Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.6, No.1, 2016


# Effect of Feeding Graded Level of Dried Acacia Saligna Leaves on Milk Yield and Milk Composition of Crossbred Dairy Cows Fed Grass Hay as Basal Diet

Tsadkan Zegeye Solomon Gebreyohaness Mehari Kebede
Mekelle Agricultural Research Center, PO Box 492 Mekelle, Tigray, Ethiopia

**Abstract**
The study was conducted to evaluate the effect of feeding graded level of *Acacia saligna* leaves on dry matter intake, milk yield and milk composition of crossbred dairy cows. Four treatments namely grass hay + 3.00kg wheat bran as a control (T1), control + 2.50Kg *A. saligna* leaves per day (T2), control + 3.75kg *A. saligna* leaves per day (T3), control and 5kg *A. saligna* leaves per day (T4). The experiment lasted for 120 days at four periods (each period containing 20 days) following 10 days adaptation through cross over design using four lactating cows. Feed offered, refused and milk yield were measured daily. For milk composition, milk samples were analyzed from each treatment during the second and last week of each period using lactoscan milk analyzer. CP contents were 6.55, 16.2 and 14.8 for native grass hay, wheat bran and dried *A. saligna* leaves, respectively. The milk fat contents were 5.2, 4.24, 5.1 and 4.6 for T1, T2, T3 and T4, respectively. The protein contents were also 3.0, 3.97, 3.10 and 3.06 for T1, T2, T3 and T4, respectively. The average milk yield for the treatments was ranged from 6.26-6.61 lit/day. The results showed that there was no significant difference ($P>0.05$) in daily dry matter intake and milk compositions but there was significant difference ($P<0.05$) in milk yield. Supplementation of lactating cows with dried *A. saligna* leaves increased milk yield. Hence, dried *A. saligna* leaves can be used as alternative feed sources for dairy farming.
**Keywords:** Dry matter intake, Feed intake, Milk quality, Supplementation.

## Introduction

Ethiopia owns 50.9 million cattle (CSA 2011) indicating huge potential for dairy production (Azage et al, 2013). There is also potentially large market for dairy products. Market oriented smallholder dairy development presents a promising option to boost rural incomes, improve food and nutrition security, achieve sustainable poverty alleviation and employment opportunity (Bennett et al 2006).

Dairy production, among other sectors of livestock production system, is a crucial issue in Ethiopia. Dairying has not been fully exploited and promoted in the country. Despite its huge numbers, the livestock sector is low in production and the contribution it makes to the national economy is limited. Policy decision on milk and milk product marketing are taken in the absence of vital information on how they affect dairy producers, traders, exporters and consumers. Similarly, current knowledge on dairy products market structure, performance and price is poor for designing policies and institutions to overcome the perceived problems in the marketing system (Ayele et al 2003).

Increased in population pressure, harms the potential feed sources like pasture land and grazing lands. These resources have been a potential feed provider for livestock for centuries. Currently, these resources are deteriorating because of mismanagement without any intervention. As reported in Tawila et al (2008), chronic feed deficiency in many of the developing countries is due to the population increase and consequently allocation of available land for cereal production. This situation demands the use of non-conventional feed resources in livestock ration, especially from the industrial by products.

Yayneshet et al (2009) reported that in semi- arid and tropical ecosystems, the quality of forages decreases greatly during the dry season, leading to substantial weight loss of animals. This phenomenon requires the alleviation of nutrients deficiency in animals through implementing different feed utilization strategies. These strategies may include maximization of livestock productivity through improving the efficiency of utilization of local feed resources (Shumuye and Yayneshet, 2011). There is, therefore, a need for an alternative feeding strategy which could alleviate livestock feed problem. Hence, the suitable supplementary protein sources feed for livestock during dry season could be utilization of locally available protein sources feeds.

*A. saligna* species is one of the evergreen leguminous browse tree/shrub species that can be used as livestock feed resource during scarcity of feed both in quality and quantity. Abdulrazak *et al* (2000) reported that the crude protein and mineral contents of acacia foliage were high enough to use it as a supplement to low quality diets. In different parts of Ethiopia, it is planted in gully areas, enclosures areas and backyards. In addition to its use as livestock fodder, this species serve as environmental rehabilitation, windbreak, fuel wood, decoration and as soil and water conservation (Shumuye and Yayneshet, 2011).

Research results (Musa, 2011; Shumuye and Yayneshet, 2011) showed that utilization of *A. saligna* leaf as small ruminant feed increases body weight gain in sheep and goat. However, little is known about its feeding

 

value and effect on dairy cow and its products. Therefore, the objectives of the study were to evaluate feed intake and milk yield of crossbred dairy cows supplemented with different graded level of dried *A.saligna* leaf meal and to assess the nutrient composition of the milk produced.

## Materials and Methods

### Study area

This on-station research was conducted at Illala, which is located at $39^0$ 30' E and $13^0$ 30'N longitudes and altitude of 1970m above sea level. The annual mean precipitation is 521.4mm and mean maximum and minimum temperatures are 26.6$^o$c and 11.6$^o$c, respectively. It is located in the Northern end of Mekelle city, the capital of Tigray region, on the Mekelle-Adigrat main road.

### Experimental Animals and management

Four crossbred milking cows (Holstein Frisian and Ethiopian indigenous cattle breed (Arado) cross) all at first parity were bought from Mekelle private farms. All cows were at their second parity during the experimental period and were at an average of 390kg body weight. The experimental animals were tagged for identification, watered (ad libitum) each day with drinking water. They were synchronized through hormone to become on heat and inseminated all at the same time. The housing for the cows was in Mekelle Agricultural Research Center dairy farm. This was a concrete floor, well aerated, roofed with corrugate sheet and good drainage for urine. The hay, wheat bran and dried acacia leaf offered and refused were measured and recorded at daily basis.

### Experimental design

The design for this experiment was a cross over design with four periods (each period containing 20 days), four treatments and four dairy cows circulating at each period. The four crossbred dairy cows were assigned randomly to each treatment with a period of time and circulates (that means every cow received every treatment during the period of the experiment).

### Feed preparation and treatments

The *A. saligna* leaves were collected from Mekelle Agricultural Research Center and air dried under sheds for (3-4 days). The native grass hay was also collected and prepared in Mekelle Agricultural Research Center while wheat bran was purchased from Mekelle flour milling industries. The treatments were native grass hay + 3.00kg wheat bran as control (T1), control + 2.50kg dried *A. saligna* leaves (T2), control + 3.75kg dried *A. saligna* leaves (T3) and control + 5.00kg dried A. saligna leaves (T4).

### Feeding experimental animals

The experimental cows were made to adapt to both the dried A. saligna leaves and wheat bran for ten days and then fed accordingly; cows fed grass hay ad-libitum and 3.00kg wheat bran control/ (T1), cows fed control and supplemented with 2.50kg dried A. saligna leaves (T2), cows fed on control and supplemented with3.75kg dried A. saligna leaves (T3) and, cows fed control and supplemented with 5.00kg dried A. saligna leaves (T4). Each experimental feed was offered for twenty days. Each experimental period was circulated followed with a given ten day adaptation period prior to the entrance of the next experimental period. This was done for a total of eighty experimental days and forty days adaptation.

### Feed intake

The amount of feed offered and refused for each cow was recorded daily. The experimental animals were not allowed to graze in pasture for controlling biasing factors for the whole experimental period. Feed intake was expressed using the following formula;
Feed intake = Amount of feed offered – Amount of feed refused

### Milk sampling

Milk samples were taken two times at the mid and end of each experimental period. Each milk sample was carefully filled to plastic container covered with a lid and put in ice box and analyzed using lacto scan milk analyzer to determine the compositions (total solids, solids not fat, fat, protein, lactose, density, ash, s. gravity) of the milk.

### Chemical Analysis

The dried samples of each feed were ground to pass through a 1 mm screen to determine their chemical composition. Dry matter percentages of the different samples were determined by oven drying the samples at 105$^o$C for 24 hours. Total ash and CP content were determined according to the procedure of AOAC (1990). Ash was also determined by complete burning of the feed samples in a muffle furnace at 500$^o$C overnight. The

 

structural plant constituents' neutral detergent fibers (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL) were analyzed using the detergent extraction method (Van Soest et al 1991). Hemicelluloses were then calculated by subtracting ADF from NDF and cellulose fraction were calculated as the difference between ADF and ADL. The condensed tannin content was analyzed as described by Burns (1971) in Ethiopian Health and Nutrition research institute.

**Statistical analysis**

Data on milk yield and quality were subjected to analysis of variance (ANOVA) using the statistical software GMP5. Chemical compositions were also analyzed using the general linear model (GLM) procedure of the statistical analysis system (SAS 1998). Treatment means were separated by least significance difference (LSD).

**Result and discussion**

**Chemical composition of the experimental feed ingredients**

The chemical composition of *A. saligna* leaves, wheat bran and native grass hay used in this experiment are presented in Table 1. The laboratory analysis showed that the dry matter (DM) content of native grass hay used in this trial was almost the same with the values of 92.9%, 93.12% and 93.8% reported by Simret (2005), Berhan and Getachew (2007) and Bruh (2008), respectively. The CP content of the grass hay was greater than 5.64% reported by Brhan and Getachew (2007), similar to 6.6% and 6.56 reported by Bruh (2008) and Simret (2005), respectively but, less than 7.8% reported by Shumuye and yayneshet (2011). The NDF was comparable to 76.8 and 77.94 % reported by Matiwos (2007) and Mulu (2005) but, greater than 65.88% reported by Shumuye and yayneshet (2011). The differences might be attributed to the varietals variation and environmental factors associated with native grass hay. Generally, native grass hay in this experiment could be characterized by its lower CP content which is below maintenance requirement for ruminants, higher NDF and moderate ADF and ADL contents.

Genet (2011), Simret (2005) and Asnake (2005), reported 21.23%, 20.1% and 19.55% CP, respectively for wheat bran. CP content for wheat bran found in this study was lower than those findings but higher than 14.90% and 13.8% reported by Mulat (2006) and Tesfaye (2009), respectively while it was similar to the finding of Zemicael (2007), Takele and Getachew (2011) and Tesfay and Solomone (2008), reported 16.66%, 16.0% and 16.82% CP content for wheat bran, respectively.

The result of this trial showed that the crude protein content of dried *A. saligna* leaves is high enough to use as a supplement to low quality diets. The CP content of *A. saligna* was higher than 11.40 %, 12.06 %, 12.50 % and 12.70 % reported by Krebs (2011), Shumuye and Yayneshet (2011), Getachew (2005) and Moujahed et al (2000), respectively and comparable to that of 13.11% and 13.07% reported by Ahmed (2007) and Mousa (2011), respectively. The NDF content for *A. saligna* is comparable to 45.2% and 46.2 % reported by Getachew (2005) and Moujahed et al (2000), respectively. However, NDF content for *A. saligna of this study was* higher than 38.7% reported by Ahmed (2007) and less than 48.99% reported by Shumuye and Yayneshet (2011). The ADF content of this study is similar to the 29.48% reported by Shumuye and Yayneshet (2011) but higher than 25.9% and 24.7% reported by Getachew (2005) and Ahmed (2007), respectively and less than 34.9 % reported by Moujahed et al (2000). The ADL content of *A. saligna* used in this study was less than the 11.3% 12.54 % and 17.6 % reported by Getachew (2005), Shumuye and Yayneshet (2011) and Moujahed et al (2000), respectively.

The CT content is lower than 18.67% reported by Shumuye and Yayneshet (2011) for dried *A. saligna* and comparable to 11.46% reported by Getachew (2005). The difference and similarities in *A. saligna* composition probably occurred due to difference in plant age, collection season, soil composition and type, storage, time of exposure to sun or duration during drying, leaf to twig ratio and others.

Table 1: Chemical composition of experimental feed ingredients

| Composition (%) | Grass hay | Wheat bran | *A. saligna* leaf |
|---|---|---|---|
| DM | 94.7 | 93.6 | 92.0 |
| OM | 91.8 | 93.7 | 84.9 |
| CP | 6.55 | 16.2 | 14.8 |
| NDF | 76.2 | 48.0 | 43.4 |
| ADF | 50.6 | 15.5 | 30.6 |
| ADL | 10.4 | 3.52 | 8.04 |
| Ash | 8.23 | 6.27 | 15.1 |
| Soluble matter | 23.9 | 52.0 | 56.6 |
| Hemicelluloses | 25.5 | 32.5 | 12.8 |
| Celluloses | 32.0 | 5.73 | 7.43 |
| CT | - | - | 13.8 |

*DM= dry matter; OM= organic matter; CP= crude protein; NDF= neutral detergent fiber; ADF= acid detergent fiber; ADL= acid detergent lignin; AS= AS; CT= Condensed Tannin; - = value not found;*

 

**Dry matter intake**

Daily dry matter intake (DMI) of the experimental dairy cows is presented in Table 2. There was difference in hay and dried *A. saligna* leaves daily dry matter intake. However, there was no difference in daily wheat bran and daily total dry matter intake among experimental cows. Hay intake was higher in experimental cows not supplemented with dried *A. saligna* leaves. Cows supplemented with higher level (5.00kg/day/head) of dried *A. saligna* leaves showed higher daily dry matter intake than cows supplemented with lower level (2.50kg/day/head). This implied that increasing the level of *A. saligna* leaves did not affect intake or the tannin level was affordable by dairy cows. The findings were similar with that of Steinshamn (2010) where legumes increased dry matter intake than grasses. Similarly, it was in line with the study of (Anbarasu et al 2001 and El-Shaer 2010) who reported that feeding a mixture of acacia shrub can minimize and overcome the problem of palatability and toxic effects. Feeding AS leaves does not affect the total dry matter intake, hence, it can be used as dairy cows feed.

Table 2: Dry mater intakes of dairy cows supplemented with different levels of air dried *A. saligna* leaves fed on grass hay as a basal diet.

| | Treatments | | | | | | |
|---|---|---|---|---|---|---|---|
| **Parameters** | **T1** | **T2** | **T3** | **T4** | **SEM** | **SL** | **P-value** |
| Hay DMI | $11.7^{a}$ | $9.98^{b}$ | $9.35^{b}$ | $9.31^{b}$ | 1.72 | *** | 0.0001 |
| Acacia DMI | 0.00 | $2.22^{c}$ | $2.68^{b}$ | $3.02^{a}$ | 0.46 | *** | 0.0001 |
| Wheat bran DMI | 3.00 | 3.00 | 3.00 | 3.00 | - | - | - |
| Total DMI | 14.7 | 15.2 | 15.0 | 15.3 | 1.89 | Ns | 0.1904 |

*a, b, c, d; means within a row not bearing a common superscript letter significantly differ; ***= ($p<0.0001$); SEM= Standard error mean; Ns; not significance; SL= Significance level; T1= Control treatment (feeding grass hay adlibitum and 3kg of wheat bran); T2= T1 and 2.5kg of air dried A saligna leaves; T3= T1and 3.75kg of air dried A saligna leaves; T4= T1and 5k g of air dried A saligna leaves.*

**Daily milk yield and milk composition**

Milk yield and milk composition of crossbred dairy cows is presented in Table 3. There was higher daily milk yield for experimental cows assigned to T2 than the other treatments. Similarly, cows assigned to T4 were higher in milk yield than cows assigned to T1 and T3. However, there was no significant difference in milk yield between cows assigned to T1 and T3.

There was no significant difference in milk fat, lactose, solids not fat, density, protein and mineral content among treatments. Feeding *A. saligna* leaves did not affect milk composition but increased milk yield which implied that the tree can be used as alternative sources of feed for dairy animals. The findings were in line with Steinshamn (2010) who reported that legumes increased milk yield than grass based feeding. Similarly, milk yield was higher for ewes fed higher level of AS leaves (Maamouri et al 2011) whereas it was not in line with the report of milk fat and protein decreased with the inclusion of the leaves.

Table 3: Milk yield and composition of milking cows fed on *A. saligna* basis

| | Treatments | | | | | | |
|---|---|---|---|---|---|---|---|
| **Parameters** | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** | **SEM** | **SL** | **P-value** |
| Milk yield (kg/head/day) | $6.26^{c}$ | $6.61^{a}$ | $6.26^{c}$ | $6.56^{b}$ | 0.05 | ** | 0.028 |
| Milk fat | 5.20 | 4.24 | 5.10 | 4.60 | 0.81 | Ns | 0.619 |
| Density of the milk | 28.4 | 29.2 | 29.5 | 29.1 | 1.44 | Ns | 0.897 |
| Lactose content of the milk | 4.49 | 4.58 | 4.61 | 4.58 | 0.21 | Ns | 0.944 |
| Solids not fat | 8.20 | 8.47 | 8.48 | 8.34 | 0.33 | Ns | 0.864 |
| Protein content of the milk | 3.00 | 3.97 | 3.10 | 3.06 | 0.54 | Ns | 0.272 |
| Mineral content of the milk | 0.68 | 0.70 | 0.78 | 1.31 | 0.45 | Ns | 0.471 |

*a, b, c, d; means within a row not bearing a common superscript letter significantly differ; Ns; not significance; SL= Significance level; T1= Control treatment (feeding grass hay ad libitum and 3kg of wheat bran); T2= T1 and 2.5kg of air dried A saligna leaves; T3= T1and 3.75kg of air dried A saligna leaves; T4= T1and 5k g of air dried A saligna leaves.*

**Conclusion**

Supplementation of dried *A. saligna* leaves to dairy cows did not affect the daily dry mater intake and milk composition of crossbred dairy cows. It also increased the milk yield than feeding grass only. *A. saligna* can easily grow in the tropical and sub tropical areas where feed deficiency is a critical problem. It is also widely grown in Ethiopia under different land uses. However, it was not included in dairy animals feeding. Hence, dried *A. saligna* leaves can be used as alternative feed sources in dairy farming.

 

**Acknowledgements**
Tigray Agricultural Research Institute (TARI) in collaboration with World Vision Australia/Ethiopia provide fund for this study through the project Acacia Species for Food Security and Environmental Rehabilitation in the dry lands of northern Ethiopia. The authors would like to give their great appreciation to TARI and WVA/E for the fund sources and Mr. Nigusse Hagazi for his valuable comments and help.

**References**

Abdulrazak S A, Fujihara T, Ondiek J K, Ørskov E R (2000). Nutritive evaluation of some *Acacia* tree leaves from Kenya. Anim. Feed Sci. Tech., 85: 89-98 http://dx.doi.org/10.1016/S0377-8401(00)00133-4

Ahmed M El-Waziry (2007). Nutritive Value Assessment of Ensiling or Mixing Acacia and Atriplex Using In Vitro Gas Production Technique Research. Journal of Agriculture and Biological science, No 3(6), Pp. 605-614,

Anbarasu C Dutta N, Sharma K (2001). Use of leaf meal mixture as a protein supplement in the ration of goats fed wheat straw. Anim. Nutr. Feed Technol. 1:113-123.

Asnake A (2005). Feedlot fattening performance and carcass characteristics of intact male hararghe highland goats fed different levels of hay to concentrate ratios. MSc Thesis Submitted to the School of Graduate Studies of Alemaya University, Pp. 65.

Ayele S, Assegid W MA, Jabbar MM, Ahmed Belachew H (2003). Livestock marketing in Ethiopia: A review of structure, performance and development initiatives. Socio-economics and Policy Research Working Paper 52. ILRI (International Livestock Research Institute), Nairobi, Kenya.

Azage T, Berhanu G, Dirk H, Berhanu B and Yoseph M (2013). Smallholder dairy production and marketing systems in Ethiopia: IPMS experiences and opportunities for market-oriented development. International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia. Working Paper No. 3, Pp 65

Bennett A F, Radford J Q, Angie H (2006). Properties of land mosaics: Implications for nature conservation in agricultural environments/ BIOLOGICAL CONSERVATION 133 (2006) 250–26. www.elsevier.com/locate/biocon

Berhan T, Getachew A (2007). Effects of different forms of ASL inclusion on feed intake, digestibility and body weight gain in lambs fed grass hay, Department of Animal Production, Faculty of Veterinary Medicine, Addis Ababa University, Debre-Zeit, Ethiopia.

Bruh W (2008). Supplementation with dried foliages of selected indigenous browses: effects on feed intake, digestibility, body weight gain and carcass characteristics of abergelle goats offered hay. MSc Thesis Submitted to the School of Graduate Studies of Alemaya University of Agriculture, Alemaya, Ethiopia. Pp. 68.

Burns R E (1971). Method of estimation of tannins in grain sorghum. *Agron. J.,63*, 511

CSA (Central Statistical Agency) (2011). Agricultural sample survey 2010/2011. Vol. II. Report on livestock and livestock characteristics. Statistical Bulletin. Addis Ababa, Ethiopia: CSA.

El-Shaer H (2010). Halophytes and salt-tolerant plants as potential forage for ruminants in the Near East region. Small Ruminant Research 91: pp. 3–12.

Genet L (2011). Effect of concentrate supplementation on feed intake, body weight gain, digestibility, and carcass characteristics of high land sheep fed on poor quality teff (eragrostis tef) straw in wukro woreda, eastern zone of Tigray, Ethiopia. MSc Thesis Submitted to the School of Graduate Mekelle University, Mekelle, Ethiopia. Pp.83.

Getachew A (2005). Evaluation of forage yield and effects of forms of feeding of *AS* on intake and live weight gain of farta sheep fed on grass hay. MSc Thesis Submitted to the School of Graduate Studies Alemaya University of Agriculture, Alemaya, Ethiopia. Pp. 66.

Maamouri O, Atti N, Kraiem K, Mahouachi M (2011). Effect of concentrate and Acacia cyanophylla folliage supplementation on nitrogen balance and milk production of grazing ewes. Journal of Livestock science. Vol 139 (3): Pp. 264-270.

Matiwos (2007). The effect of different levels of cottonseed meal supplementation on feed intake, digestibility, live weight changes, and carcass parameters of Sidama goats. MSc Thesis Submitted to the School of Graduate Studies of Alemaya University of Agriculture, Alemaya, Ethiopia. Pp. 53.

Mendieta-Araica B, Spörndly R, Reyes-Sánchez N, Spörndly E (2010). Moringa (Moringa oleifera) leaf meal as a source of protein in locally produced concentrates for dairy cows fed low protein diets in tropical areas, J. Livestock Science, doi:10.1016/

Moujahed N, Kayoulib A, Thewis Y, Beckers S, Rezgui (2000). Effects of multi-nutrient blocks and polyethylene glycol 4000 supplies on intake and digestion by sheep fed Acacia cyanophylla Lindl. foliage-based diets. Journal of Animal Feed Science and Technology, (88), Pp. 219-238.

Mousa M R M (2011). Effect of feeding acacia as supplements on the nutrient digestion, growth performance, carcass traits and some blood constituents of awassi lambs under the conditions of North Sinai. Asian

 

Journal of Animal Science, (5), Pp. 102-117.

Mulat A (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. MSc. Thesis Submitted to the School of Graduate Studies of Alemaya University of Agriculture, Alemaya, Ethiopia. Pp. 52.

Mulu 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. MSc Thesis Submitted to the School of Graduate Studies of Alemaya University of Agriculture, Ethiopia. Pp. 55.

SAS (1998). (Statistical Analysis System). Users' Guide: Statistics Version 8, SAS institute. Inc, Cary, NC

Shumuye B, Yayneshet T (2011). Effect of Feeding Treated Acacia saligna ( Labill .) H.L .Wendl. Leaves on Growth Performance and Digestibility in Goats. journal of the drylands 4(2): Pp3 41-347.

Simret B (2005). Supplementation of Graded levels of Peanut cake and wheat bran mixture on nutrient utilization and carcass parameters of Somali goats. An. MSc Thesis submitted to the school of graduate studies of Alamaya University, Alemaya, Ethiopia. Pp. 60.

Steinshamn H (2010). Effect of forage legumes on feed intake, milk production and milk quality: A review. Animal science papers and reports. Vol. 28 (3), 195-206.

Takele F, Getachew A (2011). Digestion, Intake and Live Weight Changes of Horro Lambs Fed Vetch (Lathyrus sativus) Haulm Basal Diet Supplemented with Sole Wheat Bran, Acacia albida Leaf Meal or Their Mixture. Pakistan Journal of Nutrition, No, 10, (11), Pp. 1013-1021.

Tesfay H, Solomon M (2008). Feed intake, digestibility, body weight and carcass parameters of Afar rams fed tef (Eragrostis tef) straw supplemented with graded levels of concentrate mix. Journal of Tropical Anim Health and Production, (41), Pp. 599-606

Tesfaye T (2009). Characterization of goat production systems and on- farm evaluation of the growth performance of grazing goats supplemented with different protein sources in metema woreda, amhara region, Ethiopia. MSc Thesis Submitted to the School of Graduate Studies of Alemaya University of Agriculture, Alemaya, Ethiopia. Pp. 90.

Tawila M, Omer H, Gad S (2008). Partial Replacing of Concentrate Feed Mixture by Potato Processing Waste in Sheep Rations. Journal of Agriculture & Environmental Science, 4 (2), Pp.156-164.

Yayneshet T., Eik L O and Moe S R (2009). The effects of enclosures in restoring degraded semi-arid vegetation in communal grazing lands in northern Ethiopia. Journal of Arid Environments, 73: 542-549.

Zemiceal G (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. MSc thesis submitted to the school of studies of Alemaya University of Agriculture, Alemaya, Ethiopia. Pp. 57.