Journal of Fisheries & Livestock Production

Gebreselassie et al., J Fisheries Livest Prod 2015, 3:1
DOI: 10.4172/2332-2608.1000124

Research Article | Open Access

# Effect of Supplementation with Dried Leaves of *Acacia albida, Acacia seyal* and their Mixture on Feed Intake and Digestibility of Local Sheep Fed Barley Straw as a Basal Diet

**Neamn Gebreselassie[1]*, Getachew Animut[2] and Mengistu Urge[2]**

[1]*Department of Animal Sciences, Ambo University, P.O. Box: 19, Ambo, Ethiopia*
[2]*Department of Animal Sciences, Haramaya University, P.O. Box: 138, Dire Dawa, Ethiopia*

## Abstract

This study was conducted to evaluate the effect of supplementation of Acacia Albida (AA), Acacia Seyal (AS) and their mixture on feed intake and digestibility of local sheep fed a basal diet of barley straw (BS)". "Twenty four yearling intact male sheep with initial BW of 16.6 kg ± 2.4 (Mean ± SD)" were blocked in to six based on initial BW and animals within a block were randomly assigned to treatments. Treatments were ad libitum barley straw(BS) and 100 g wheat bran (WB) alone (T1) or supplemented with 200 g of dried leaves of *Acacia Albida*(AA) (T2), *Acacia Seyal*(AS) (T3) and a 1:1 mixture of AA:AS (T4). The feeding and digestibility trial "was" conducted for 90 and 7 days, respectively. Dry matter (DM) intake of BS was in the order of T1>T2=T4>T3 (P<0.05). Total DM intake (500, 650, 597 and 636 g/day (SEM=12.96) for T1, T2, T3 and T4, respectively) was lowest for T1, highest for T2 and T4 and intermediate for T3 (P<0.05). Total CP intake "were"38, 77, 65 and 71 g/day for T1, T2, T3 and T4, respectively, and was increased by supplementation (P<0.05). Among the supplemented treatments, T2 had higher (P<0.05) CP intake than T3, while the CP intake of T4 was similar with T2 and T3. Apparent digestibility of DM and CP increased (P<0.05) and that of NDF and ADF was unaffected (P>0.05) by the supplementation. Therefore, result of the current study suggested that 200g AA leaf meal supplementation to barley straw basal diet to be better in feed intake and digestibility.

**Keywords:** *Acacia albida; Acacia seyal;* Sheep; Intake and digestibility

## Introduction

Ethiopia is believed to have the largest livestock population in Africa. This livestock sector has been contributing considerable portion to the economy of the country, and still promising to rally round the economic development of the country [1]. Small ruminants are important sources of foreign currency [2] and at a farm level small ruminants serve as investment and insurance due to high fertility, short generation interval and their ability to produce in limited feed resource and their adaptation to harsh environment [3]. Cereal crop residues can play an important role in the feeding of sheep under different management systems [4]. However, crop residues are low in crude protein and phosphorus, marginal in calcium and high in fiber and lignin. As a result, digestion is slow and voluntary intake is limited [5].

To solve the problem of low digestibility and correct nutrient deficiencies in crop residues use of leaves of browse plants and agro-industrial by-products as supplements is regarded as a good option [6]. Leaves of many trees and shrubs are rich sources of protein, vitamins and minerals and can be used for supplementing low quality roughages (grasses, straws and stovers) [7]. Assessing the feeding value of certain browse species such as *Acacia albida* and *Acacia seyal* "are" essential to develop alternative and relatively cheaper "supplemental diets" to improve animal performance during harsh environmental conditions when insufficient amount of natural pasture and crop residues are available in the area. *Acacia albida* and *Acacia seyal* are important "source" of protein and they can be used to correct nutritional deficiencies of low quality feeds such as crop residues. Studies on supplementation of *Acacia albida* and *Acacia seyal* fodder tree leaves on feed intake and digestibility of local sheep found in Eastern zone of Tigray (Northern part of Ethiopia) has not been done so far. The present study was therefore, undertaken to explore the feeding value of *Acacia albida* and *Acacia seyal* fodder tree leaves available in the Eastern zone of Tigray around Adigrat for small ruminants. In view of these facts the present study was designed 'with the objective to assess" the feed intake and digestibility of local sheep fed a basal diet of barley straw and supplemented with dried leaves of *Acacia albida, Acacia seyal* and their mixture.

## Materials and Method

### Description of the study area

The experiment was conducted at Ganta-AfeshumWoreda, which is found in Eastern Zone of Tigray Regional State. The study area is located at 898 km North of Addis Ababa and 115 km from Mekelle (capital city of Tigray). It is found between 14°16' N latitude and 39° 27' E longitudes with an elevation of 2457 meter above sea level. It has Weinadega climate, with 552 mm mean annual rain fall and 16°C temperatures.

### Feed preparation and feeding

Barley straw was purchased from surrounding farmers and stored under a shade to maintain its quality and was used as basal diet throughout the experimental period. *Acacia Albida and Acacia Seyal* tree leaves were collected by hand harvesting the small side branches containing the green leaves from trees of area closures, farm lands, and grazing lands. The collected leaves were dried under shade on plastic sheet for later use in animal feeding. After they were dried, the leaves were stored in sacks. Wheat bran was purchased from flour milling factory in the surrounding and used to adjust the maintenance requirement for the control treatment since the CP content of barley straw is low or under the maintenance requirement. The amount of supplement to be offered to each animal was weighed separately and

***Corresponding author:** Neamn Gebreselassie, Department of Animal Sciences, Ambo University, Ethiopia, E-mail: neamsellase@gmail.com

**Received** September 27, 2014; **Accepted** October 30, 2014; **Published** January 07, 2014

**Citation:** Gebreselassie N, Animut G, Urge M (2015) Effect of Supplementation with Dried Leaves of *Acacia albida*, *Acacia seyal* and their Mixture on Feed Intake and Digestibility of Local Sheep Fed Barley Straw as a Basal Diet. J Fisheries Livest Prod 2: 124. doi: 10.4172/2332-2608.1000124

offered to the animal. When offered in mixture the supplements were weighed separately and mixed together for feeding animals. Barley straw, salt and water were offered *adlibitum* to the animal throughout the experiment.

### Experimental design and treatments

Twenty four yearling local male sheep with a live weight of 16.6 kg ± 2.4 (Mean ± SD) were purchased from local market and used for the experiment. During the quarantine period of 21 days the animals were ear tagged, drenched with Albendazol a broad-spectrum "anti-helminthic" drug, vaccinated against ovine Pasteurelosis and sprayed with Acaricides against external parasites. To conduct the experiment a randomized complete block design (RCBD) was used. Before the adaptation period the experimental animals were blocked in to six blocks of four animals based on their initial body weight. The initial body weight of lambs for blocking was determined after overnight fasting of the lambs during the starting of adaptation period. Then after the animals were offered *ad libitum* barley straw with 100 g wheat bran and supplemented with dried leaves of *Acacia albida, Acacia seyal* alone or their 1:1. They were "adapted to the feeds" prior to the feeding trial for 15 days. The four treatment diets (Table 1) were randomly assigned to each animal in the block which results in six animals per treatment.

### Measurements

**Feed intake:** Feed offered to the experimental animals and the corresponding refusals of every animal were recorded daily throughout the experimental period to determine daily feed intake. Both basal and supplement feed intake was determined as a difference between the amount of feed offered and refused. Daily refusal and offered samples were taken from each feed offered and feed refusals of each animal for chemical analysis. Then, at the end of week 12, the refusal and offered samples were mixed well for each animal and each feed, respectively. Because of the high expense associated with chemical analysis, the refusal samples were bulked into 4 (i.e., refusal of six animals per treatment bulked together).

**Digestibility:** Digestibility trial was conducted after the 90 days of feeding trial. The lambs were fitted with fecal collection bags (harness) and were adapted to fecal collection bags for 3 days which was followed by 7 days fecal collection period. Samples of faeces were collected every day in the morning. The total faeces voided in the harness per animal was weighed daily during the fecal collection period. After the daily collected faeces were weighed a 20% representative sample was taken from each sample to form a composite of fecal sample for each animal and stored in the refrigerator for 7 days. Then after, the fresh feaces from each animal was taken to Mekelle soil laboratory for an oven drying and dried at 55°C for 72 hours. Partially dried, weight of samples was taken, and faeces samples were grounded to pass through 1 mm sieve and were stored in air tight polyethylene bag until analyzed. The apparent digestibility coefficient (DC) of nutrients was calculated by using the equation:

$$\text{Apparent digestibility coefficient} = \frac{\text{Nutrient intake- Nutrient in feces}}{\text{Nutrient intake}}$$

## Results and Discussion

### Chemical composition of treatment feeds

The chemical compositions of the treatment feeds are given in Table 2. The CP content of the barley straw used in this study was 4.66%, indicating that the CP content of the straw used in this study has a low potential to support the maintenance requirements of sheep, and as such wheat bran was added to fulfill the maintenance requirement of the sheep especially for the control treatment. The CP content of barley straw used in this study was relatively comparable to the CP of 4% reported by Mesfin and Ledin [8] but higher than the CP content of 3.9% and 3.55% reported by Dawit and Zewdie [9,10], respectively. The difference in CP content of barley straw in different studies may be due to the variation in variety and the environment the crop was grown. The chemical composition of the barley straw could be characterized by its low CP, high NDF and ADF contents. This high content of NDF in barley straw may imply low intake of the basal diet since NDF is a major factor regulating feed intake as it is the major component limiting rumen fill, and directly correlated with rumination or chewing time [11].

The NDF content of barley straw used in this study was similar to the NDF content of 78.9% [8]. Acid detergent fiber content of barley straw used in this study was higher than 50.2% reported by Mesfin and Ledin [8].

The DM content of wheat bran used in this study was similar to the result of 90.5% and 90.4% reported by Emebet and Hirut [12,13],

| Treatments | Barley straw | WB (gDM/day) | Supplement(gDM/day) |
|---|---|---|---|
| 1 | *Ad libitum* | 100 | __ |
| 2 | *Ad libitum* | 100 | 200g *Acacia albida* leaves |
| 3 | *Ad libitum* | 100 | 200g *Acacia seyal* leaves |
| 4 | *Ad libitum* | 100 | 100 g *Acacia albida* + 100 g *Acacia seyal* |

DM=dry matter; WB=wheat bran

**Table 1:** Experimental treatments.

| Feed offered | Chemical composition | | | | | |
|---|---|---|---|---|---|---|
| | DM (%) | CP (% DM) | NDF (% DM) | ADF (% DM) | ADL (% DM) | Ash (% DM) |
| Barly straw | 91.96 | 4.66 | 77.50 | 51.20 | 7.92 | 10.49 |
| Wheat bran | 90.15 | 17.49 | 48.57 | 13.95 | 6.94 | 4.71 |
| *AAL* | 91.28 | 20.81 | 51.28 | 35.59 | 15.57 | 9.49 |
| *ASL* | 91.60 | 16.96 | 68.43 | 58.32 | 24.70 | 13.18 |
| *AAL:ASL* | 91.23 | 18.18 | 62.67 | 52.94 | 19.75 | 11.86 |

*AAL* = *Acacia albida* leaves; *ASL* =*Acacia seyal* leaves; ADF =Acid detergent fiber; ADL =Acid detergent lignin; CP = crude protein; DM = dry matter; NDF = Neutral detergent fiber. T1= Barley straw *ad libitum* + 100 g Wheat bran; T2 = Barley straw *ad libitum* + 100 g Wheat bran + 200 g *Acacia albida* leaf meal; T3 = Barley straw *ad libitum* + 100 g Wheat bran + 200 g *Acacia seyal* leaf meal; T4 = Barley straw *ad libitum* + 100g Wheat bran + 100 g *Acacia albida* leaf meal + 100 g *Acacia seyal* leaf meal.

**Table 2:** Chemical composition of treatment feeds.

respectively. The NDF and ADF content of the wheat bran was higher than the values reported by Awet and Jemberu [14,15]. But, the NDF content is lower than 58% and 55.5% reported by Emebet and Hirut [12,13] respectively. The CP content of wheat bran is variable. According to Lonsdale [16], the CP content of wheat bran varies from 13.3 to 17.0%. The result of the current study (17.49%) also relates to the highest value (17%) of this range. The CP content of wheat bran used in this experiment was also comparable to the values of 17 and 19.55% reported by Fentie and Simret [17,18] respectively. The differences between the results in chemical composition of wheat bran used in the different studies observed might be due to the variation in milling method, and possibly due to the variation in variety of the crop.

The DM contents of *Acacia albida, Acacia seyal* leaves and their mixtures were almost similar and ranged from 91.23-91.6%. But the OM content of *Acacia albida* leaf meal was higher than that of *Acacia seyal* leaf meal. The CP content of *Acacia albida* leaf meal was relatively higher than that of *Acacia seyal* leaf meal. The CP content of *Acacia albida* leaf used in this study was similar to the CP content of 20.1% reported by Reed et al. [19]. Robyn et al. [20] also found 19.7% CP for *Acacia albida* leaf. The CP content of *Acacia seyal* leaf was lower than that of 19.43% reported by Ahmed et al. [21], but higher than the result of 15% CP reported by Dommergues [22]. The NDF and ADF values of *Acacia albida* leaf meal were lower than that of *Acacia seyal* leaf meal. Feeds that contain high proportion of ADF have lower availability of nutrients due to ADF being less correlated with feed digestibility [23]. The NDF and ADF content of *Acacia* leaves used in this study was comparable to the findings of Kamalak et al. [24] that reported 42% to 56% and 28.3% to 34.2% and Kaitho et al. [25] that noted 22% to 69.4% and 14% to 52.3 % for NDF and ADF, respectively.

## Feed intake

The mean daily feed DM and nutrient intake of the experimental sheep is given in Table 3. There was a significant difference among treatments in barley straw DM intake. Barley straw DM intake was highest for the control diet (P<0.05). Thus, the non-supplemented animals consumed more barley straw in order to satisfy their nutrient requirements. Similar to the present result DM intake of basal diet in various studies was greater for the non-supplemented than the supplemented animal [12]. On the other hand, the decline in barley straw DM intake with the supplementation of *Acacia seyal* leaf meal alone than the other supplemented treatments might be associated with the high fiber contents of *Acacia seyal* leaf meal as compared to *Acacia albida* leaf meal. The higher the composition of the NDF and ADF in feedstuffs, the lower the nutritive value and/or intake of that feed [26]. Wheat bran as well as the supplemental leaf meals were readily consumed by all animals with no left over.

Total DM intake was lowest for T1, highest for T2 and T4 and intermediate for T3 (P<0.05). The greater DM intake in the supplemented sheep is obviously due to the additional DM intake from the supplement. Difference in total DM intake among the supplemented treatments was also consistent with differences in intake of the basal diet. Similar result to the present study was reported by Girma et al. [27] in which sheep fed maize stover supplemented with legumes and legumes plus concentrate mixture showed significantly higher total DM intake. Becholie et al. [28] also reported that supplementation with a protein source (tagasaste) increased total DM, OM and CP intakes in lambs fed on a basal diet of grass hay. The values of total DM intake noted in this study was within the range of values of 434.8-753.3 g/d reported by Ermias [29] for sheep fed a basal diet of fababean haulms and supplemented with barley bran, linseed meal and their mixtures.

The total OM intake followed a similar trend with DM intake as it is the reflection of total DM intake. Total CP intake was significantly increased by supplementation (P<0.05). Among the supplemented treatments, animals on sole *Acacia albia* leaf meal supplementation had higher (P<0.05) CP intake than sole *Acacia seyal* leaf supplemented animals, while the CP intake of the mixture supplemented animal was similar (P>0.05) with the other two supplemented treatments. It appeared that differences in total CP intake were a result of difference in intakes of the basal diet and the chemical composition of the feeds. Intakes of total NDF and ADF were lower (P<0.05) for control treatment as compared to the supplement treatments being proportional to variation in total DM intake.

## Dry matter and nutrient digestibility

Apparent digestibility of DM, OM, CP, NDF and ADF is given in Table 4. The apparent digestibility of DM, OM and CP in the present study increased (P<0.05) by the supplementation of the *Acacia albida* or *Acacia seyal* leaf meal or their mixture. Differences in DM, OM, and CP digestibility among the supplemented treatments were not significant (P>0.05). NDF and ADF digestibility were not significantly affected (P>0.05) in the current study. The lower DM and OM digestion for barley straw sole diet as compared to the supplemented treatments 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. [30] where barley straw was supplemented with alfalfa hay. The similarity in apparent digestibility of DM and OM among the supplemented treatments may be explained by the relatively similar

| Intake (g/day) | Treatments | | | | SEM |
|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | |
| Barley straw DM | 399.91[a] | 350.24[b] | 296.75[c] | 335.81[b] | 8.72 |
| Wheat bran DM | 100 | 100 | 100 | 100 | - |
| BS+WB DM | 499.91[a] | 450.24[b] | 396.75[c] | 435.81[b] | 8.72 |
| Supplement DM | - | 200 | 200 | 200 | - |
| Total DM | 499.91[c] | 650.24[a] | 596.75[b] | 635.81[a] | 12.96 |
| OM | 483.58[c] | 617.23[a] | 555.98[b] | 598.43[a] | 11.49 |
| CP | 38.03[c] | 76.86[a] | 65.45[b] | 70.87[ab] | 3.33 |
| NDF | 384.76[c] | 446.29[ab] | 433.98[b] | 456.93[a] | 6.75 |
| ADF | 236.05[c] | 280.13[b] | 294.75[ab] | 306.81[a] | 6.47 |

[a-c]Means with different superscripts in a row are significantly different (P<0.05); ADF = Acid detergent fiber; CP = Crude protein; DM = Dry matter; NDF = Neutral detergent fiber; OM = Organic matter; SEM = standard error of mean; BS = Barley straw; WB = Wheat bran; T1= Barley straw *ad libitum* + 100 g Wheat bran; T2 = Barley straw *ad libitum* + 100 g Wheat bran + 200 g *Acacia albida* leaf meal; T3 = Barley straw *ad libitum* + 100 g Wheat bran + 200 g *Acacia seyal* leaf meal; T4 = Barley straw *ad libitum* + 100 g Wheat bran + 100 g *Acacia albida* leaf meal + 100 g *Acacia seyal* leaf meal.

**Table 3:** Dry matter and nutrient intake of local sheep fed barley straw basal diet and supplemented with *Acacia Albida, Acacia Seyal* leaves and their mixture.

| Digestibility coefficient | Treatments | | | | SEM |
|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | |
| DM | $0.59^b$ | $0.69^a$ | $0.67^a$ | $0.69^a$ | 0.52 |
| OM | $0.66^b$ | $0.72^a$ | $0.70^a$ | $0.71^a$ | 0.29 |
| CP | $0.56^b$ | $0.73^a$ | $0.68^a$ | $0.70^a$ | 0.02 |
| NDF | 0.58 | 0.63 | 0.65 | 0.64 | 0.87 |
| ADF | 0.51 | 0.53 | 0.57 | 0.56 | 0.43 |

$^{a-b}$Means with different superscripts in a row are significantly different (P<0.05); ADF = Acid detergent fiber; CP = Crude protein intake; DM = Dry matter; NDF = Neutral detergent fiber; OM = Organic matter; SEM = standard error of mean; T1= Barley straw *ad libitum* + 100 g Wheat bran; T2 = Barley straw *ad libitum* + 100 g Wheat bran + 200 g *Acacia albida* leaf meal; T3 = Barley straw *ad libitum* + 100 g Wheat bran + 200 g *Acacia seyal* leaf meal; T4 = Barley straw *ad libitum* + 100 g Wheat bran + 100 g *Acacia albida* leaf meal + 100 g *Acacia seyal* leaf meal.

**Table 4:** Apparent dry matter and nutrient digestibility of feeds in local sheep fed barley straw basal diet and supplemented with *Acacia Albida, Acacia Seyal* leaves and their mixture.

intake of DM and nutrients in the supplemented group. In line with the current result Dawit [9] reported that the apparent digestibility of DM of the diet increased by supplementation of urea treated barley straw with vetch and alfalfa hay as compared to the control. Koralagama et al. [31] also reported that supplementation significantly improved the apparent digestibility of DM and OM in sheep supplemented with cowpea or commercial concentrate at 150 or 300g DM/day to maize-stover.

The increased digestibility of CP in supplemented animals compared to non-supplemented 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 alone and any increase in protein intake may result in an increase in apparent digestibility of CP. In agreement with the present study, Abebe and Amare [32,33] reported that supplementation with oil seed cakes and wheat bran improved (P<0.05) the digestibility of CP. On the other hand, the lack of difference in fiber digestibility due to supplementation may be attributed to reduction in rumen PH which has a depressing effect on the population of fiber fermenting rumen microorganisms, as a result of feeding more digestible supplement to the animals. The digestibility coefficient for fiber constituents observed in the present study is in agreement with the result reported by Kaitho et al. and Abebe [32,34] who concluded that supplementation had little or no effect on fiber digestibility.

## Summary and Conclusions

This study was conducted to evaluate the effect of supplementation of *Acacia albida, Acacia seyal leaves* and their mixture on feed intake and digestibility of local sheep. Feed intake was measured daily and fecal output was measured in the digestibility period. Samples of feed offered and refusals during both trials and feces during the digestibility trial were collected for chemical analysis (DM, ash, CP, NDF, ADF and ADL).

There was a significant difference among treatments in barley straw DM intake. Barley straw DM intake was highest for the control diet (P<0.05) and was in the order of T1>T2=T4>T3 (P<0.05). Total DM intake was lowest for T1, highest for T2 and T4 and intermediate for T3 (P<0.05). The greater DM intake in the supplemented sheep is obviously due to the additional DM intake from the supplement. Total CP intake was significantly increased by supplementation (P<0.05). Among the supplemented treatments, animals on sole *Acacia albia* leaf meal supplementation had higher (P<0.05) CP intake than sole *Acacia seyal* leaf supplemented animals, while the CP intake of the mixture supplemented animal was similar (P>0.05) with the other two supplemented treatments. The differences in total CP intake were a result of difference in intakes of the basal diet and the chemical composition of the feeds.

The apparent digestibility of DM, OM and CP in the present study increased (P<0.05) by the supplementation of the *Acacia albida* or *Acacia seyal* leaf meal or their mixture. However differences in DM, OM, and CP digestibility among the supplemented treatments were not significant (P>0.05). NDF and ADF digestibility were not significantly affected (P>0.05) in the current study. The lower DM and OM digestion for barley straw sole diet as compared to the supplemented treatments may be explained in part by the presence of high fiber concentration in barley straw. Therefore, result of the current study suggested that feeding barley straw basal diet plus 100g wheat bran and supplemented with 200 g *Acacia albida* leaf meal to local sheep to be better both in feed intake and digestibility.

### Acknowledgements

I wish to express my deepest gratitude and appreciation to all my family for their unreserved material and moral assistance during my MSc thesis research. Sincere thanks are also extended to Ministry of Education for the study grant which made it possible for the first author to pursue graduate study at Haramaya University.

### References

1. Central Statistical Agency (CSA) (2010) Agricultural Sample Survey 2009/10. Report on Livestock and Livestock Characteristics (Private Peasant Holdings).
2. Berhanu G, Hoekstra D, Tegegne A (2006) Improving the competitiveness of Agricultural input markets in Ethiopia: Paper presented at the Symposium on seed-fertilizer Technology, cereal productivity and proper growth in Africa.
3. Tsedeke K (2007) Production and Marketing of sheep and goats in Alaba, Hawassa University, Awassa, Ethiopia.
4. Jayasuriya MC (1984) Potential for the better utilization of crop residues and agro-industrial by-products in animal feeding in the Indian sub-continent.
5. McDowell RE (1985) Importance of crop residues for feeding livestock in smallholder farming systems.
6. Aganga AA (2002) Indigenous browses as feed resources for grazing herbivores in Botswana. African Journal of Science 3: 14-19.
7. Aganga AA, Mesho EO (2008) Mineral contents of browse plants in Kweneng district of Botswana. Journal of Agriculture 3: 93-98.
8. Mesfin R, Ledin I (2004) Comparison of feeding urea-treated teff and barley straw based diets with hay based diet to crossbred dairy cows on feed intake, milk yield, milk composition and economic benefits. Livestock Research for Rural Development.
9. Dawit A (2007) Effect of Vetch (vicia dasycarpa, l.) and Alfalfa (medicago sativa 'hunter river') hay supplementation on feed intake, digestibility and body weight change of Arsi- Bale sheep fed a basal diet of urea treated Barley straw.
10. Zewdie W (2012) Livestock production systems in relation with feed availability in the highlands and central rift valley of Ethiopia.
11. Cheeke PR (1999) Applied Animal Nutrition. Feeds and feeding. (2nd edn) Prentic Hall, Upper Saddle River Publishing Company, New York.
12. Emebet L (2008) Supplementation of Black head Ogden sheep feed haricot bean haulms with mixture of wheat bran and brewers dried grain: effects on feed utilization, live weight gain and carcass parameters. School of Graduate Studies, Haramaya University.

13. Hirut Y (2008) Supplementation of concentrate mixture to Hararghe highland sheep fed a basal diet of urea-treated maize stover: effect on feed utilization, live weight change and carcass characteristics. School of Graduate Studies, Haramaya University.

14. Awet E (2007) Feed utilization, body weight change and carcass parameters of intact and castrated Afar sheep fed on urea treated teff straw supplemented with wheat bran. An. M.Sc. Thesis presented to the School of Graduate Studies, Haramaya University.

15. Jemberu D (2008) Effect of supplementation of Simada sheep with graded levels of concentrate mixture on feed intake, digestibility and live weight parameters. School of Graduate Studies, Haramaya University.

16. Lonsdale C (1989) Row materials for Animal feed compounders and farmers. Straights (Book) Chalcombe publications, Great Britain.

17. Fentie B (2007) Feed utilization and live weight change of Farta sheep supplemented with noug seed (Guizotia abyssinica) cake, wheat bran and their mixtures. School of Graduate Studies, Haramaya University.

18. Simret B (2005) Supplementation of graded levels of peanut cake and wheat bran mixture on nutrient utilization and carcass parameters of Somali goats. School of Graduate Studies, Alemaya University.

19. Reed JD, Rittner U, Tanner J (1992) Nutritive value of leaves and fruits of Acacia albida and their use in feeding ruminants.

20. Robyn DA, Anthony CS (2002) Livestock potential of Australian species of Acacia.

21. Mahala AG, Fadel Elseed MA (2007) Chemical Composition and invitro gas production characteristics of six fodder trees leaves and seeds. Research Journal of Agriculture and Biological Science 3: 983-986.

22. Dommergues E (1999) Description, distribution and nutritional quality of Acacia seyal.

23. McDonald RE, Edward RA, Greenhalgh JFD, Morgan GA (2002) Animal Nutrition 6th edition. Longman scientific and technical Co-published in the USA, New York.

24. 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.

25. Kaitho RI, Nsahlai IV, Williams MK, Umunna NN, Tamminga S, et al. (1997) Relationships between preference, rumen degradability, gas production and chemical composition of browses. Agro-forestry systems, 39: 129-144.

26. Alemu Y (1981) Laboratory evaluation and estimation of nutritive value of some feed stuffs produced in the Alemaya Woreda. School of Graduate Studies, Addis Ababa University.

27. Girma G, Said AN, Sundstol F (1994) The effect of forage legume supplementation on digestibility and body weight gain by sheep fed a basal diet of Maize stover. Animal Feed Science and Technology 46: 97-108.

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

29. Ermias T (2008) The effect of supplementation with barley bran, linseed meal and their mixtures on the performance of Arsi-Bale sheep fed a basal diet of Faba bean haulms. School of Graduate Studies, Haramaya University.

30. 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.

31. Koralagama KDN, Mould FL, Fernandez S, Hanson J (2008) The effect of supplementing Maize stover with Cowpea (Vigna unguiculata) haulms on the intake and growth performance of Ethiopian sheep. Cambridge Journal of Animal Science 2: 954 -961.

32. Abebe T (2006) Supplementation with linseed (linum usitatissimum) cake, wheat bran and their mixtures on feed intake, digestibility, live weight changes, and carcass characteristics in intact male Arsi-Bale sheep. School of Graduate Studies, Haramaya University.

33. 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.

34. Kaitho RJ, Umunna NN, Nsahlai IV, Tamminga S, Van Bruchem J (1998) Effect of feeding graded levels of Leucaena leucocephala, Leucaena pallida, Sesbania sesban and Chamaecytisus palmensis supplements to teff straw given to Ethiopian Highland sheep. Animal Feed Science and Technology 72: 355-366.