeds (Van Soest, 1994).

When fed alone, such feeds are unable to provide even the maintenance requirement of livestock (ILRI, 1999). Moreover, the rapid increase in human population to increased conversion of grazing lands to crop land ; resulting in less and less land available for grazing and leading to an increased feed shortage (Duguma *et al*., 2003). The small holder farmers of developing countries have limited resources available for feeding to their ruminant livestock. They do not have the luxury of being able to select the basal diet but use whatever is available at no or low cost. The available resources are essentially low digestibility forages such as tropical pastures (both green and mature), straws and other crop residues and agricultural by-products which are generally low in protein.

The major criterion for improvement in production is to optimize the efficiency of utilization of the available fodder resource. Therefore, production of alternative protein supplements is very important in the highlands of Ethiopia. Tagasaste is one of the potential multipurpose fodder trees that can serve as a source of protein supplement for ruminant livestock. Tagasaste is the name given (on the island of La Palma, in the Canary Islands) to the indigenous plant known botanically as *Chamaecytisus palmensis*. This legume, belonging to the family Fabaceae, has also been called tree lucerne, false tree lucerne and lucerne tree in Australia. Tagasaste is a shrub or small tree growing to a height and crown diameter of about 5 m, often with long, drooping, leafy branches. Variations occur, including upright and prostrate types.

Tagasaste, being an evergreen, can provide green feed at any time of the year. Under good management the annual biomass yield is reported to reach up to 10 tons of dry matter per hectare and the yield has been observed to increase as the plant gets older (Assefa, 1998), providing substantial amount of high quality fodder. Nutritionally the leaves are highly palatable with 20-30 % protein and 77-82 % *in vitro* dry matter digestibility. Use of tagasaste leaf to supplement low quality crop residue basal diets is, therefore, expected to enhance the nitrogen content, digestibility and overall feeding value of local feed resources. Understanding the optimal level of supplementation in relation to intake, digestibility and weight gain of small ruminants needs further investigation. Thus, this study was conducted with the following objectives to minimize the gap.

The general objective of this study was to evaluate the effect of graded levels of tagasaste leaf supplementation on the performance of yearling Menz sheep. The specific objective was:

- To evaluate the effect of graded levels of tagasaste leaf supplementation on feed intake, body weight gain, nutrient digestibility and carcass characteristics of yearling Menz rams fed a basal diet of barely straw

2. LITERATURE REVIEW

2.1 Production of sheep in Ethiopia

Ethiopiaôs vast sheep population, estimated at 29.33 million heads (CSA, 2014) is widely distributed across the different agro-ecological zones of the country (EARO, 2000; Kassahu, 2004). Sheep are owned by smallholder farmers as an integral part of the livestock sub-sector and contribute to both household consumption and cash income generation (EARO, 2000; Ehui *et al*., 2000). The productivity of indigenous sheep breed is low as compared to temperate breeds due to limited genetic capacity, and mainly environmental factors. Among the environmental factors, the main bottleneck is the inadequate supply and low level of feeding due to serious shortage of feedstuffs.

The major feed resources for small ruminants in Ethiopia are forage from natural pastures, crop residues and agro-industrial by-products (Ben Salem *et al.,* 2004). Among these feed resources, the expansion of cropping area as a result of growing human population pressure makes crop residues to be very important, especially during the dry season (Awgchew 2004). The scenario holds true where limited areas of permanent grazing are available and livestock depend upon thinnings from annual crops during the growing season and crop residues and stubble grazing during the dry season (Anderson,1987). Quality of these crop residues is limited by deficiencies of crude protein (CP), metabolizable energy (ME), minerals and vitamins. Awgchew (2000) indicated that in Ethiopia, most sheep are slaughtered at about 12 months of age with 18-20 kg body weights (BW). This implies that through better feeding, reproductive and health care management, the efficiency of growth could be increased to the desired market weight so that the economic benefit of sheep production could be enhanced. One of a feeding management practice is improving the nutritive value of low quality feed resources.

2.2. Factors affecting sheep production

There are various factors that contribute for low productivity. The main constraints hindering the productivity of the livestock sector in most sub- Saharan Africa (SSA) countries are disease, feed shortage both in quality and quantity (Tsedeke, 2007; Getahun, 2008). Seasonal feed deficiency cause the loss of weight; health problems cause high mortality and reduced reproductive and growth performance resulting in reduced output per animal and flock off-take rates. Other contributing factors also include low genetic potential; policy issues (Berhanu *et al*. 2006), market and institutional problems and problem of credit facilities (Berhanu *et al*. 2006). The common diseases which affect goat and sheep in SSA are helminthosis, contagious ecthyma, goat and sheep pox, pneumonia, anthrax and brucellosis. Physical injuries and chemical or poisoning are reported to occur in occasional incidences (Kusiluka and Lughano, 1996).

2.2.1 Nutritional constraints of fattening sheep

The major constraints of tropical ruminant livestock production systems include low herbage availability physical limitations of intake of tropical forages, nutrient deficiencies limiting rumen microbial digestion of fibrous feeds, and imbalance between nutrients extracted from feeds and nutrients required by the animal (Ibrahim *et al*., 1995). In most areas of sub-Saharan Africa, the major feed resources available to smallholder production systems are natural pastures, crop residues, browse trees and household wastes (Smith, 1992b). The region suffers from seasonally dry periods during which the available grasses drop in quality, especially in the contents of protein and energy (Ibrahim *et al*., 1995; Van Gylswyk, 1995).

Fodder tree and shrub foliages can play a major role as an economic protein supplement to provide critical nutrients lacking in the basal diet and improve the nutritive values of tropical grasses (Bonsi *et al*., 1995a). High altitude and other factors such as soil features in the central highlands of Ethiopia limit the growth of common fodder trees. On the other hand, tagasaste (*Chamaecytisus palmensis*), a leguminous shrub, introduced in 1984 by the Ethiopian Ministry of Agriculture from Western Australia grows well in these areas (Varvikko, 1991). Since its introduction to Ethiopia, an estimated 10 million tagasaste shrubs have become well established over a wide area of the central highlands with altitudes above 2000m (Varvikko, 1991). A marked feature of this species is its ability to retain leaves and hence maintain a relatively high nutritive value during the dry season. Leaves and twigs of tagasaste are easily digested and have average CP and DM contents of 20 and 29%, respectively (Lindeque and Rethman, 1998). Tagasaste also has a high leaf to stem ratio of 4:5, thus providing a good proportion of leaves favored over stems by animals (Varvikko, 1991; Varvikko and Khalili, 1993). On the basis of its favorable chemical composition, tagasaste may have a role as a high quality feed source or supplement (Borens and Poppi, 1990).

2.3 Available feed resources and status of livestock in highlands of Ethiopia

Inadequate livestock nutrition is a common problem in the developing world, and a major factor affecting the development of viable livestock industries in poor countries (Sere *et al.,* 2008). The Ethiopian highlands are inhabited by high human and livestock populations. High density of human and livestock population ranging between 37-120 people and 27-130 Tropical Livestock Unit (TLU) per square kilometer is one of the major reasons for severe degradation of the natural resource base (CSA 2008) resulting in poor animal nutrition. Approximately 88% of the human, 75% of the cattle, 75% of the sheep and 34% of the goat population in Ethiopia are found in the highlands (CSA 2008). However, the productivity of livestock in Ethiopia is extremely low in terms of milk, meat and draught output (Tegegne and Alemu, 1998). The fact that Ethiopia is importing milk products while possessing the largest cattle population in Africa is a very good indicator of the complexity of the problem. The major problem to livestock productivity is scarcity of livestock feeds in both quantity and quality, especially in the dry season.

Notwithstanding the continued reduction in the size of grazing lands and forest areas to crop production to feed the ever-increasing human population, ruminants will still continue to depend primarily on forages from natural pastures and crop residues. Poor grazing management (e.g. continuous overgrazing) has resulted in very low carrying capacities brought about by replacement of productive and nutritious flora by unpalatable species and reduction in vegetation cover. Livestock feed supply from natural pasture is characterized by seasonal fluctuation in total dry matter (DM) production and nutritional quality because of the distinct seasonal variation in plant growth, in relation to the annual rainfall pattern.

2.3.1 Grazing on natural pastures

The availability and quality of native pastures available to livestock vary with altitude, rainfall, soil type and cropping intensity. In the highland areas (between 2,200 and 3,000 m) as characterized by grass and legume pastures with the legume component decreasing with decreasing altitude. The area available for grazing is determined by the intensity of annual cropping and in southern Ethiopia, by the areas sown to coffee, *Ensett*e (pseudo-banana, a carbohydrate source), and *chat* (*Catha edulis*, a narcotic leaf which is chewed). There are extensive grassland *plateaux* and areas of seasonally waterlogged soils. Active plant growth is restricted to periods during the short rains, where these occur, and to one or two months after the small rains. Pastures are generally overgrazed and many areas are invaded by *Pennisetum* species. Overgrazing is less severe in areas with lower cropping intensity. The lower-altitude farming areas are characterized by grass-dominant pastures and production varies with rainfall, which in some areas is poor and erratic overgrazing is common in settled farming areas (Tembely, 1998).

Extensive sheep grazing was the main grazing system in the north for centuries, though intensive sheep farming strategies may also have been practiced in early ages (Ingimundarson, 1995). Some sheep are grazed on the lowlands throughout the summer, but others are grazed on extensive mountain or highland ranges. The variability of both the lowlands and the highlands is high, with various different plant communities intermixed. The wet areas such as mires are, in general, poorly utilized for grazing sheep (Thorhallsdottir and Thorsteinsson, 1993), whereas the dryer areas, especially in the mountains and highlands, usually support good lamb growth in Iceland (Gudmundsson and Dyrmundsson 1989).

2.3.2 Crop residues

Crop residues are the plant materials that remain after food crops have been harvested. It is the most abundant feed in most regions. They are widely used in animal feeding next to grazing (CSA, 2003). They may be left in the field as grazing for livestock and / or as mulch, or transported to the homestead for stall feeding. In the mixed cereal livestock farming systems of the Ethiopian highlands, crop residues provide on average about 50% of the total feed source for ruminant livestock. The contributions of crop residues reach up to 80% during the dry seasons of the year (Tolera 2007). Further increased dependence on crop residues for livestock feed is expected, as more and more of the native grasslands are cultivated to satisfy the grain needs of the rapidly increasing human population. In spite of the rising dependence on fibrous crop residues as animal feeds, there are still certain constraints to their efficient utilization. Substantial efforts have been made so far to resolve the feed shortage problem in the Ethiopian highlands, aiming at improving feed availability and thereby improve livestock productivity. However, the impact was so little to cope with the problem that animals are still subjected to long periods of nutritional stress (LDMPS 2006). More efficient management and utilization of available feed resources may help to improve livestock production in sustainable manner.

2.3.3 Agro- industrial by-products

Agro-industrial by-products are oil seed by-products and grain by-products both of which are obtained from the processing of seeds and grins for human consumption which result in residual protein rich products of great value as livestock feeds (Ensiminger *et al*., 1990). Though the contribution to the total animal feed resource is limited (1.45%), agro-industrial by-products are one of the important feed resources available in Ethiopia (CSA, 2003). Agro-industrial by-products produced in Ethiopia include; by-products from flour milling, oil processing, sugar factory and brewery by-products. These products are mainly used for dairy and fattening animals (Alemayehu, 2004).

2.3.4 Fodder trees and browse species

Tree fodders contain high levels of crude protein and minerals and many show high levels of digestibility. They are readily accepted by livestock and presumably because of their deep-root systems, they continue to produce well into the dry season (Paterson *et al*., 1998). Fodder tree and shrub species are mostly required as supplement to low quality feeds. Fodder tree and shrub species are considered important contributors to grazing animal nutrition in the highlands. Local people generally recognize the trees and shrubs which are well appreciated by ruminants, and their nutritive importance. For the improvement of forage production, the screening of browse plants and evaluation of biomass production has concentrated on improved species such as *Leucaena leucocephala and Gliricidia sepium,* for which planting material and information are available from international sources. Hence, some authors have recently focused on screening indigenous fodder trees and shrubs by involving farmers in the choice of promising species. Indigenous browse species are well adapted to the local environment, are well known by farmers and the planting material can easily be collected in the area. The methods have consisted of interviews with informants on the diversity of browse species and their knowledge of their palatability by livestock

2.3.4.1 Supplementary value of fodder tree foliage for small ruminants

Feed and fodder availability among Asian countries is not sufficient to meet even dry matter requirement of growing ruminant population, there is need to explore new feed resources which do not compete with human feed chain (Raghuvansi *et al*., 2007). Tree forages form an integral part of ruminant feeds and use of tree forages as components of diets is a widespread practice in many countries. Fodder tree leaves are an alternative source of livestock feeding and tree leaves have the potential for alleviating some of the feed shortages and nutritional deficiencies for small ruminant and important component of goats and sheep diets (Kamalak *et al*., 2004). Fodder trees are an important source of supplementary protein, vitamins and minerals in developing countries. However, in the cooler highlands especially above 2400m.a.s,l., the number of perennial herbaceous and tree legumes adapted and cultivated as source of forage are very few. Moreover, information on performance of the few native browse trees species found in the highlands is scanty. The local forage tree Erythrina abyssinica is well adapted from mid to high altitude area and proved to have high forage potential as a source of protein supplement for ruminants (Larbi *et al*., 1993). Among the introduced browse tree legumes in the highlands, tagasaste (*Chamaecytisus palmensis*) is successfully adapted to the ecology and produced a high herbage yield with desirable agronomic features such as fast coppicing abilities and persistency (Assefa, 1998; Berhe *et al*., 1993).

2.4 Origin, distribution and adaptations of tagasaste

Tagasaste is native to the Canary Islands (Spain). It is distributed and grown in temperate environment like in New Zealand, and widely cultivated in the Mediterranean climate in Western Australia (Snook, 1986). Out of 200,000 ha of cultivated browse trees in Australia about 100,000 ha are planted with tagasaste in the south-western and southern region (RIRDC, 2002). It is also well adapted in tropical highlands of Africa, like the Ethiopia highlands up to an altitude of 3000 meters above sea level (ICRAF, 2006). In the highlands of Rwanda, tagasaste was selected among the eight best on adaptation and biomass productivity (Niang *et al*., 1996). Tagasaste is well adapted to a wide temperature range and could survive under very cool temperature and is resistant to light frost. It is highly susceptible to water logging and saline condition but performs well on drained soils and is tolerant to acidic soils. It is deep rooted and resistant to drought (Snook, 1982; Hawely, 1984; Borens and Poppi, 1990).

2.5 Tagasaste as a multipurpose tree in the highlands

Tagasaste is an evergreen, hardly leguminous shrub that originated in the Canary Islands (Snook, 1982; Borens and Poppi, 1990). Tagasaste was introduced to Ethiopia in 1984 and adapted well in the highlands as a multipurpose tree cultivated as a backyard crop and in integration with other food crop (Lazier, 1987;; Berhe *et al*., 1993; Assefa, 1998). Annual biomass production of tagasaste was found substantially high (4.7-10 t/ha DM) with crude protein (CP) contents and in vitro organic matter digestibility (IVOMD) of 18 ï 21.2% and 65.3 ï 70.5% on dry matter basis, respectively (Assefa, 1998). Due to its promising excellent performance, tagasaste is one of the recommended forage crops for the highlands farming system in Ethiopia (EARO, 2000; Mengistu, 2006). Popularization of tagasaste to the highland farming system could substantially contribute to overcome the critical protein feed shortage for ruminants. Moreover, its ease of establishment, nitrogen fixing ability, and the possibility to grow in integration with crops and in marginal areas, make this plant a complement in the crop production system. Since its introduction in 1984, an estimated 10 million trees have been established over a wide area of the highlands of Ethiopia. Every year more than a million additional seedlings are distributed to farmers for planting in homesteads as fenceï line or as hillsides erosion control (Berhe and Tothill, 1997). Unlike the lowland, with many well - adapted species of browse trees available, it is only tagasaste, which adapted and performed very well in the highlands particularly in higher altitudes above 2400m.a.s.l. Its acceptance and adoption in wider areas of the highlands over only a short period of time is a clue to its potential use and importance. Tagasaste which is a very important forage tree in Australia and New Zealand could also have a great potential to be widely adapted and utilized in the different agro-ecologies and farming systems in the African highlands, Latin America and many other sub-tropical and temperate areas.

2.6 Nutritional qualities of tagasaste

Forage quality is function of many factors including the species, growth stage, plant part, agro-ecology, and the agronomic and post- harvest processing practices (Buxton, 1996). Therefore a given species varies in quality accordingly. Tagasaste forage has an average has an average crude protein content of 185g/kg DM within a range of 167-207, neutral detergent fiber (NDF) of 375g/kg DM (290-4180, acid detergent fiber (ADF) of 249g/kg (217-302) and acid detergent lignin (ADL) of 72g/kg (64-77) (Tolera *et al*., 1997; Ventura *et al*., 2002). The high level of crude protein makes Tagasaste forage a supplement feed for poor quality roughages. Among the most common browse trees used in the mid and high altitude areas, *Sesbania sesban* has the highest CP and lowest fiber content followed by tagasaste and *Leucanea leucocephala* (Assefa, 2007).

2.7 Feeding value of tagasaste

The feed value of forage is a function of its nutrient content, digestibility, its palatability and associative effects with other feeds. An example of the latter is the low protein content of low-quality tropical feeds that limits their digestion. This limitation can be overcome by supplementing a protein source e.g. fodder trees or shrubs. Sufficient literature exists on the nutrient content of several fodder trees and shrubs (Topps, 1992; Siaw *et al*., 1993). Though the reported crude protein (CP = 6.25 * the nitrogen (N) content) is variable, it is within the range of 12-30%, and several exceed alfalfa hay in protein content. Therefore, most fodder trees would be good protein supplements, provided they are degraded adequately in the rumen to make the protein available to the animal and non-toxic (Leng, 1997). Fodder trees contain significant fibre, but in *vitro* digestion studies indicated that the fibre was as digestible as that of alfalfa hay, and much better than that of cereal straws (El Hassan *et al.,* 2000). Macro- and micro- mineral content of fodder trees are usually adequate to cover animal requirements (Smith, 1992a)

3. MATERIALS AND METHODS

3.1 Description of study area

The experiment was conducted at Debre Brihan Agricultural Research Center which is found in North Showa Zone of Amhara Regional State. The area is located in central highlands of Ethiopia at about 120 km North East of Addis Ababa, at an altitude of 2800m above sea level (Mukssa-Mugerwa, and Lahulou, 1995). The geographical location of Debre Brihan is 09ę 35ô45ò to 09ę 36 45ò north latitude 39ę 29ô40ò to 39ę 31ô30ò east longitude (NSRC, 2006). According to the climatic data records from 1954 to 2005, the mean annual rainfall at Debre Brihan is 897.8 mm (NSRC, 2006). According to NSRC (2006), the mean annual maximum temperature is 19.9ęC in June and the mean annual minimum temperature is 6.5ęC and monthly values range between 3.2ęC in November and 8.5ęC in June.

3.2 Experimental feeds preparation and feeding procedure

Barley straw was purchased from surrounding farmers and stored under a shade to maintain its quality, and used as basal diet throughout the experimental period. The tagasaste leaf (*Chamaecytisus palmensis*) was collected from Muush and Gudoberet kebeles which are located around Debre Brihan and the leaf was used as protein supplement in the experiments. The leaves were collected at the stage of maturity and dried under shade to prevent the loss of vitamins and other volatile nutrients. During the drying process, the leaves were turned frequently to ensure quick and uniform drying. The dried leaves were transported to Debre Brihan Agricultural Research Center where the experiment was conducted.

3.3 Experimental animals and management

Thirty yearling intact male Menz sheep were purchased from the local market. The age of animals was determined based on the dentition and information obtained from the owner. Immediately after purchase, animals were kept in the quarantine for 21 days at Debre Brihan Agricultural Research Center compound to observe whether they were healthy or not. During this time, they were vaccinated against common sheep pox and Ovine pasteurollosis. They were also de-wormed against internal parasites with anthelminthic (Albendazole and fasinex) and sprayed with diazinone for external parasite before the commencement of the experiment based on the recommendation of veterinarians. After the animals finished the quarantine period, they were transferred to separate experimental pens which were provided with individual feeding and watering troughs. In the experimental pens, the animals were allowed to adapt to the new setting and experimental feeds for two weeks.

3.4 Experimental design and treatment

The feeding experiment and digestibility trial involved five treatments. Treatment 1 was the control, where animals received only barley straw basal diet *ad libitum*. The remaining treatments involved supplementation of dried tagasaste leaves at 100g (treatment 2), 200g (treatment 3), 300g (treatment 4) and 400g (treatment 5) per day on top of the barley straw basal diet (Table1). The design of the experiment was Randomized Complete Block Design (RCBD). The sheep were blocked into six blocks of five animals each based on the similarity of their initial body weight and individual animals from each block were randomly assigned to one of the five treatments.

Table 1:-Experimental treatments used in the feeding trial

Treatments	Feeding ingredients

T1(control)	Barley straw basal diet (fed *ad lib*)
T2	100g dried tagasaste leaf
T3	200g dried tagasaste leaf
T4	300g dried tagasaste leaf
T5	400g dried tagasaste leaf

3.5 Feeding management

All experimental animals received the basal diet barely straw *ad libtum* (at 20% refusal rate) offered twice daily in the morning and afternoon. Animal in the supplemented group were fed the supplement at 08:30 hours daily. Water and salt block was available to all animalsô free choice. For all animals samples of daily feed offered and refused were collected, measured and pooled over the experimental period for each feed and animal and stored in plastic bags. Representative samples of the feed offered and refused for different treatments were then taken for chemical analysis. The daily average feed intake was determined by calculating the difference between the amounts of feed offered and refused on DM basis. Body weight of each rams was recorded every 14 days after overnight fasting to determine body weight change.

3.6 Measurements and observation

3.6.1 Feeding trial and teed intake

The feeding trial lasted for 90 days. The sheep were penned individually and each sheep was fed according to the treatments. During the feeding trial, feed offered and refusals were recorded daily and feed intake was determined as a difference between feed offered and refused. Grab samples from the two feeds (barely straw and tagassaste) were taken daily and a composite sample for each feed type was formed for the entire feeding trial. Feed refused was sampled for each animal daily by taking grab of samples and compositing the samples for each animal. Finally refusal samples were pooled per treatment for chemical analysis.

3.6.2. Digestibility trial

Immediately after the end of feeding trial, the digestibility trial was carried out using all animals from each treatment in metabolic cages. The trial was under taken for 7 consecutive days after 3 days of adaptation period, during which each sheep was accustomed to carrying a fecal collection bag. During the fecal collection period, fecal output of each sheep was collected every morning just before feeding and weighed and recorded separately. Ten percent (10%) of the daily fecal output of each animal was sampled and bulked in an airtight plastic bag, and preserved in a freezer at -20ǓC. A sub-sample of feces was dried daily at 105Ǔc overnight to determine the DM content of the feces. At the end, samples of feces collected during the collection period were thawed to room temperature for 24h and pooled for each sheep, mixed thoroughly and used for chemical analysis. The apparent digestibility coefficients (DC) of nutrient were calculated by using the following equation according to (Ranjhan ,2001).

$$DC = \frac{\text{Total amount of nutrients in feed} - \text{Total amount of nutrients in feces}}{\text{Total amount of nutrient in feed}}$$

3.6.3. Body weight change

The initial body weight of each of the experimental sheep was determined as a mean of two subsequent weighing after overnight fasting at the beginning of the experiment, after that they were weighed fortnightly. Final body weight was taken at the end of the experiment. All body weight measurements were taken after overnight fasting. Average daily gain (ADG) was calculated as the difference between the final and initial BW divided by the number of feeding days. Feed conversion efficiency was also calculated as a proportion of average daily gain to daily feed intake.

3.6.4. Evaluation of carcass parameters

Carcass parameters were analyzed at the end of the experiment. All experimental sheep were slaughtered after overnight fasting at Debre Brihan Agricultural Research centre abattoir for carcass measurement. The animals were killed by severing the jugular vein and the carotid artery with a knife Okubanjo (1997). The blood was drained in to a bucket and its weight was recorded. Empty body weight of each animal was determined by deducting the gut content from the slaughter weight. Gut contents was determined by weighing the gut before and after emptying the gut contents. Dressing percentage was calculated as a proportion of hot carcass weight to slaughter and empty body weight. Hot carcass weight was estimated after subtracting weight of the head, thorax, abdominal and pelvic cavity contents as well as legs below the hock and knee joints (Gilmour *et al*., 1994). The rib-eye muscle area of each animal was determined by tracing the cross sectional area of the 12^{th} and 13^{th} ribs after cutting perpendicular to the back bone. The left and right rib-eye muscle area was traced on a transparent water proof paper and the area was measured by using planimeter as recommended by Torell and Suverly (2004). The mean of the right and left cross sectional area was taken as a rib-eye muscle area.

3.6.6 Chemical analysis

Chemical analysis was determined at the Nutrition Laboratory of ILRI, Addis Ababa. Dry matter content of the feed was determined by drying the samples at 105°C overnight and ash was determined by combusting the samples at 550°C for 5 h. Nitrogen was extracted with Keldjhal method and then the crude protein (CP) was calculated as nitrogen (N) ×6.25. The acid detergent fibre (ADF) and neutral detergent fibre (NDF) contents were analyzed using the method of Van Soest and Robertson (1985).

3.6.7 Statistical analysis

The collected data on feed intake, digestibility, growth performance, carcass characteristics, and chemical composition was subjected to analysis of variance (ANOVA). When P values ($P < 0.05$) was found to be significant, the means of each parameter was compared using the least significant differences (LSD) procedures of SAS (2008).

Model

$Y_{ij} = \varepsilon + T_i + B_j + E_{ij}$

Where, Y_{ij} = the response variable (the observation in jth block and ith treatment)

ε = over all mean

T_i = treatment effect

B_j = block effect

E_{ij}= random error

4. RESULTS

4.1 Chemical composition of experimental diets

The chemical composition of the feeds used in this experiment is shown in Table 2. The Ash content was high in barley straw and low in tagasaste leaf. There was a wide variation in the chemical composition of feeds used in the experiment. The CP and N content of tagasaste leaf was much higher than barley straw. The NDF and ADF content for tagasaste leaf were lower than those of barley straw.

Table 2. Chemical compositions of barley straw and tagasaste leaf fed to yearling Menz sheep

Nutrients	Barley satraw	Tagasaste leaf
Dry matter	92	90
Ash	7.0	6.2
Organic matter	93	93.8
Nitrogen	0.84	2.7
Crude protein	5.3	16.6
Neutral detergent fiber	79	36
Acid detergent fiber	56	24

4.2. Feed intake

The feed DM and nutrient intake of sheep in each treatment is given in Table 3. There was significant (P<0.05) difference in total DM, OM and CP intake among treatments. The DM, OM and CP intake increased significantly (P<0.05) with increasing level of Tagasaste leaf supplementation. However, the DM intake of barley straw showed a decline with increasing level of supplementation being significantly higher (P<0.05) in the control group than in animals supplemented with 100 and 200g tagasaste leaf, which in turn were higher (P< 0.05) than those supplemented with 300 and 400g of tagasaste leaf supplementation.

Table 3. Nutrient intake (g/day) of Menz sheep fed barley straw supplemented with different levels of tagasaste leaf

Intake	Treatments					SEM	LS
	T1	T2	T3	T4	T5		
Barley straw DM	403[a]	391[b]	388[b]	379[c]	377[c]	1.86	***
Tagasaste DM	-	85[d]	170[c]	255[b]	340[a]	0	***
Total DM	403[e]	476[d]	558[c]	634[b]	717[a]	1.86	***
Total OM	405[e]	483[d]	572[c]	648[b]	732[a]	1.87	***
Total CP	23[e]	36[d]	52[c]	66[b]	83[a]	0.18	***

[a,b,c, d,e] means with different super script in the same row are significantly different; ***=(P<0.001), SEM= standard error of mean, LS=significance level, T1=barley straw *ad lib*, T2 = barley straw *ad lib* +100g tagasaste leaf, T3= barley straw *ad lib* +200g tagasaste leaf, T4 = barley straw *ad lib* +300g tagasaste leaf, T5 = barley straw *ad lib* +400g tagasaste leaf

4.3 Digestibility of nutrients

Digestibility in sheep fed a basal diet of barley straw supplemented with different levels of tagasaste leaf is given in Table 5. The apparent digestibility values of DM, OM, and CP increased with increasing level of supplementation and were lowest for the unsupplemented group (T1) and highest in the group supplemented with 400g of tagasaste leaf (T5). The NDF and ADF digestibility values were higher ($P<0.05$) in T4 and T5 than in the other treatment group.

Table 4. Apparent digestibility in sheep fed basal diet of barley straw supplemented with different levels of Tagasaste leaf

Apparent digestibility (%)	Treatments					SEM	LS
	T1	T2	T3	T4	T5		
DMD	51.7^{d}	57.6^{c}	60.3^{c}	66.1^{b}	72.1^{a}	1.376	***
OMD	56.2^{d}	59.8^{cd}	62.0^{c}	67.6^{b}	72.1^{a}	1.345	***
CPD	45.7^{c}	52.0^{b}	55.4^{b}	56.0^{b}	62.9^{a}	1.681	***
NDFD	58.8^{b}	58.6^{b}	59.9^{b}	65.7^{a}	69.8^{a}	1.519	***
ADFD	59.2^{b}	58.7^{b}	59.0^{b}	64.8^{a}	68.3^{a}	1.605	***

^{a,b,c,} means with different super script in the same row are significantly different; *** = ($P<0.0001$); LS = level of significance; SEM=standard error of mean, T1=barley straw *ad lib*, T2 = barley straw *ad lib* +100g tagasaste leaf, T3= barley straw *ad lib* +200g tagasaste leaf, T4 = barley straw *ad lib* +300g tagasaste leaf, T5 = barley straw *ad lib* +400g tagasaste leaf, DMD=dry matter digestibility, OMD= organic matter digestibility, CPD=crude protein digestibility, NDFD= neutral detergent fiber digestibility, ADFD= acid detergent fiber digestibility

4.4. Body weight change

Effect of dietary levels of tagasaste leaf on live weight change of sheep fed a basal diet of barley straw is shown in Table 4.There was no significant difference ($p>0.05$) in initial body weight among treatments. Final BW showed a significant increase ($P< 0.05$) as the level of supplementation increased up to 300 g/head/day although there was no significant difference ($p>0.05$) between 300 and 400g of supplementation. Total weight gain and average daily gain of the sheep significantly increased ($p<0.05$) with increasing level of supplementation while the unsupplemented animals (control treatment) lost body weight. Sheep fed high levels of tagasaste leaf had higher mean average daily gains. The FCE values as observed too indicated that while the values were lowest among the rams reared on T1, the highest values were observed among those reared on T5 diets the values being different ($P<0.05$) across the two treatments. The results also indicated that there was no significant difference between those reared on T4 and T5 diets. The FCE value for T2 and T3 was intermediate between the two extreme values.

Table 5. Effect of level of tagasaste leaf on live weight change of sheep fed a basal diet of barley straw

Parameters	Treatments					SEM	LS
	T1	T2	T3	T4	T5		
Initial body weight (kg)	16.8	16.7	16.8	16.8	17.0	0.397	NS
Final body weight (kg)	16.3[d]	18.5[c]	20.4[b]	22.3[a]	23.5[a]	0.427	***
Total weight change (kg)	-0.5[e]	1.73[d]	3.67[c]	5.57[b]	6.47[a]	0.187	***
ADG (g)	-5.56[e]	19.2[d]	40.7[c]	61.8[b]	71.8[a]	2.087	***
FCE (g ADG/g DMI)	-0.01[d]	0.04[c]	0.07[b]	0.09[a]	0.10[a]	0.004	***

[a,b,c,d,e] Mean with the different superscript are significantly different; *** ($p<0.001$), SEM=standard error of mean, LS=level of significant, NS =not significantly different ($p>0.05$) , T1=barley straw *ad lib*, T2 = barley straw *ad lib* +100g tagasaste leaf, T3= barley straw *ad lib* +200g tagasaste leaf, T4 = barley straw *ad lib* +300g tagasaste leaf, T5 = barley straw *ad lib* +400g tagasaste leaf, ADG= average daily gain, FCE= feed conversion efficiency

The effect of supplementation level on body weight gain of experimental sheep during the course of the experimental period is shown in Figure 1. All animals fed the supplemented diets (T2-T5) showed increased body weight with advancement of experimental days whereas those in the control group showed a decrease. Figure 1 also depicts that difference in body weight among the different treatments widened with increasing number of days of feeding.

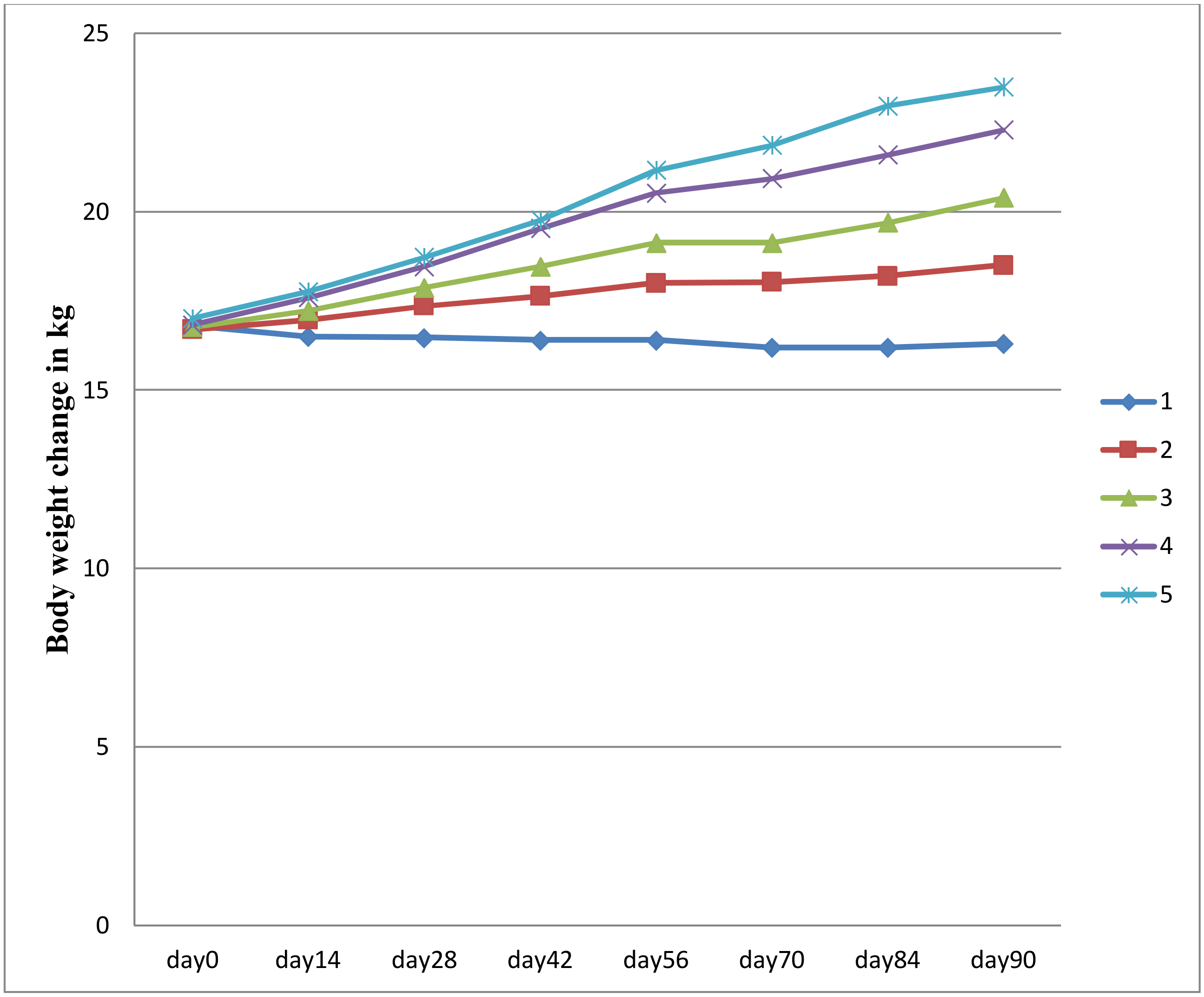

Figure 1. Effects by dietary treatments containing various levels of tagasaste leaf on Menz sheep's growth performance throughout the experimental periods

4.5 Carcass parameters

The carcass parameters of Menz sheep fed barley straw supplemented with different levels of Tagasaste leaf is presented in Table 6.The slaughter weight and rib-eye area showed a significant increase ($P<0.05$) with increasing level of supplementation with the lowest value recorded for the unsupplemented group and the highest value for the group supplemented with 400 g tagasaste leaf. The values for empty body weight and hot carcass weight also increased with increasing level of supplementation being lowest in T1 and highest in T5.Dressing percentage on both slaughtering weight and empty body weight basis did not differ significantly ($P>0.05$) among treatments.

Table 6. Carcass parameters of Menz sheep fed barley straw supplemented with different levels of Tagasaste leaf

Parameters	Treatments					SEM	LS
	T1	T2	T3	T4	T5		
SW (kg)	16.2^{e}	18.3^{d}	20.0^{c}	21.8^{b}	23.1^{a}	0.44	***
EBW (kg)	11.6^{d}	12.9^{cd}	14.5^{bc}	16.1^{ab}	17.3^{a}	0.56	***
HCW (kg)	6.98^{d}	7.44^{cd}	9.02^{bc}	10.3^{ab}	11.3^{a}	0.59	***
REA (cm^2)	5.34^{e}	6.73^{d}	8.05^{c}	9.28^{b}	10.7^{a}	0.15	***
Dressing percentage							
SW basis (%)	42.9	40.5	45.0	47.0	48.2	2.44	NS
EBW basis (%)	59.3	57.4	61.7	63.6	64.5	2.19	NS

[a,b,c,d,e] means with in a row not bearing a common superscript are significantly different; *** = (P<0.001); LS = level of significance; T1= barley straw *ad lib*, T2 = barley straw *ad lib* +100g tagasaste leaf, T3= barley straw *ad lib* +200g tagasaste leaf, T4 = barley straw *ad lib* +300g tagasaste leaf, T5 = barley straw *ad lib* +400g tagasaste leaf SW = slaughter weight, EBW= empty body weight, HCW = hot carcass weight, REA = rib eye area;

4.5.1 Edible offal components

The edible offal components of the carcass obtained from the slaughter of yearling Menz sheep fed a basal diet of barley straw and supplemented with graded levels of tagasaste leaf are presented in Table 6. The weight of head with tongue and heart were significantly (P<0.05) higher in supplemented groups than non-supplemented group. The weights of these organs were significantly higher (P<0.05) in T5 than in T1, T2 and T3 whereas T1 had significantly (P<0.05) lower values than T3, T4 and T5. Liver weight was higher (P<0.05) in T5 and T4 than in the other three treatments. The weight of reticlo-rumen and omasum-abomasum were highest (P<0.05) in T5 and lowest in T1. The tail weight was higher (P<0.05) in T5 than in T4, which in turn had higher (P<0.05) tail weight than T1, T2 and T3. Overall, there was an increase in the weight of edible offals with increasing levels of supplementation.

Table 7. Weights (g/head) of edible offal component of Menz sheep fed barley straw supplemented with graded levels of Tagasaste leaf

Parametrs	Treatments					SEM	LS
	T1	T2	T3	T4	T5		
Heart	70^{c}	83^{bc}	91^{b}	93^{ab}	106^{a}	7.95	*
Head with tongue	1051^{c}	1183^{bc}	1206^{b}	1243^{ab}	1363^{a}	60.7	*
Liver	136^{b}	151^{b}	181^{a}	193^{a}	198^{a}	9.9	**
Kidney	16	16	20	20	23	3.05	NS
Reticlo-rumen	296^{c}	353^{b}	386^{ab}	386^{ab}	415^{a}	18.1	**
Omasum-abomasum	91^{c}	115^{bc}	123^{b}	128^{ab}	156^{a}	10.8	*
Tail	118^{c}	103^{c}	128^{c}	216^{b}	343^{a}	29.5	***

^{a,b,c,} Mean values within the same row bearing different superscript letters are significantly different; * = (P<0.05); *** = (P<0.001); NS = non significant; LS = level of significance T1= barley straw *ad lib*, T2 = barley straw *ad lib* +100g tagasaste leaf, T3= barley straw *ad lib* +200g tagasaste leaf, T4 = barley straw *ad lib* +300g tagasaste leaf, T5 = barley straw *ad lib* +400g tagasaste leaf.

4.4.2 Non-edible offal components

The value as presented in Table 8 indicate that the weight of skin, blood, lung and trachea, testis, feet, and gallbladder were significantly (P<0.05) higher in the supplemented treatments than non-supplemented group. The average of the skin varied (P<0.05) across the rams reared in different treatments and higher value observed in T5 and the lowest one on T1 diet. There was significant (P<0.05) difference between treatment groups in lung and trachea weight, and values were greatest for T4 and T5 and lowest for T1. The weight of the feet also varied across the rams reared in five treatments in which the values being higher (P<0.05) among those reared on T5 diet while the least values were observed among those reared on T1 and the values for other three treatments were intermediate between the two extremes

Table 8. Effect of graded levels of tagasaste leaf supplementation on non-edible offal component of Menz sheep fed barley straw as a basal diet

Parameters	Treatments					SEM	LS
	T1	T2	T3	T4	T5		
Skin (g)	1365^{b}	1553^{ab}	1506^{b}	1536^{ab}	1756^{a}	83.4	*
Blood (ml)	456^{d}	578^{c}	646^{b}	618^{bc}	720^{a}	23.4	***
Feet(g)	363^{b}	376^{b}	400^{ab}	418^{a}	420^{a}	13.4	*
Lung and trachea(g)	186^{c}	215^{bc}	255^{ab}	261^{a}	286^{a}	15.7	**
Spleen (g)	23	28	30	33	33	3.35	NS
Gallbladder (g)	16^{d}	30^{c}	38^{bc}	46^{ab}	53^{a}	2.92	***
Testis (g)	46^{d}	88^{c}	123^{bc}	141^{ab}	175^{a}	13.6	***

^{a,b,c,} Mean values within the same row bearing different superscript letters are significantly different; * = (P<0.05); *** = (P<0.001); NS = not significant; LS = level of significance T1= barley straw *ad lib*, T2 = barley straw *ad lib* +100g tagasaste leaf, T3= barley straw *ad lib*+ 200g tagasaste leaf, T4 = barley straw *ad lib* +300g tagasaste leaf, T5 = barley straw *ad lib* +400g tagasaste leaf

5. DISCUSSION

5.1 Nutrient composition of feeds during growth and digestibility experiment

The CP content of barley straw was below the critical level of CP requirement for normal rumen microbial activity to satisfy the maintenance requirements of ruminant animals (Bediye *et al*., 2001). The fiber content of the straw was also high which may affect digestibility of the feed and limit voluntary feed intake. Thus, barley straw necessitates supplementation with CP rich feeds for its effective utilization.

The CP content of tagasaste leaves used in current study was greater than 15%, a level that is usually required to support lactation and growth (Norton, 1982). Protein supplements are feeds of animal or plant origin that contain more than 15% CP to serve as a protein supplement (Susan, 2003). Furthermore, the NDF values of the supplement feeds are lower than the 55% reported by Van Soest (1965) to limit appetite and digestibility. Tagasaste in the present study possess NDF value of 36% and can be expressed as a high quality feed. Singh and Oosting (1992) noted that roughages with NDF content of 45-65% are generally categorized as medium quality feed, while feed with NDF below 45% are grouped as high quality feeds. In general, the NDF content of tagasaste is very low, which has an implication with regard to feed intake. On the other hand, the high NDF and ADF contents of the barley straw may have an impact on intake and digestibility, respectively. Feeds with high ADF content could lower the availability of nutrients since there is a negative relationship between ADF and digestibility of feeds (McDonald *et al*., 2002)

5.2 Feed intake, body weight change and feed conversion efficiency

Feed intake is one of the most important factors which influences performance of animals and can be defined as the amount of feed consumed by an animal or group of animals in a given period of time during which they have free access to it. It is a potential parameter to determine the nutritive value of animal feeds. In the present study, the significant difference in intake of DM, OM and CP with increasing levels of tagasaste supplementation ($P<0.05$) is consistent with Becholie *et al* .(2005) who reported supplementation with (tagasaste as a protein source) increased total DM, OM and CP intakes in lambs fed a basal diet of grass hay. Sánchez *et al. (*2006) also observed increased intake in cows supplemented with *Moringa oleifera* leaves to a basal diet of grass hay. Similar results were also reported by Foster *et al. (*2009) and Gebregiorgis *et al.* (2011) who found that supplementation of sheep with *Moringa stenopetala* fed a basal diet of grass hay improved intake of DM, OM, and CP.

Assefa *et al*. (2008) observed increased CP intake with increasing levels of tagasaste supplementation in sheep fed a basal diet of grass hay. The finding of Assefa (2007) also showed that supplementation of Menz sheep with tagasaste forage significantly ($P<0.01$) improved daily CP intakes over the noug based concentrate mix. The increased DM, OM, and CP intake with increasing levels of tagasaste supplementation can be attributed to the lower fiber and higher CP contents of tagasaste. Improvement in intake through dietary protein supplementation is due to an increase in N supply to the rumen microorganisms (Van Soest, 1994). The low total intake observed in this experiment in unsupplemented animals may be due to the low level of CP in the barley straw.

Sheep in the control group lost weight, while those animals supplemented with tagasaste leaf gained weight and the rate of gain increased with increasing level of supplementation. The increase in body weight gain with increasing levels of tagasaste leaf could be due to increasing total DM and CP intake leading to increased feed conversion efficiency. The loss in body weight in the control group could be explained by low intake and low N content of the barley straw. The body weight loss for control treatment indicates that supplementation with protein source is necessary for sheep fed barley straw for growth and development.

In accordance with the present study, Nega (2007) reported that live weight change and final live weight of sheep supplemented with noug seed cake and rice bran at different proportion were superior to the control and sole rice bran supplemented groups. Similarly, Gebregiorgis *et al. (*2011) also reported increased body weight in sheep receiving supplement containing *Moringa. stenopetala* leaf meals. Manaye *et al*. (2009) and Gebregiorgis *et al. (*2012) also reported that there was improvement in body weights of sheep receiving supplementation ration containing *Moringa stenopetala* leaf meals. Similar studies by Mpairwe *et al. (*1998) also reported linear increase in body weight of sheep supplemented with *Moringa stenopetala* leaf meal and *Gliricdia sepium* leaf meal with a basal diet of elephant grass and Rhodes grass. In all the three body weight parameters, the control treatments had the lowest value signifying the importance of protein supplementation in improving growth rate of growing animals.

Animals that have a high FCE are considered efficient users of feed (Brown *et al.,* 2001). This indicates that sheep in supplemented groups were best feed converters as compared to sheep in the control group. In general, supplementation of sheep in the present study, significantly improved FCE compared to the non-supplemented group. The improvement in FCE are in accordance with the observations of Banerjee *et al. (*2013) in rams reared on *Milletia ferruginea* leaf meal when compared to those reared on a basal diet alone. Alemu (2006) also showed that FCE was significantly improved ($P<0.001$) for supplemented sheep compared to the control treatment.

5.3 Apparent digestibility of nutrients

Digestibility of DM, OM, CP, NDF and ADF were improved with increasing levels of tagasaste leaf supplementation. In agreement to this result Melaku (2001) reported that multipurpose trees are seldom fed to ruminants as a sole source of feed and, therefore, their important attributes are their ability to improve the digestibility and utilization of fibrous feeds when used as a supplement. Bonsi and Osuji (1997) also reported that supplementation of Sesbania or Leucaena to tef straw improved the digestibility of DM, OM and N.

The improved DM and OM digestion for supplemented groups as compared to the sheep fed barley straw sole diet may be explained in part by the presence of high fiber concentration in barley straw. This result is in line with the value reported by Arthun *et al.* (992) where barley straw was supplemented with alfalfa hay. The increased digestibility of CP in supplemented treatments as compared to unsupplemented ones could be due to the high total CP intake of the supplemented animals and relatively lower CP intake of sheep fed the basal diet of barley straw alone. This result is similar with Tolera and Sundstøl (2000) who observed a linear increase in CP digestibility with increasing levels of legume supplementation in sheep fed a basal diet of maize stover. Tafa (2006) and Amare (2007) also reported that supplementation with oil seed cakes and wheat bran improved ($P<0.05$) the digestibility of CP. Foster *et al.* (2009) indicate that digestibility of CP generally increase as CP intake increase because metabolic fecal N is inversely related to CP intake and is higher at lower intake than at higher intake. In the current study, the DM, OM, CP, NDF and ADF digestibility of different levels of tagasaste leaf supplemented with barley straw were higher than the control (sole barley straw) diet. This clearly indicates that tagasaste leaf supplementation has played a significant role in improving digestibility of barley straw based diets.

5.4 Carcass parameters

Among the supplemented groups, T5 and T4 had greater slaughter weight and hot carcass weight than the others two supplemented treatments. The slaughter body weight and hot carcass weight values of this study was comparable to the 21.9kg and 8.3kg, respectively reported by Eshete (2011) but was lower than the 28.9kg and 14.2kg, respectively reported by Awgchew (2000). This might be attributed to differences in the initial age and weight of the experimental animals.

The value obtained for dressing percentage on both slaughtering weight and empty body weight bases were in accordance with the results reported by Gereslassie (2007) for Arado sheep and Ermias (1990) for Menz and Horro sheep. The dressing percentages on empty body weight basis were higher than on slaughter weight basis, implying the influence of digesta (gut fill) on dressing percentage. Similar to the current results, Nuhu (2010) also reported higher body weight in animals reared on supplemented diet compared to unsupplemented ones. This may be explained by more availability of nutrients due to supplementation when compared to those not receiving such supplementation.

The value obtained for rib eye area (REA) in this study was comparable to the 5.1 to 10.6 cm^2 range of values noted by Teklesadik (2008) and also relatively comparable to the 5.7 to 8.6 cm^2 result reported by Kefeni (2008) for the sheep supplemented with 200 and 300 g linseed cake. The effect of supplementation on REA was also reported by Matiwos (2007) who reported higher REA values for the goats receiving supplementary feed. In present study there was a linear increase in REA with increasing level of tagasaste supplementation, with the highest being observed for those supplemented at 400 g/d (10.6 cm^2). This implies that supplementation of tagasaste increased not only body weight gain, but also carcass yield and quality. This finding was in line with many other studies (Aweke, 2005; Moges, 2005; Betsha, 2005; and Gereslassie, 2007).

Heart, liver, head with tongue, kidney, reticlo-rumen, omasum-abomasum and tail were considered as edible offals. Blood, spleen, lung, trachea, testicles, skin, feet and gallbladder were categorized as non-edible offals in the study area. Offal represents additional protein and energy sources for human consumption in many developing regions; especially where protein is in limited supply goat skin is eaten after cooking (Prasad and Kirton, 1992). In countries where offals are used in the food habit such as Ethiopia, sellable offals add values to the carcass (Legesse, 2001). Due to differences in eating habit of the people and social tabbos, the edible portions of the carcass in one area of the country may not be the same as the other. Therefore, in this study categorization of offals as edible or non edible was based on the eating habit of the people in the locality where the study was conducted.

In the present study, weight of head with tongue (g) was heavier (P<0.05) in supplemented groups than non-supplemented group. The increase in liver weight with increasing supplementation of tagasaste leaf might be related with the storage of reserve substances such as glycogen as described by Lawrence (1998). Similarly, Fluharty and McClure (1997) reported that high protein diets resulted in greater weights of liver, small intestine, and kidney compared to normal protein diets in lambs. Previous studies (Moges, 2005; Tafa, 2006; Yirga, 2008) reported that heavier weight of edible offal components for supplemented groups than the non-supplemented group, which is consistent with the results of the current study. The values obtained in this study for heart, head with tongue and lung and trachea were higher for the supplemented group compared to the control group and it was in accordance with the findings of Sebsibe *et al. (*2007), who also reported that goats reared on supplemented diet had higher weight of the heart when compared to those of the un supplemented group.

The higher weight of non-edible offal component of the supplemented groups were due to the higher CP and lower fiber fraction content compared to barley straw basal diet. In agreement with the present study, Okello *et al*. (1994) reported that the non-carcass components of goat were significantly affected by diet. Similarly, Kumer *et al*. (1991) showed that the weights of total non-carcass components were significantly ($p<0.01$) affected by diet. The weight of skin of rams supplemented with the highest tagasaste leaf were significantly higher ($p<0.05$) than rams kept only on barley straw. The increasing trend in skin weight might be due to an increase in subcutaneous fat deposition under the skin (Lawrence and Fowler, 1997). Similar results were also reported by Moges (2005) on Wogera sheep fed hay and supplemented with brewery dried grain.

6. CONCLUSION AND RECOMMENDATION

This study explored the effects supplementation of graded levels of tagasaste to Menze sheep fed barley straw basal diets. The results showed that the supplementation linearly improved feed intake, nutrient digestibility, body weight gain, carcass yield and quality. Supplementation with tagasaste leaf at a level of 400g/d/head did not show any negative effecton any of nutritional and carcass characteristics, and this rate of supplementation can be applied to achieve higher daily weight gains and carcass yield. It is thus recommended to promote the adoption of tagasaste cultivation to produce high quality feed supplement, while at the same time contributing to the ecological sustainability of the mixed farming system in the Ethiopian highlands, where the plant is well adapted.

REFERENCE

Alemayehu, M., 2004 Rangelands biodiversity: concepts, approaches and the way forward. Addis Ababa University, Faculty of Science, Addis Ababa, Ethiopia. 80p.

Alemu, M., 2006. Effects of supplementing different protein sources on feed intake and live weight gain of local sheep fed on finger millet (*Eleucine coracana*) straw basal diet. An Msc Thesis submitted to School of Graduate Studies. Haramaya University. 52p.

Amare, D., 2007 Effects of supplementation of cactus (opuntia ficus-indica) teff straw based diets with oil seed cakes on feed utilization, body weight changes and carcass traits of Tigray highland sheep. School of Graduate Studies, Haramaya University.

Anderson, F. M,1987 Animal feed resources for small-scale livestock producers. In: Kategile J A, Said A N and Dzowela B H (eds.) Proceedings of the Second Pastures Network for Eastern and Southern Africa (PANESA) workshop, held at the International Laboratory for Research on Animal Diseases, Kabete, Nairobi, Kenya, 11-15 November 1985.

A O Okubanjo (1997), Meat characteristics of singed and conventionally dressed chevron carcasses. *Food Science and Technology,* 34, 6, 494-497.

Arthun, D., Holecheck JL, Wallace JD, Galyean ML, Cardenas M, et al. (1992) Forbs and shrub influences on steer nitrogen retention. Journal of Range Management 45: 133-136.

Assefa, G., 1998a. Observation on potential of various treatment options to overcome the inhibition of germination in tagasaste (*Chamaecytisus palmensis*). Proceddings of ESAP, Fifth national conference of Ethiopian Society of Animal Production. 5-17 May, Addis Ababa, Ethiopia. pp 220-227

Assefa, G.,1998b, Biomass yield, botanical fraction and quality of tagasaste (Chamaecytisus palmensis) as affected by harvesting interval in the highlands of Ethiopia. Agroforestry system, 42,13-23.

Assefa, G., 2007. Evaluation of tagasaste (*Chamaecytisus palmensis*) as forage for ruminants PhD Dissertation, Huboldt University, Berlin, German.

Assefa, G., Kijora, C., Kehaliew, A., Bediye, S., Peters, K.J., 2008. Evaluation of tagasaste (*Chamaecytisus palmensis*) forage as a substitute for concentrate in diets of sheep. Livestock Science, 114, 296ï 304.

Aweke, A., 2005. Feedlot fattening performance and carcass characteristics of intact male

Hararghe highland goats fed different levels of hay to concentrate ratios. MSc Thesis Presented to the School of Graduate Studies of Alemaya University of Agriculture, Ethiopia. Pp65

Awgchew, K., 2000 Comparative performance evaluation of Horro and Menz sheep of Ethiopia under grazing and intensive feeding conditions. PhD. Dissertation. Animal Science, University of Wales, UK. 159p

Awgchew, K., 2004. The State of Ethiopia's Farm Animal Genetic Resources-Country Report: A Contribution to the First Report on the State of the World's Animal Genetic Resources. ESAP (Ethiopian Society of Animal Production) Newsletter. Issue No. 10, 2004.

Banerjee, S., Kassa Demo and Aster Abebe., 2013. Some serum biochemical and carcass Traits of Arsi bale rams reared on graded levels of *millettia ferruginea* leaf meal.

Becholie, D., Terril B, Singh TH, Kassa H (2005) Suitability of Tagasaste (Chamaecytisus palmensis) as a source of protein supplement to tropical grass hay fed to lambs. Small Ruminant Research 56: 55-64.

Bediye, S; Getinet Asefa, Abate, Tedla and Dereje, Fikadu, 2001. Present status and future direction in feed resources and nutrition research targeted for wheat based crop livestock production system in Ethiopia. pp. 207-226. Proceedings of Two Stakeholder Workshops. Improving the productivity of Crop Livestock Production in Wheat-based Farming Systems in Ethiopia, Addis Ababa, Ethiopia, 10-11 October 2000.

Ben Salem H, Makkar H P S, Nefzaoui A., 2004 Towards better utilization of non-conventional feed resources by sheep and goats in some African and Asian countries. In: Nutrition and feeding strategies of sheep and goats under harsh climates. Proceedings of the Ninth Seminar of the Sub-Network on Nutrition of the FAO-CIHEAM Inter-Regional Cooperative Research and

Development Network on Sheep and Goats, Hammamet (Tunisia), 8-10 Nov 2001. pp. 177ï 187.

Berhanu, G., D.Hoekstra and Azege T., 2006.Improving the Competitiveness of Agricultural Input Market in Ethiopia: Experiences since 1991. Paper presented at the Symposium on seed-fertilizer Technology. Cereal productivity and Pro-Poor Growth in Africa: time for New Thinking 26th Triennial Conference of the Internatinal Association of Agricultural Economics (IAAE), August 12 -18, Gold Coast, Australia.

Berhe, K., Tedla, A., Mohammed, S.M.A., 1993. Establishment and evaluation of multipurpose trees for sustainable farming systems in the Ethiopian highlands Paper presented at the 5th annual conference of the crop science society of Ethiopia. 2-3 Fed.,1993. Addis Ababa.

Berhe, K., Tothill, J.C.,1997. Dry matter yield, P response and nutritive value of selected accessions of *Chamaecytisus palmensis* (tagasaste) and Teline monspessulana (Montpellier broom) in the Ethiopian highlands. Tropical grasslands, 31, 49-57 .

Betsha, S., 2005.Supplementation of graded levels of peanut cake and wheat bran mixture on nutrient utilization and carcass parameters of Somali goats. M.Sc. Thesis Presented to the School of Graduate Studies of Alemaya University of Agriculture, Alemaya, Ethiopia. Pp. 60.

Bonsi, M.L.K., Osuji, P.O., 1997. The effect of feeding cottonseed cake, Sesbania or leucaena with crushed maize as supplement to tef straw. Livest. Prod. Sci. 51, 173ï 181.

Bonsi, M.L.K., Osuji, P.O., Tuah, A.K., 1995. Effect of supplementing teff straw with different levels of leucaena or sesbania leaves on the degradabilities of teff straw, sesbania, tagasaste and vernonia and on certain rumen and blood metabolites in Ethiopian Menz sheep. Anim. Feed Sci. Technol. 52, 101ï 129.

Borens, F.M.P., Poppi, D.P., 1990. The nutritive value for ruminants of tagasaste (Chamaecytisus Palmensis), a leguminous tree. Anim.Feed Sci.Technol., 28, 275-292.

Brown, L., R. Hindmarsh, R. Mcgregor, 2001. Dynamic agricultural book three (2nd ed.) McGraw-Hill Book Company, Sydney, 357p.

Buxton, D.R.,1996.Qualty ï related characteristics of forage as influenced by plant environment and agronomic factors. Anim. Feed Sci. Technol. 59: 37-49

CACC (Central Agricultural Census Commission) 2008 Ethiopian Agricultural Sample Enumeration 2007/08. Results at country level. Statistical report on socio-economic characteristics of the population in agricultural household, land use, and area and production of crops. Part I. (December 2008) Addis Ababa, Ethiopia).

CSA (Central Statistic Authority) of Ethiopia, 2014,Agricultural sample survey Report on livestock and livestock characteristics(Private peasant holdings). Vol.II.194p.

CSA (Central Statistic Authority) 2008 Ethiopian Statistical Abstract, Central Statistical Authority, Addis Ababa Ethiopia.

CSA (Central Statistic Authority) 2003 Central Statistics Authority of the Federal Democratic Republic of Ethiopia.

Duguma, G; Tackler, K., Ulfina Gemeda and Solomon Abegaz, 2003. Growth performance of weaned Horo lambs fed basal diet of barley (*Mosnoo)* straw and supplemented with different levels of concentrate. In: Proceeding of the 11th National Livestock Improvement Conference (ESAP), Addis Ababa, Ethiopia. Pp. 355-358.

EARO (Ethiopian Agricultural Research Organization). (2000). National Small Ruminants Research Strategy Document. EARO, Addis Ababa, Ethiopia. EPA (Ethiopian Privatization Agency).2002. Accessed 25 Sept 2011.

http://www.telecom.net.et/~epa/Sectors/leather.html.

Ehui S.K., Benin S. and Nega Gebreselassie. 2000. Factors affecting urban demand for live sheep: The case of Addis Ababa, Ethiopia. Socio-economic and Policy Research Working Paper 31. ILRI (International Livestock Research Institute), Nairobi, Kenya. 32 pp.

El Hassan, 2000. Chemical composition and degradation characteristics of foliage of some African multipurpose trees. Anim. Feed Sci. Technol. 86, 27-37. http://www.unctad.org/en/docs/poiteipcm4.en.pdf.

Ensiminger M.E., J.E. Oldfish and W.W. Heinmann,1990. Feeds and Nutrition. 2nd edn. The Ensiminger Publishing Company. USA. PP.433-460.

EPA (Ethiopian Privatization Agency). (2002). Investment and innovation policy review of Ethiopia. United Nations Confer-ence on Trade and Development. 138 p. United Nations New York and Geneva, 2002. Accessed 22 October 2011.

Ermias, E., 1990. Between and within breed variation in feed intake and fat deposition, and genetic association of these with some production traits in Menz and Horro sheep. MSc Thesis presented to the school of Graduate Studies of Alemaya University.

Eshete, T., 2011. Effect of inclusion of different proportions of tossign (Thymus serrulatus) in concentrate mix supplement on feed intake, body weight change, digestibility and carcass parameters of Menz sheep fed grass hay. An MSc Thesis Presented to the School of Graduate Studies of Haramaya University, Haramaya, Ethiopia. 89p

FAO (2009) *FAO STAT Data* Accessed 25 October 2011) http://www.fao.org/docrep/012/i0680e/i0680e.pdf.

Fluharty, F.K.L. and E.K. McClure, 1997 Effect of dietary energy intakes and protein concentration on intakes and visceral organ mass lambs Journal of Animal Science, pp. Pp 604-610.

Foster, J.L., Adesogan, A.T., Carter, J.N., Blount, A.R., Myer, R.O., Phata, K., 2009. Intake, digestibility and N retention by sheep supplemented with watm-season legume hays or soybean meal. Journal of Animal Science, 87, 2891ï 2898.

Gebregiorgis, F.; Negesse, T.; Nurfeta, A. Feed intake and utilization in sheep fed graded levels of dried moringa (*Moringa stenopetala*) leaf as a supplement to Rhodes grass hay. *Tropical Animal Health Production* 2011, *44*, 511ï 517.

Gebregiorgis, F; Tegene Negesse and Ajebu Nurfeta, 2012. Feed intake and utilization in sheep fed graded levels of dried moringa (Moringa stenopetala) leaf as a supplement to Rhodes grass hay. Tropical Animal Health Production 44:511ï 517

Gereslassie, Z., 2007. Supplementation of sesame seed (*Sesame indicum*) cake, wheat bran and their mixtures on feed intake, digestibility, live weight changes and carcass characteristics of Arado sheep fed a basal diet of teff straw. An MSc Thesis Presented to the School of Graduate Studies of Alemaya University of Agriculture, Ethiopia. Pp. 57.

Getahun, L., 2008. Procuction and performance of smaal ruminant in two production system of the highlands of Ethiopia

Gilmour, A.R., Cullis, J.J., Fogarty, N.M. and Banks, R. (1994): Genetic parameter for ultrasonic fat depth and eye muscle measurement in live poll Dorset sheep. *Aust. J. of Agric. Res.,* 45:1281-1291.

Gizaw S., Van Arendonk J.A.M., Komen H., Windig J.J. and Ha-notte O. (2007). Population structure, genetic variation and morphological diversity in indigenous sheep of Ethiopia. *Anim. Genet.* 38**,** 621-628.

Gudmundsson, O. & O. Dyrmundsson. 1989. Grazing and lamb growth. In: Dyrmundsson, Olafur R.and Sigurgeir Thorgeirsson (eds.). Reproduction, Growth and Nutrition in Sheep. Dr

Halldor Palsson Memorial Publication. Agricultural Research Institute and Agricultural Society, Iceland, pp. 147-168.

Hawley, K., 1984. Tree Lucerne and establishment. Western Australia Department of Agriculture Bulletin No MA 25/84, Manjimp Regional Office.

Ibrahim, M.N.M., Tamminga, S., Zemmelik, G., 1995. Degradation of tropical roughages and concentrate feeds in the rumen. Anim. Feed Sci. Technol. 54, 81ï 92.

ICRAF, 2006 Agro forestry tree database, a tree species reference and selection site: Chamaecytisus Palmensis, world agroforestry centre. (www.worldagroforestrycentre.org).

ILRI (International Livestock Research Institute), 1999. Building a global research institute. ILRI. Addis Ababa, Ethiopia.

Ingimundarson, J. H. 1995. Of sagas and sheep: Toward a historical anthropology of social change and production for market, subsistence and tribute in early Iceland (10th to the 13th century). PhD dissertation, Dept. Anthropology, University of Arizona. 355 p

Kamalak A, Canbolat O, Gurbuz Y, Ozay O, Ozkan CO, et al. (2004) Chemical Composition and invitro gas production characteristics of several tannin containing tree leaves. Livestock research for rural development

Kefeni, B., 2008. Effects of supplementation with sweet potato tuber and haricot bean screanings on feed utilization, growth, and carcass characterstics of Adilo sheep. An MSc Thesis Presented to the School of Graduate Studies of Haramaya Universitry, Ethiopia. 73p.

Kosgey I.S. and Okeyo A.M. (2007). Genetic improvement of small ruminants in low-input, smallholder production systems: Technical and infrastructural issues. *Small Rumin. Res.* **70,** 76-88.

Kumer, S. S.P.Tiwari, and M.P. Narang,1991. Effects of different plane of nutrition on carcass characteristics on Gadi goats. Indian vet.J.68: 953-956.

Kusiluka Lughano and Dominic Kambarage. 1996. Disease of small ruminants in sub-Saharan Africa.

Larbi, A., Osakwe, I.I., Lambourne, J.W**.** 1993. Variation in relative palatability to sheep among *Gliricidia sepium* provenances. *Agroforestry Systems*, 22: 221-224.

Lawrence, T.L.J. and V.R. Fowler, 1998. Growth of Farm Animals. CAB International, London. pp. 64-84.

Lawrence, T. J. L., and V. R. Fowler. 1997. Growth of farm animals. CAB International, New York.

Lazier, J.,1987. Tree Lucerne, Chamaecytisus palmensis. Forage Network in Ethiopia (FNE). Newsletter 18:21-23 International livestock Research centre (ILCA). Addis Ababa, Ethiopia.

LDMPS 2006 Livestock development master plan study. Phase 1. Addis Ababa, Ethiopia

Legesse, G., 2001. Growth pattern and carcass characteristics of Somali and Mid-Rift valley goats. An MSc Thesis Presented to the School of Graduate Studies Haramaya University. Pp.1-106.

Leng, R.A., 1997. Tree Foliage in Ruminant Nutrition. FAO Animal Production and Health Paper. No. 139. FAO (Food and Agriculture Organization), Rome, Italy.

Lindeque, J.P., Rethman, N.F.G., 1998. The nutritive value of tagasaste, a leguminous fodder tree, in marginal summer rainfall areas of South Africa. S. Afr. For. J. 182, 51ï 54.

Manaye, T., Tolera, A., Zewdu, T., 2009. Feed intake, digestibility and body weight gain of sheep fed Napier grass mixed with different levels of *Sesbania sesban*. Livestock Science, 122, 24ï 29.

Matiwos , S., 2007. The effect of different levels of cotton seed meal supplementation on feed intake, digestibility, live weight changes and carcass parameters of Sidama goats. An Msc. thesis Presented to the School of Graduate Studies of Alemaya University of Agriculture, Alemaya Ethiopia. pp. 19-34.

McDonald, P., R.A. Edward, J.F.D. Greenhalgh and G.A. Morgan., 2002. Animal Nutrition 6th ed. Pearson Educational Limited. Edinburgh, Great Britain. Pp 544.

McDonald, P., Edwards, R.A., Greenhalgh, J.F.D., Morgan, C.A., 2002. Animal Nutrition, 6th ed., (Prentice Hall, USA).

Melaku, S., 2001. Evaluation of selected multi-purpose trees as feed supplements in tef (Eragrostis tef) straw based feeding of Menze sheep. Ph.D Thesis, Humboldt University, Berlin, Germany. 210 pp.

Mengistu, A., 2006. Forage resource profile of Ethiopia. FAO forage resources profile. FAO, Rome Italy. http://www.fao.org/ag/AGP/AGPC/doc/Counprof/Ethiopia/Ethiopia.htm.

Moges, M., 2005. Effect of feeding different levels of breweries dried grain on live Weight gain and carcass characteristics of Wogera sheep fed on hay basal diet. An MSc Thesis Presented to the School of Graduate Studies of Alemaya University Agriculture, Ethiopia. Pp. 1-39.

Mpairwe D R, ;Sabiiti E N and Mugerwa J S 1998. Effect of dried *Gliricidia sepium* leafSupplement on feed intake, digestibility and nitrogen retention in sheep fed dried KW4 Elephant grass (*Pennisetum purpureum*) *ad libitum*, Agroforestry Systems. 41: 139 ï 150.

Mukssa-Mugerwa, A. and K.Lahulou, 1995. Reproductive Performance and Productivity of Menz sheep in the Ethiopian High lands. Small Ruminant Research. 17:167-177.

National Soil Research Center (NSRC). 2006. Soils of the farms of Debre-Birehan agricultural research center and its testing sites. Technical report, NSRC, Addis Ababa, Ethiopia, 57p

Nega, A., 2007. Effect of rice bran and/ or Noug (Guizotia abayssinica) seed cake supplementation on feed utilization and live weight change of Farta sheep fed native grass hay. An MSc Thesis Presented to the School of Graduate Studies of Haramaya University, Haramaya, Ethiopia. 75p.

Niange, A., 1996. Forage potential of eight woody species: intake and growth rates of local young goats in the highland region of Rwanda. Agroforestry systems. 34, 171-178.

Norton, B. W., 1982. Difference between species in forage quality. In: J. B.(ed), nutritional limits to animal production from pastures. pp. 89-110. Proc. Of an international symposium held at St. luice, Queens land, Australia, August 24-28, 1981, Common Wealth Agricultural Bureaus, UK.

Nuhu, F., 2010. Effect of Moringa leaf meal (MOLM) on nutrient digestibility, growth, carcass and blood indices of weaner rabbits. A thesis submitted to the school of graduate studies, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

Okello, K.L., C. Ebong and J. Opida-Asibo, 1994. Effect of feed supplement on weight gain and carcass characteristics of intact male Mubende goats fed Elehant grass (*P.purpureum*) adlibitum in Uganda.IN: Proceeding of 3 biennial conference of the African small ruminant research network, Udanda.

Paterson, R.T., G.M. Karanja, O.Z. Nyaata, I.W. Kariuki and R.L. Roothaert, 1998. A review of tree fodder production and utilization within smallholder agroforestry systems in Kenya. Agroforestry Syst.,41: 181-199.

Prasad, V.S. and A.H. Kirton, 1992. Classification of live goats, their carcasses and cuts. In:v international conference on goats, pre-conference proceeding and invited papers, volume ŌŌpart ŌŌ New Delhi. Pp. 440-450.

Raghuvansi, S.K.S., R. Prasad, A.S. Mishra, O.H. Chaturvedi, M.K. Tripathi, A.K. Misra, B.L. Saraswat and R.C. Jakhmola. 2007. Effect of inclusion of tree leaves in feed on nutrient utilization and rumen fermentation in sheep. Biores. Technol., 98: 511-517.

Ranjan S. K., 2001. Animal Nutrition in the Tropics. 5th Revised ed. Vikas Publishing House Pvt.Ltd. Masjid Road, jangpura, New Delhi. 207p.

RIRDC, 2002. Forage trees and shrubsnin Australia- their current use and future potential. Rural Industries Research and Development Corporation (RIRDC). RIRDC publication, 02/039. Australia.

Sánchez, R., Spröndly, E., Ledin, I., 2006. Effect of feeding different level of foliage of Moringa oliefera to Creole dairy cows on intake, digestibility, milk production and composition. Livestock Science, 101, 24ï 31.

SAS (2008), Statistical Analysis System Userœ Guide . SAS Institute Inc., Cary, N.C. 27513 U.S.A.

Sebsibe, A., 2009. Sheep and goat meat characteristics and quality. Pp326-340. Ethiopian Sheep and Goat productivity Improvement Program hand book, Addis Ababa, Ethiopia

Sebsibe, A; N.H. Casey; W.A. Van Niekerk; Azage Tegegne; R.J. Coertze;, 2007. Growth performance and carcass characteristics of three Ethiopian goat breeds fed grain less diets varying in concentrate to roughage ratios. *South African Journal of Animal Science.* 37 (4):221-232

Sere, C., 2008 Livestock production and poverty alleviation-challenges and opportunities in arid and semi-arid tropical rangeland based systems. In: the proceedings of multi-functional grasslands in a changing world. XXI International Grassland Congress and VII InternationalRangelandCongress,China.19-29 pp. http://64.95.130.4/ILRIPubAware/Uploaded%20Files/Sere%20IGC%20paper%208%20pages%20final_formatted.pdf and http://www.slideshare.net/ILRI/china-grasslands-congress-june-16-v3

Siaw, 1993. Screening of two *Sesbania* species for fodder potential and response to phosphorus application on an acid soil in Ethiopia. In: Kategile, J.A. and Adoutan, S.B. (Eds), Collaborative Research on *Sesbania* in East and Southern Africa. Proceedings of an AFRNET Workshop held in Nairobi, 9-14 September 1991, ILCA, Nairobi, Kenya.

Singh, G.P.and S.J. Oosting, 1992. A model describing the energy value of straw. *Indian Dairyman* XLIV: 322-327.

Smith, O.B., 1992a. Fodder trees and fodder shrubs in range and farming systems of tropical humid Africa. In: Speedy, A. and Pugliese, P.L. (Eds), Legume trees and other fodder trees as protein sources for livestock. FAO (Food and Agriculture Organization) Animal Production and Health Paper No. 102. FAO, Rome, Italy. pp. 43-60.

Smith, O.B., 1992b.Small ruminant feeding systems for small-scale farmers in humid West Africa. In: Stares, J.E.S., Said, A.N., Kategile, J.A. (Eds.), The Complementarity of Feed Resourcesfor Animal Production in Africa. Proceedings of the Joint Feed Resources Network Workshop, Gabrone, Botswana, 4ï 8 March, pp. 363ï 376.

Snook, L.C., 1982 Tagasaste (tree Lucerne) *Chamaecytisus Palmensis*: a shrub with high potential as production fodder crop. Journal of the Australia Institute of Agricultural Science 48, 209-213.

Snook, L.C., 1986.Tagasaste (tree Lucerne), high production fodder crop. Night Owl Publishers Australia.

Solomon, A., 2009: Technical Bulletin no. 28. Sheep Breeds of Ethiopia: a Guide for Identification and Utilization**:** http://www.esgpip.org. Accessed March, 2015.

Susan S., 2003. An Introduction to feeding Small Ruminants. Western Maryland Research and EducationCenterMarylandCooperativeExtension.http://www.sheepandgoat.com/ articles/feedingsmallruminants.html, May 30,2012

Tafa, A., 2006. Supplementation with linseed (*linum usitatissimum*) cake, wheat bran, and their mixture on feed intake, digestibility, live weight changes and carcass characteristics in intact male Arsi- Bale sheep. An MSc Thesis Presented to the School of Graduate Studies of Harama University, Haramaya, Ethiopia. 52p.

Tegegne, A and Alemu, G., 1998 Prospects for Peri-urban Diary Development in Ethiopia pp.28-39. In: ESAP proceedings: Fifth National Conference of the Ethiopian Society of Animal Production. Addis Ababa, Ethiopia, 15-17 may 1997. Institute of Agricultural Research

Tekletsadik, E., 2008. Effect of Supplementation with Barley Bran, Linseed Meal, and TheirMixtures on the Performance of Arsi-Bale Sheep Fed a Basal Diet of Faba Bean Haulms. An MSc Thesis Presented to the School of Graduate Studies of Haramaya University, Haramaya, Ehiopia. 66p.

Tembely, S.,1998. Small ruminantôs production in Ethiopia. Prospects for improving Productivity. Proceedings of the 5th National conference of Ethiopian Society of Animal production. 15-17 May 1997. Addis Ababa, Ethiopia.

Thorhallsdottir, A. G. and I. Thorsteinsson. 1993. Behaviour and plant selection. Búvísindi ï Icel. Agr. Sci. 7:59-77.

Tibbo M. (2006). Productivity and health of indigenous sheep breeds and crossbreds in the central Ethiopian highlands. Ph D. Thesis. Swedish Univ. Uppsala, Sweden.

Tolera, A and Abebe, A., 2007. Livestock production in pastoral and agro-pastoral production systems of southern Ethiopia. Livestock Research for Rural Development 19 (12) . pp 4-7.

Tolera, A., 1997. Nutritive evaluation of some browse species. *Animal Feed Science and Technology,* 67:181-1 95.

Tolera, A., Sundstøl, F. 2000. Supplementation of graded levels of *Desmodium intortum* hay to sheep feeding on maize stover harvested at three stage of maturity 1: Feed intake, digestiility and body weight change. Animal Feed Science and Technology, 85, 239ï 257.

Topps, J.H., 1992. Potential, composition and use of legume shrubs and trees as fodders for livestock in the tropics. J. Agric. Sci. (Camb.) 118, 1-8.

Torell, R. and N. Suverly, 2004. Nevada Market Lamb Carcass Merit Program. *Fact Sheet- 04 02.*http://www.meatupdate.csiro.au/data/Advances_in_Meat_Tech_III_07-82.pdf 10- 07 2009.

Tsedeke K., 2007. Production and marketing of sheep and goat in Alaba, SNNPR. Msc thesis. Hawassa University. Hawassa, Ethiopia

Van Gylswyk, N.O., 1995. Factors limiting proliferation of desirable groups of bacteria in the rumen of animals feed poor quality feeds of high fiber contents. In: Wallace, R.J., Lahlou-Kassi, A. (Eds.), Proceedings of the Workshop on Rumen Ecology Research Planning, ILRI, Addis Ababa, Ethiopia, 13ï 18 March, pp. 121ï 127.

Van Soest, P. J. 1994. Nutritional Ecology of the Ruminant, 2nd Edition, (Cornell University Press, Ithaca, NY)

Van Soest, P.J. and Robertson, J.B. (1985): Analysis of Forages and Fibrous Feeds. Laboratory Manual for Animal Science, Vol. 613. Cornell University, New York.

Van Soest, P.J., 1965. Symposium of factors influencing the voluntary intake in relation to chemical composition and digestibility. Journal of *Animal Science*. 24: 834p.

Varvikko, T., 1991. Smallholder dairy production in North Shoa, Ethiopian Highlands: assessment of feed resources in relation to the requirements in smallholder farm. Development of Appropriate FeedingSystems for Dairy Cattle in Ethiopian Highland Resource Development Project. Final Report. ILCA, Addis Ababa, Ethiopia.

Varvikko, T., Khalili, H., 1993. Wilted tagasaste (*Chamaecytisus palmensis*) forage as replacement for a concentrate supplement for lactating crossbred *F*riesian × Zebu (Boran) dairy cows fed low-quality native hay. Anim. Feed Sci. Technol. 40, 239ï 250

Ventura, M.R., Castanon, J.I.R., Rey, L., Flores, M.P., 2002. Chemical composition and digestibility of tagasaste (Chamaecytisus proliferus). Sub-species for goats. . *Animal Feed Science Technology*. 46, 207ï 210.

Yirga, H., 2008. Supplementation of concentrate mix to Hararghe highland sheep fed a basal diet of urea treated maize stover: effect on feed utilization, live weight change and carcass characteristics. An MSc Thesis Presented to the School of Graduate Studies of Haramaya University.75p.

APPENDICES

Appendix Table 1: ANOVA for feed intake of yearling Menz sheep fed basal diet of barley straw supplemented with graded levels of tagasaste leaf

Parameters	Source	Sum of square	DF	Mean square	F	Sig
Basal diet DMI	Treatment	2664.466667	4	666.116667	32.09	0.0001
	Error	519.000000	25	20.760000		

	Total	3183.466667	29			
Supplement DMI	Treatment	433500.0000	4	108375.0000	Infty	0.0001
	Error	0.0000	25	0.0000		
	Total	433500.0000	29			
Total DMI	Treatment	387956.3726	4	96989.0931	514.22	0.0001
	Error	4715.3625	25	188.6145		
	Total	392671.7351	29			
Total OMI	Treatment	423879.6985	4	105969.9246	543.26	0.0001
	Error	4876.5815	25	195.0633		
	Total	428756.2800	29			
Total CPI	Treatment	15579.49298	4	3894.87325	6484.01	0.0001
	Error	15.01722	25	0.60069		
	Total	15594.51020	29			

Appendeix Table 2: ANOVA for body weight change of yearling Menz sheep fed basal diet of barley straw supplemented with graded levels of tagasaste leaf

Parameters	Source	Sum of square	DF	Mean square	F	Sig
Initial body weight	Treatment	0.29866667	4	0.07466667	0.08	0.988
	Error	23.65333333	25	0.94613333		
	Total	23.95200000	29			

Final body weight	Treatment	203.2853333	4	50.8213333	46.35	0.0001
	Error	27.4133333	25	1.0965333		
	Total	230.6986667	29			
Total weight gain	Treatment	192.9413333	4	48.2353333	227.81	0.0001
	Error	5.2933333	25	0.211733		
	Total	198.2346667	29			
Average daily gain	Treatment	23819.9177	4	5954.97942	227.81	0.0001
	Error	653.49794	25	26.13992		
	Total	24473.41564	29			
FCE	Treatment	0.05404617	4	0.01351154	162.43	0.0001
	Error	0.00207959	25	0.00008318		
	Total	0.05612576	29			

Appendix Table 3: ANOVA for apparent digestibility of yearling Menz sheep fed basal diet of barley straw supplemented with graded levels of tagasaste leaf

Parameters	Source	Sum of square	DF	Mean square	F	Sig
DM digestibility	Treatment	1477.138667	4	369.284667	32.48	0.0001
	Error	284.200000	25	11.368000		
	Total	1761.338667	29			

OM digestibility	Treatment	954.502000	4	238.625500	21.98	0.0001
	Error	271.365000	25	10.854600		
	Total	1225.867000	29			
CP digestibility	Treatment	945.623333	4	236.405833	13.94	0.0001
	Error	424.071667	25	16.962867		
	Total	1369.695000	29			
NDF digestibility	Treatment	598.6353333	4	149.6588333	10.8	0.0001
	Error	346.3633333	25	13.8545333		
	Total	944.9986667	29			
ADF digestibility	Treatment	454.3433333	4	113.5858333	7.34	0.0005
	Error	386.6516667	25	15.4660667		
	Total	840.9950000	29			

Appendix Table 4: ANOVA for carcass parameters of yearling Menz sheep fed basal diet of barley straw supplemented with graded levels of tagasaste leaf

Parameters	Source	Sum of square	DF	Mean square	F	Sig
SW	Treatment	182.0800000	4	45.5200000	38.73	0.0001
	Error	29.3866667	25	1.1754667		
	Total	211.4666667	29			
EBW	Treatment	124.3214533	4	31.0803633	16.01	0.0001
	Error	48.5288167	25	1.9411527		
	Total	172.8502700	29			
HCW	Treatment	80.4958467	4	20.1239617	9.39	0.0001
	Error	53.5508500	25	2.1420340		
	Total	134.0466967	29			
REA	Treatment	106.7263333	4	26.6815833	182.15	0.0001
	Error	3.6620833	25	0.1464833		
	Total	110.3884167	29			
DP on SW basis	Treatment	228.303009	4	57.075752	1.6	0.206
	Error	893.043322	25	35.721733		
	Total	1121.346331	29			
DP on EBW basis	Treatment	208.5252401	4	52.1313100	1.81	0.1582
	Error	719.4282188	25	28.7771288		
	Total	927.9534588	29			

Appendix Table 5: ANOVA for edible offal component of yearling Menz sheep fed basal diet of barley straw supplemented with graded levels of tagasaste leaf

Parameters	Source	Sum of square	DF	Mean square	F	Sig
Heart	Treatment	4386.6666	4	1096.66667	2.89	0.04
	Error	9483.33333	25	379.33333		
	Total	13870.00000	29			
Head with GB	Treatment	302480.0000	4	75620.0000	3.41	0.02
	Error	554416.6667	25	22176.6667		
	Total	856896.6667	29			
Liver	Treatment	17420.00000	4	4355.00000	7.4	0.0004
	Error	14716.66667	25	588.66667		
	Total	32136.66667	29			
Kidney	Treatment	186.666667	4	46.666667	0.83	0.516
	Error	1400.000000	25	56.000000		
	Total	1586.666667	29			
Reticlo-rumen	Treatment	49253.33333	4	12313.33333	6.27	0.001
	Error	49083.33333	25	1963.33333		
	Total	98336.66667	29			
Oma-abomassum	Treatment	13246.66667	4	3311.66667	4.71	0.005
	Error	17583.33333	25	703.33333		
	Total	30830.00000	29			
Tail	Treatment	242113.3333	4	60528.3333	11.52	0.0001
	Error	131366.6667	25	5254.6667		
	Total	373480.0000	29			

Appendix Table 6: ANOVA for non edible offal components of yearling Menz sheep fed basal diet of barley straw supplemented with graded levels of tagasaste leaf

Parameters	Source	Sum of square	DF	Mean square	F	Sig
Skin	Treatment	472813.333	4	118203.333	2.83	0.046
	Error	1044483.333	25	41779.333		
	Total	1517296.667	29			
Blood	Treatment	227086.6667	4	56771.6667	17.30	0.0001
	Error	82033.3333	25	3281.3333		
	Total	309120.0000	29			
Testis	Treatment	58566.66667	4	14641.66667	13.17	0.0001
	Error	27783.33333	25	1111.33333		
	Total	86350.00000	29			
Lung &Trachea	Treatment	38020.00000	4	9505.00000	6.41	0.001
	Error	37050.00000	25	1482.00000		
	Total	75070.00000	29			
Spleen	Treatment	413.333333	4	103.333333	1.53	0.2226
	Error	1683.333333	25	67.333333		
	Total	2096.666667	29			
Gallblader	Treatment	4946.666667	4	1236.666667	24.09	0.0001
	Error	1283.333333	25	51.333333		
	Total	6230.000000	29			
Feet	Treatment	15186.66667	4	3796.66667	3.5	0.021
	Error	27150.00000	25	1086.00000		
	Total	42336.66667	29			

BIBLOGRAPH SCATCH

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APPROVAL SHEET

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Effect of Graded Levels of Tagasaste (*Chamaecytisus palmensis*) Leaves Supplementation on Performance of Yearling Menz Sheep in Ethiopian Highlands

Submitted by:

Meron Mengesha	________________________	_______________
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