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Research Article

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Ficus sycomorus (Sycamore Fig or Shola) Leaf, A Potential Source of Protein for Ruminants: A Review

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Abstract

Review was carried out on the nutritional value of *Ficus sycomorus* (Sycamore Fig or Shola) leaf, different techniques employed to feed animals at different treatment to evaluate the nutritional and chemical composition of as alternative feed sources and its potential as animal feed particularly to sheep. Sycamore Fig can fix nitrogen from the atmosphere, fertilizing the soil for other plants, tolerant of infertile soils and capable of pioneering change in barren and poor quality soils. The leaf contains CP content of *F. sycomorus* leaf was 17.9% and The NDF, ADF, ADL, DM and ash content of *F. sycomorus* leaf on DM basis in this study was 64.6%, 52.5%, 17.4%, 93.2% and 11.9%, respectively. The CP content of the *F. sycomorus* leaf in the current in dry matter basis which depends on the species and Climatic conditions. The composition of the seed and especially the high protein content makes Sycamore Fig leaf highly suitable for livestock diets than pods. However, the presence of quinolizidine alkaloids and some ant nutritional factors results in characteristically bitter taste making the tree legume unacceptable for food/feed. Different strategies (processing methods) have been used to reduce/eliminate the alkaloid contents and enhance the feed value of the grain. Supplementation of ruminant diets with processed Sycamore Fig has been shown to have many positive effects in terms of growth and reproductive efficiency, comparable with supplements of other feeds and which is better than hay and more than the maintenance requirements of the animals.

Keywords: *Ficus sycomorus*; Sycamore fig or shola; Leaf; Potential source of protein; Ruminants; Review

Introduction

Feed shortage particularly during dry season; limit the animal output in most part of the Ethiopia. The available feed resources cannot meet the nutritional requirements of animals throughout the year in many parts of the country either due to inadequate supply or quality of the feed [1]. Livestock feed resources in Ethiopia are mainly natural grazing and crop residues, which are low in energy and protein leading to significant limitation in the productivity of sheep. Such feed deficiencies causes loses of weight gains made during more favorable periods, while fodder conservation to help eliminate seasonal feed supply fluctuations are rarely practiced. As result, the annual off take of sheep is estimated to be 33%, with an average carcass weight of 10 kg, which is the second lowest among sub Saharan Africa countries. However, these trends of events can be changed if animals are strategically supplemented with available protein and energy sources such as agro industrial by products or multi-purpose trees (MPT). Nevertheless, the use of agro industrial by products is limited to the area where they are produced or economic factors limit their wider use.

This calls for searching for alternative feed resources which could be used as supplement to improve animal performance. Multi-purpose trees (MPT) are among the alternatives to be employed since it is abundant in different agro-ecological set up and contains higher nutrients. One potential source in the study area, in this regard, is the leaf of *F.sycomorus. F. sycomorus is* MPT and belongs to the family of Moraceae which is native to Ethiopia [2]. It is available in Amhara National Regional State. *F. sycomorus* has been identified as feed of cattle, goat and sheep [3]. *F. sycomorus* leaf are valuable fodder in overstocked semi-arid areas where the trees occur naturally and leaf are much-sought fodder with fairly high nutritive value of about 14-17.95% crude protein (CP) and 12 MJ/kg net energy on DM basis [4].

F. sycomorus leaf and petioles are well accepted by West African Dwarf lambs and led to higher levels of apparent digestibility than the other tree species [5]. Feeding *Ficus* fodder to lambs is actively encouraged in Nigeria. Fruit of the plant are round from 2.8-5 cm in diameter conspicuous opening that may break at the one end and with various colours.

In Sekela District, where this study was conducted, sheep feed on natural pasture, fallow land grazing and crop residues; where the nutrients supplied by these feed resources are insufficient to meet for maintenance, growth and production requirements of animals. Sometimes farmers in the area purchase protein supplements such as cotton seed meal and low quality roughage during dry season, but it is not effectively utilized. Moreover, the animals feed on fallen leaf and fruit of *F. sycomorus* since the tree grows around farm land residence and on the degrading area .In fact the leaf and fruit of tree are important sources of nutrient for small ruminants in the dry season. However, systematic evaluation of the value of *F. sycomorus* leaf for sheep has not been well researched in the study area. Therefore the objectives of this paper were to review the nutritional value of the leaf, different techniques employed to reduce alkaloid contents and its potential as animal feed particularly to sheep.

Species, Cultivation and Characteristics of the Plant

Multipurpose fodder trees

Unlike other feed resources that may be used by smallholder farms,

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MPT have a number of advantages in that they are available on the farm and can be used for other purposes. Being perennial plants, MPT are not susceptible to sudden climatic changes and continue to produce high quality fodder even during drought years when grasses and other annual forages are dry and long gone. Their capacity to grow fast enables them to produce large quantities of biomass, which can be used not only for animal feeding but also as mulch in cropping systems. They are also used to control soil erosion [6]. When intercropped with food crops, fodder legumes do not compete with food crops for nutrients as their deep root system enables them to tap nutrients from the deeper soil layers, which are generally not available for shallow rooted food crops. They also improve soil fertility by fixing atmospheric nitrogen and have other symbiotic relationships, which enhances uptake of minerals such as phosphorus by plants [7]. In the dry season, fodder trees also provide shade to animals and protect them from the hot and dry weather conditions. They are also used as a source of firewood, fencing, and function as a hedge around the fields. A number of these trees bear fruit, which are used as a source of food for humans.

The feed value of forage is a function of its nutrient content, digestibility, its palatability and associative effects with other feeds. Rumen microbes require a source of fermentable N usually as ammonia although some species require preformed amino acids and peptides [8]. In tropical forages, more than 20% of plant proteins are present in structures such as the vascular bundle sheath which are resistant to microbial attack [9]. The low N content of most mature grasses points to a need to combine them with forages of high N content when offered to animals.

In addition to adequate N and energy supplies, rumen microbes require a stable pH environment of 6.5 to 6.8. However, tropical grasses and straws have low ion exchange and buffering capacities while tropical legumes, due to, their high lignin content has high ion exchange and buffering capacities [10]. MPT have more lignin than grasses, but more degraded in the rumen, mainly because of the high fragility of their cell walls [11]. This limitation can be overcome by supplementing a protein source, e.g., MPT or shrubs. A number of tree legumes and MPT leaf and fruit uses as supplementary dry season feed for livestock [12]. A number of tree legumes and multipurpose trees such as *Leucaena leucocephala, F. sycomorus, Grewia* spp. and *Ziziphus* spp. provide foliage for livestock at all seasons [13]. In the hills of Nepal, numerous *Ficus* spp. are used to bridge the gap of feed shortage [14]. MPT have high leaf potential and can effectively serve as a cheap source of protein supplement for low quality diets during the dry season for resource-poor farmers with stall-fed Sheep and Goats [15]. In common with many tree fodders, those species of Ficus which do not shed their leaf tend to maintain their quality well into the dry season, making them valuable feed resources when herbaceous vegetation is in short supply. In general, the role of MPT in ruminant nutrition has not been truly defined and is likely to be different depending on whether they are used as strategic supplement or sole feed source [16]. Long-term feeding trials should be conducted to study the potentially of *Ficus* spp.

It has been recommended that the optimum dietary level of MPTs on DM basis shall be in between 30 to 50% or 0.9 to 1.5% live weight [17]. Since smallholder farmers lack capital to acquire agro-industrial by-products on one hand and that the availability of these by-products is limited to areas close to the processing industries on the other hinders free access by smallholders. On the other hand, MPTs are grown integrated directly to pastureland or in fences and can be accessed easily. The leaf and fruits of MPTs contain high protein, ranging from 10-30% of the 'Dry Matter' (DM). Thus, MPTs leaves and fruits have the potential to replace agro-industrial by-products to a great extent and become a cheap source of protein supplementation [18].

***Ficus sycomorus* tree:**

Distribution of *Ficus sycomorus*: *F. sycomorus* is a MPT which belongs to the family Moraceae. It is native to Middle East, South West Africa, Egypt, Ethiopia, Israel, and Kenya. It grows well in the area, which receives mean annual rainfall ranging from 500-1800 (max. 2200) mm per year with deep, well-drained loam to clay soil types or Sandy soils with a shallow ground water [2]. The best site for *F. sycomorus* trees is next to drainage lines, streams, rivers, springs or dams. The plant grows in altitude, which ranges from 0-2000 m.a.s.l. and mean annual temperature range from 0-40°C.

The plant grows to 20 m tall and 6 m wide with a dense round crown of spreading branches while leaf are heart-shaped ,deep green with a round apex and 14 cm long by 10 cm wide [19]. It tolerates lopping when continuous and adequate water supply is available. A tree can bear several crops of fruit a year and growth rate is fairly fast at 1-1.5 m/year in frost-free areas [2]. At high altitudes in India, fruit yields of *F. sycomorus*12 kg/tree/year were reported [20]. Fruit contain up to several hundred to several thousand seeds and seed is dioecious. *F. sycomorus* tree leaf, unripe and ripe fruit indicated in Figure 1, respectively in the study area.

Socio-economic significance of *Ficus sycomorus*: The economic significance of *F. sycomorus* trees can be determined from the fact that they are hardy and can provide year-round fodder to be used as a supplement in lean periods. With proper management and propagation techniques, this fodder can be a viable feed resource to supplement small ruminants for landless farmers. *F. sycomorus* fruit and forage serves as feed for livestock in Ethiopia highlands [21]. Leaf is a much-sought fodder with fairly high nutritive value; they are valuable fodder in overstocked semi-arid areas where the trees occur naturally. Leaf stored on farms for use as manure for paddy fields [22].

In mixed farming systems, trees and shrubs can have a stabilizing effect on prices as farmers have a longer holding capacity and are not forced into selling animals in periods of drought due to shortage of feeds [23]. *F. sycomorus* used as ornamental purposes roadsides, wells and community places such as market centers in rural areas. It also serves as soil erosion control and sand-dune fixation and riverbank stabilization [2]. Shed leaf improve the nutrient status, infiltration rate and water-holding capacity of the soil and serves as intercropped with bananas as an understory and coffee shade and increase the yield [24] . Its fruit are available all the year round in Africa fruiting 3-5 times per year and used as keystone or staple food of early hominids living [25]. In the hills of Nepal, numerous *Ficus* spp. show potential for bridging tile gap between the amount of feed needed by existing livestock populations and the availability from present feed resources [14]. Further variation may be explained by differences in genetic potential, bioclimatic conditions and cropping systems. There would also appear to be differences between species of domestic livestock in the way in

Source: Awoke and Yoseph [26]

Figure 1: *F. sycomorus tree* (Shola).

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which they can utilize fig foliage. *F. sycomorus is* browse plant plays a significant role in nutrition of ruminants' livestock in tropical region. *F. sycomorus* has large canopy and difficult to browse the leaf and fruit by livestock as showed in Figure 1. In general farmer can use *F. sycomorus* leaf and fruit through 'cut and carry' feeding system where this resource available in Ethiopia [26].

Utilization and chemical composition of sycamore fig or shola leaf: *F. sycomorus* MPT leaf is a much-sought fodder with fairly high nutritive value [2]. The leaf has different proximate chemical composition on DM basis (g/100 g DM) as reported by different authors. Njidda and Ikhimioya [27] reported 95.6% DM, 14.90% CP, and 32.5% CF, 3% EE, 18% ash, 54.80% NDF, 33.4% ADF, 12.60 % ADL and 4.49 ME (MJ/kg DM). According to Nkafamiya [28] the leaf of *F. sycomorus* has 14.12% moisture, 10.24% ash, 3% lipids, 31.52% CF, and 17.95% CP. The other author also reported that leaf has 14% CP, 22.4% CF, 4.5% EE, 5.7% ash and 12.0 (MJ/kg) ME [4]. On the other hand Lorenzo [29] reported 22.1% CP for Young leaf.

Fruit of *F. sycomorus* has different Proximate chemical composition on DM basis (g/100 g DM) as reported by different authors. It has 9.5% CP and 33% fats [29], 10% CP, 29.3% NDF, 24.8% ADF, 11.4% ADL, and 7.0% ash [30]. Gurr et al. [31] reported CP content of *F. sycomorus* fruit 16%. The edible portions of wild fruits were reported to contain 91.6% DM, 17.0% CP, 45.3% CF, 11.2% ash and 88.2% carbohydrate, respectively [32]. In general, the chemical composition of *F. sycomorus* leaf and fruit have sufficient CP contents to be considered as supplements for low quality roughage's and has satisfactory energy value with considerably high DM digestibility [27].

In eastern Africa, leaf and fruit of *F. thonningii* and *F. capensis* is rated as highly palatable to domestic animals [33]. *F. elasticoides* is a browse species which is available at all times of the year and their leaf has good milling characteristics and could be included in preparation of ration in Nigeria [34]. In this region, several species of *Ficus* are highly rated as cattle feed. Gohl [35] listed *F. benghalensis, F. carica, F. glomerata, F. lacor, F. sycomorus and F. religiosa* as being trees which are often lopped for fodder. Even if, conclusive, long-term data are scarce; different reports showed that *Ficus spp*. are commonly utilized by livestock, and are valuable as dry season forage [36].

Anti-nutritional factors: Anti-nutritional factors are compounds that limit the wide use of many plants due to its ubiquitous occurrence as natural compounds capable of eliciting deleterious effect in human and animals [19]. The anti-nutritional factors such as oxalate (2.88 ± 0.37%), tannin (4.01 ± 0.22%), saponin (1.78 ± 0.11%), phytate (1.98 ± 0.78%), alkaloids (5.64 ± 0.41%) and (3.05 ± 0.51%) were present in varying amounts in *F. sycomorus* leaf [28]. This anti nutritional factor tends to bind to mineral elements by forming indigestible complex [37]. An anti-nutritional factor of *F. sycomorus* is low to interfere with nutrients utilization. It has below the established toxic level. In general, the level of anti-nutritional factors of the leaf of *F. sycomorus* is below the established toxic level, which implies that, the overall nutritional value of the leaf will not be seriously affected [28]. On the others side, according to Gohl [35] several species of Ficus were commonly lopped for animal, as sole feed, particularly in India and Pakistan. The young leaf of *F. elastica*, however, was poisonous to most animals. Mortality in cattle and buffaloes due to consumption of the leaf of *F. tsiela* has been reported from a number of areas of India [38].

Feed intake of sycamore fig or shola leaf for ruminant

The mean daily intakes of DM, OM, CP, NDF and ADF of Washera sheep fed a basal diet of natural pasture hay and supplemented with *F. sycomorus* leaf, fruit and their mixtures is presented in Table 1. The basal feed DM intake was higher (P>0.05) for sheep fed on T_1 diet as compared to sheep in supplemented group (T_2-T_4) [39]. Among supplemented group, sheep in T_2 had higher (p<0.05) dry matter intake from the basal diet followed by sheep in T_3 and T_4. In spite of the fact that supplemented group received equal quantity of the supplements (300 g/day ,were no leftover), the lower basal DM intake recorded for sheep in T_4 followed by T_3 as compared to sheep in T_2 might be explained by differences in nitrogen content of the different supplements. Consequently, this had negatively impacted total dry matter intake. Topps [40] reported that supplementation level beyond 30-40% of the total DM offered reduces intake of the basal feed.

The total DM intake was higher (P<0.001) in the order $T_2 > T_3 > T_4$ which could be attributed to differences in crude protein composition of the different types of supplements. The supplemented sheep consumed higher total DM because supplementation might have created a favorable rumen environment resulting in enhanced fermentation of the basal roughage and thus increased microbial protein synthesis [41]. The positive effects of supplementation on feed intake may have been a reflection of the increase in the intake of essential nutrients such as energy, vitamins and minerals and in particular nitrogen. Moreover, the high total DM intake in supplemented group could be due to lower gut fill of the supplements compared to natural pasture hay. The increase in total DM intake due to supplementation in the present study was in agreement with the result reported by Hirut [42] and Wondwosen [43].

The total average daily CP intake was significantly lower (P<0.001) in un-supplemented group than supplemented sheep. This could be attributed to the relatively low CP content of the basal feed. However, the CP content of the basal diet was slightly higher than maintenance requirement of small ruminants [16,44].

DM intake (g/day)	Treatments				SEM
	T_1	T_2	T_3	T_4	
Basal	581.7^a	429.9^b	402.6^c	375.4^d	3.85
Supplement	--	300.0	300.0	300.0	--
Total DMI	581.7^d	729.9 ^{a}	702.8^b	675.4^c	13.18
DMI as %BW (%)	3.0^b	3.7^a	3.6^a	3.5^a	0.07
DMI as MBW(g/kg$^{0.75}$)	66.0^d	73.4^a	71.9^b	69.5^c	0.36
Total CPI	45.7^d	85.8^a	79.2^b	72.7^c	3.51
Total OMI	538.7^d	662.7^a	646.8^b	631.3^c	11.19
Total NDFI	360.1^d	484.8^a	422.4^b	393.9^c	2. 58
Total ADFI	303.2^d	392.0^a	347.6^b	317.5^c	7.87
Total ADLI	101.5^d	122.2^a	113.3^b	104.5^c	1.89
ME (MJ /kg DM)	4.9^c	8.0^a	7.7^{ab}	7.4^b	0.29
Substitution rate	--	0.51^c	0.60^b	0.69^a	0.016
Digestible nutrient intake (g/day/head)					
DMI	332.8^d	559.6^a	528.3^b	496.5^c	8.04
OMI	305.2^c	499.1^a	480.6^{ab}	465.3^b	7.62
CPI	35.3^d	80.6^a	67.3^b	58.4^c	0.68
NDFI	237.6^c	361.4^a	299.2^b	238.1^c	5.53
ADFI	174.5^c	273.1^a	230.9^b	185.6^c	4.75

$^{a-d}$means with different superscripts in row are significantly different; ADF=Acid Detergent Fiber; ADL=Acid Detergent Lignin; CP=Crude Protein; DM=Dry Matter; ME=Metabolisable Energy; FSL=*F. sycomorus* Leaf; NDF=Neutral Detergent Fiber; OM=Organic Matter; SEM=Standard Error of Mean; FSF=*F. sycomorus* Fruit; T_1=Natural pasture hay alone; T_2=hay+300 g FSL DM; T_3=hay+300 g 1FSL:1FSF DM mix; T_4=hay+300 g FSF on DM basis.

Source: Awoke and Yoseph [26]

Table 1: Daily dry mater and nutrient intake of Washera sheep fed natural pasture hay alone and supplemented with *F. sycomorus* leaf, fruit and their mixtures.

The CP, OM, NDF and ADF intakes in the current study were significantly higher (P<0.001) for sheep in the supplemented group (T_2-T_4) than in the un-supplemented (T_1). This could be due to improved rumen condition created by the supplementation that enhanced feed intake. Adugna and Sundstol [45] also reported that the increased intake in the supplemented group could be due to increased availability of nitrogen to rumen microbes and enhanced rate of digestion. Among supplemented group, however, it was higher for sheep in T_2 followed by T_3 and T_4. The higher CP contained in *F. sycomorus* leaf (17.9%) as compared to *F. sycomorus* fruit (11.8%) might have rendered sheep in T_2 followed by T_3 to have higher intakes. According to Kempton et al. [46] dietary protein supplementation is known to improve intake by increasing the supply of N to the rumen microbes or can be increased by reducing poor quality feed retention time after supplementing concentrates to micro-organisms and stimulating their function in the rumen. There was also significantly higher (P<0.001) estimated metabolizable energy intake (EME) for supplemented group as compared to sheep in the un-supplemented. The intake of energy increased in the order of T_2>T_3>T_4 with increased energy intake as suggested previously [47].

The total DM intake as a percent of body weight was also higher for sheep in supplemented group as compared to the un-supplemented. Among the supplements, sheep in T_2 had higher DMI expressed as percent of body weight followed by sheep in T_3 and T_4. The results obtained in the current study (3.0-3.69%) was comparable to 2.5-3.9% reported by Emebet [48]. Abdulrazak et al. [49] reported that the total DM intake increased up to 3.9% of body weight when sheep fed on Rhodes grass and supplemented with *A. tortilis* leaves and pods. This could be probably due to differences in the body weight of the experimental sheep and the type of diet. However, the results were not very different from those reported for various breeds of sheep and goats in the tropics [50].

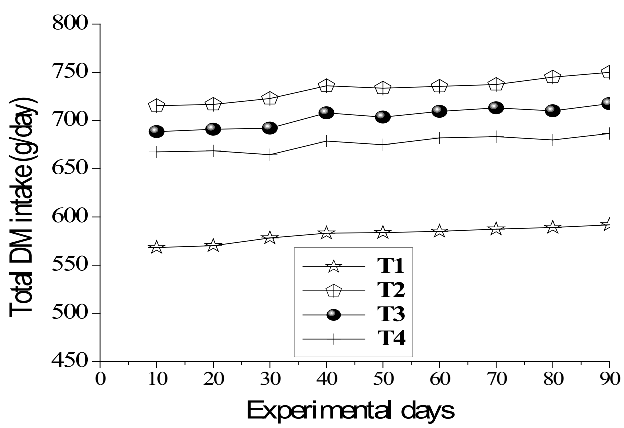
The rate of substitution was higher in the present experiment and the difference among dietary treatments is significant (P<0.001). Substitution rates are often low when animals consume forage of low to medium digestibility. Doyle et al. [51] suggested that the rate at which basal hay intake reduce with increasing supplement intake (the substitution rate) reflects directly the effect of the supplement on the fractional rates of digestion and outflow from the rumen. Those supplement feeds with rapid fermentation rate replace the basal roughage to a lower extent than those that ferment slowly [52]. Huston [53] reported a decrease of 22% in forage intake when goats were supplemented at 30% of their digestible energy requirement, as compared with un-supplemented goats. Osuji and Odenyo [54] reported a decrease of 10% in forage intake when goats were supplemented at 1.5% of body weight with lablab legume hay.

Trends in total dry matter intake of Washera sheep fed natural pasture hay alone and supplemented with *F. sycomorus* leaf, fruit and their mixtures is presented in Figure 2. It is apparent from the figure that total feed dry matter intake increased as feeding period advanced. However, sheep in the un-supplemented group maintained lower feeding intake throughout the study period compared to supplemented animals.

Dry matter and nutrients digestibility of sycamore fig or shola leaf for ruminant

The digestion coefficient of nutrient for sheep fed hay alone and supplemented with *F. sycomorus* leaf, fruit and their mixture is presented in Table 2. The current supplementation strategy, in general, improved (P<0.05) feed DM, OM, CP, NDF and ADF digestibility compared to the un-supplemented. The lower digestion coefficients for animals in the un-supplemented could be due to the relatively low CP composition and higher fiber fraction contained in the basal feed. However, among supplemented group, the apparent digestibility coefficient of DM and OM were significantly higher (P<0.01) for T_2 compared to T_3 and T_4. The digestibility coefficient of CP was significantly higher (P<0.001) for T_2 followed by T_3, T_4.

This might be due to the relatively higher intake of dietary protein in these groups in the order depicted above. The finding is in agreement with McDonald et al. [55] who reported that higher CP intake is associated with better CP digestibility. There is no statistically significant difference (p<0.05) between, T_3 and T_4 in OM and NDF digestibility. The DM digestibility of the supplemented group in the present study is comparable with 75.8-80% reported by Tegbe et al. [56] in West African dwarf goats feed a basal diet of *Panicum maximum* and supplemented with *M. indica, F. thonningii, G. sepium* leaf and concentrate. Similarly, dry matter digestibility (DMD), which is related to nutrient composition, varied widely among tree and shrub species. Skarpe and Borgstrom [57], working in Botswana with Kalahari woody species reported a range in digestibility from 38 to 78%. Anugwa and Okori [5] also reported that the fresh Ficus leaf and petioles were well accepted by West African dwarf lambs and led to higher levels of apparent digestibility than the other tree species, ranging from 70.1% for crude fibre (CF) to 81.8% for crude protein. Ahn et al. [58] have shown that drying of MPT leaf decreases tannin content which showed increase in digestibility of protein from 64-84%. The DM and OM digestibility in the present study is higher than values reported by Solomon et al. [59] in Menz sheep supplemented with *L. pallid* (0.55-0.61) and *S. sesban* (0.57-0.61) on tef straw based feeding. The lower digestibility of DM and ADF observed in the un-supplemented than the supplemented sheep might be due to the lower supply of dietary CP and higher fiber fraction as compared to the other treatments. According to Bonsi, lower CP content of feed affect microbial growth and fermentation in the rumen. In agreement with the present study, Banamana et al. [60] reported that increasing CP in the diet increased the digestibility of OM, ADF and CP. It has been documented that supplementation with *F. sycomorus* leaf improved digestion of the NDF and ADF [61].



DM=Dry Matter; FSL=*F. sycomorus* Leaf; FSF=*F. sycomorus* Fruit; T_1 (un-supplemented) =Natural Pasture Hay; T_2=hay+300 g FSL; T_3=hay+300 g 1FSL:1FSF DM mix; T_4=hay+300 g FSF DM.

Source: Awoke and Yoseph [26].

Figure 2: Trends in dry matter intake across the experimental period for Washera sheep fed natural pasture hay alone and supplemented with *F. sycomorus* leaf, fruit and their mixtures.

Tesfay and Solomon [62] also reported that Afar rams fed teff straw and supplemented with concentrate mix had significantly higher digestibility of DM, OM and CP than the un-supplemented ones. Similarly, the result of this study is in line with that of Osuji [54] who reported that supplementation of tef straw with *S. sesban* (leucaena) improved the OM, DM, N, NDF and ADF apparent digestibility. It has also been demonstrated that supplementation of sheep with *F. sycomorus leaf* improved digestion of the NDF and ADF [61]. Therefore, supplementation with *F. sycomorus* leaf, fruit and their mixture improves digestibility of low quality feeds.

Effect of supplementation of sycamore fig or shola leaf for ruminant

Mean initial and final body weight (FBW), average daily body weight gain (ADG) and feed conversion efficiency (FCE) of Washera sheep fed on grass hay and supplemented with *F. sycomorus* leaf, fruit and their mixtures are presented in Table 3. Supplementation significantly improved (P<0.001) daily BW gain compared to the un-supplemented. However, among the supplemented group, sheep in T_2 performed significantly better (P<0.05) than sheep in T_3 and T_4. Supplementation also significantly increased (P<0.001) FCE and FBW of sheep compared to the un-supplemented treatment. The lower FCE for T_1 was probably because of the relatively low CP and energy intake and higher fiber content of the basal diet that might have caused the use of metabolizable energy to be depressed slightly. Adebowale et al. [63] also reported that the low degree of digestion coupled with low passage rate through the alimentary tract limit net energy availability for production. However, supplemented sheep (T_2-T_4) did significantly (P>0.01) differ in these parameters. The results of this study agree with the finding of Solomon and Simret [64] who supplemented sheep with different levels of peanut cake and wheat bran.

Supplementation of MPT to small ruminants improved growth performance in a number of independent studies [59,65]. In a study that involved feeding of *C. calothyrsus* and *L. leucocephala* to goats, supplemented group gained 11-15% more body weight than that of the un-supplemented group. Sheep fed on leaf of *S. sesban* as a protein supplement also had higher body weight gain compared to un-supplemented group [65]. Sheep and Goats fed on *P. purpureum* supplemented with 0.3 to 1.8 kg Gliricidia per day gained 17-27% more weight than the un-supplemented animals while with Bali cattle fed on 80% of natural grasses plus 9% of Leucaena and Musa and 11% of tree leaf, the increase in weight was 58% more than that of the un-supplemented group [66]. In line with this, the use of Leucaena and Gliricidia as supplementary feeds significantly increased the growth and survival rates of lamb. Atta-Krah and Reynolds [67] demonstrated that each 100g of browse DM consumed per day raises the productivity index by 1.41 kg lamb weaned/dam/year.

The current result is comparable with the findings of BW gain of 44.64 g/day for West African dwarf goats fed a basal diet of *P. maximum* and supplemented with *M. indica* and concentrate. It is higher than BW gain of 14.4-33.9 g/day reported for Goats fed on a basal diet of Rhodes grass hay and supplemented with *A. tortilis* leaves and pods [49]. It is also higher than 13-40.7 g/day reported for Menz sheep fed on tef straw and supplemented with MPT or their mixtures [59]. Kaitho et al. [68] reported mean BW gain of 6.5-65.2 g/day in sheep fed tef straw and supplemented with different levels of Leucaena and Sesbania trees. Bruh [69] also reported that BW gain ranges from 12.4-23.8 g/day in goats fed hay and supplemented with foliages of *Z. spina-christ, S. africana* and *T. brownie* at a level of 200 g. On the other hand, Aynalem and Taye [70] reported average daily gain of 43.3, 50.5 and 95.1 g/day in lambs supplemented with 200, 300 and 400 g/day Girawa, respectively.

Similarly, supplementation of sheep with mixture of MPT improves performance of animals in terms of BW gain, and may also enhance their reproductive performance as demonstrated in higher scrotal circumference [71]. It has been reported that fodder trees would be good protein supplements for ruminants, provided that they are degraded adequately in the rumen to make the protein available to the animal and non-toxic [72]. Anugwa and Okori [5] reported that, West African dwarf lambs gained 71 g/day over a 14-day period when fed a sole diet of *F. elasticoides* foliage. However, the *F. sycomorus* leaf, fruit and their mixture in the current study could change the body weight gain, possibly sufficient supply of protein. Generally, supplementation with MPTs like *F. sycomorus* leaf, fruit and their mixture appeared to improve daily BW gain of sheep, probably either by providing nutrient available for absorption or by enhancing microbial protein synthesis.

Though there has not been exhaustive study conducted on *F. sycomorus* in Ethiopia on one hand and Washera sheep on the other, the average daily gain recorded in the present study was small compared to literature. This might be attributed to the alkaloid concentration of *F. sycomorus* and/or size of the sheep breed used for the study. Similarly, in this study, sheep fed natural pasture hay alone exhibited mean BW gain of 8 g/day. This positive ADG indicates that natural pasture hay used in the current experiment provided nutrients sufficient for maintenance requirements of the animals. Similarly, Matiwos et al. [73] and Wondwosen [43] reported body weight gain of 10.2 and 21.1 for Sidama goats fed on a basal diet of natural pasture hay contained 9.2 and 9.9% CP, respectively. Wogenie [74] also documented ADG of 18.9 g/day for Blackhead Somali sheep fed natural pasture hay having CP content of 9.1%. On the other hand, Solomon and Simret [75], Mulu et al. [76] and Abebe [76] recorded variable body weight losses in sheep fed natural pasture hay alone.

Digestibility coefficients	T_1	T_2	T_3	T_4	SEM
DM	0.57^c	0.77^a	0.74^b	0.73^b	0.017
OM	0.57^c	0.75^a	0.74^{ab}	0.73^b	0.079
CP	0.63^d	0.87^a	0.83^b	0.78^c	0.021
NDF	0.56^d	0.70^a	0.67^b	0.62^c	0.013
ADF	0.55^c	0.70^a	0.66^b	0.61^b	0.052

[a-c]Means with different superscripts in row are significantly different; ADF=Acid Detergent Fiber; CP1=Crude Protein; DM=Dry Matter; FSL=*F. sycomorus* Leaf; NDF=Neutral Detergent Fiber; OM=Organic Matter; SEM=Standard Error of Mean; FSF=*F. sycomorus* Fruit; T_1=Natural pasture hay; T_2=hay+300 g FSL DM;T_3=hay+300 g 1 FSL:1g FSF DM mix; T_4=hay+300 g FSF DM.

Table 2: Digestibility coefficients of nutrients in Washera sheep fed natural pasture hay alone and supplemented with *F. sycomorus* leaf, fruit and their mixtures.

Parameters	T_1	T_2	T_3	T_4	SEM
Initial body weight (kg)	17.5	17.5	17.6	17.5	0.08
Average daily gain (g/day)	8.0^c	45.1^a	36.9^b	36.2^b	3.41
Final body weight (kg)	18.2^c	21.6^a	20.9^b	20.8^b	0.32
Body weight change (kg)	0.72^c	4.1^a	3.3^b	3.3^b	0.31
FCE (g ADG/g DMI)	0.01^d	0.06^a	0.05^b	0.05^c	.004

[a-c]Means with different superscripts in the same row differ significantly; DMI=Dry Matter Intake; FCE=Feed Conversion Efficiency; HCW=Hot Carcass Weight; FSL=*F. sycomorus Leaf*; SEM=Standard Error of Mean; FSF=*F. sycomorus* Fruit; T_1=Natural pasture hay; T_2=hay+300 g FSL DM; T_3=hay+300 g 1FSL:1FSF DM mix; T_4=hay+300 g FSF DM.

Source: Awoke and Yoseph [26]

Table 3: Body weight parameters, feed conversion efficiency of Washera sheep fed natural pasture hay alone and supplemented with *F. sycomorus* leaf, fruit and their mixtures.

Trends in body weight change of Washera sheep fed natural pasture hay alone or supplemented with *F. sycomorus* leaf, fruit or their mixtures is presented in Figure 3. It was made clear from the figure that as the feeding period advanced, body weight change of experimental animal varied. Thus, animals in the un-supplemented maintained their body weight. However, animals in the supplemented group (T_2-T_4) showed an increasing trend across the feeding period.

The relationship between average daily gain (dependent variable) and CP intake (independent variable) was assessed using simple linear regression analysis as presented in Figure 4. Thus, the fitted regression model explained 95% of the total variation (R^2=0.951). The result showed that for each unit change in CPI, ADG changes by 0.903.

Growth and production performance

The effect of supplementing *F. sycomorus* leaf on reproductive performance of yearly washera sheep fed hay showed that ovulation rate increased in ewes which received the supplement. Supplementation with *F. sycomorus* leaf during feeding trial, all the sheep were slaughtered to evaluate carcass parameters. The chemical composition analysis result of the experimental feeds indicated that CP and OM contents of grass hay were 7.8% and 92.6%, respectively. The CP contents of leaf of *F. sycomorus* were 17.9%. The study demonstrated that supplementation decreased ($P<0.05$) basal dry matter intake, but increased the rate of substitution. The total DMI was significantly ($P<0.001$) increased with supplementation with two ovulations.

The study showed that supplementation with *F. sycomorus* leaf, fruit and their mixture (1FSL: FSF) resulted in better utilization of nutrients and animal performance for intact male yearling Washera sheep. Supplementation with 300 g DM per head /day had higher effect on total CP intake and ADG. There was significantly higher ($P<0.001$) FCE in un-supplemented group (0.01) compared to supplemented treatments (0.06, 0.05 and 0.05) in T_2, T_3 and T_4, respectively. Feeding 300 g leaf/head/day for 14 days commencing 12 days after the introduction of vasectomised rams, increased the number of ovulations from 126 to 146 per 100 ewes exposed to rams. However, significant difference ($P>0.001$) was observed among supplemented treatments in this parameter. The average body weight gain, empty body weight and hot carcass weight were positively ($P<0.001$) correlated with total DM intake and total CP intake. The rib-eye muscle area (REMA) in supplemented treatments was significantly higher ($P<0.001$) for T_2 (7.4 cm^2) compared to T_1 (5.5 cm^2). Sheep in T_3 and T_4, however, were similar ($P<0.01$) in REMA compared with the un-supplemented group. The total non-edible offal (TNEO) was numerically higher ($P>0.01$) but Total edible offal content (TEOC) was significantly ($P<0.001$) increased with increased level of supplemented. In general, supplementation with 300g FSL, FSF and their mixture (FSL: FSL) improved the performance of sheep compared to the un-supplemented. Among the feeding strategy employed, supplementing sheep with T_2 becomes biologically optimum and economically feasible.

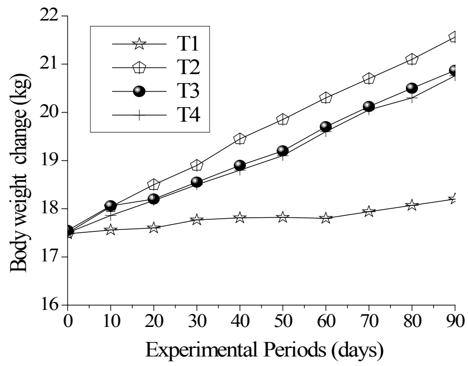
Sycamore fig or shola leaf processing strategies

Leaf of *F. sycomorus* was harvested by climbing the tree and mowing/pruning the branch of tree at the end of the rainy season from communal lands, local farmer's farm yard, and river banks around Gish Abay. The time of harvesting was determined based on the intensity of sunlight that facilitates drying and optimum growth of leaf with which biomass becomes higher. *F. sycomorus* around Gish Abay. The leaf was air-dried under shade. *F. sycomorus* leaf's petiole was removed (twigs separating after lopping). The dried leaf (partially crushed) and fruit were collected and put into sacks and stored in a well-ventilated shade until used at room temperature. After harvesting the hay was transported to the study sites, stored under shade to maintain its quality and used as a basal diet throughout the experimental period.

Conclusion

Supplementation with different forms of processed *F. sycomorus* leaf has generally a positive effect on feed intake, nutrient digestibility and carcass parameters on sheep. Among the different forms of processed grain supplements, *F. sycomorus* leaf increases its feeding value. This study was conducted to determine the effect of supplementation with *F. sycomorus* leaf, fruit and their mixtures on feed intake, digestibility, body weight gain and carcass parameters of yearling male intact Washera sheep feed natural pasture hay. The study was conducted at Sekela Woreda using twenty intact male yearling Washera sheep, with mean body weight of 17.5+ 0.39 kg (mean + SD). The experiment was conducted using a randomized complete block design with four treatments and five block. Experimental animals underwent 15 days of adaptation for the treatment feeds prior to commencement of the experiment. Digestibility trial was conducted after three days of adaptation for feces collection bags for seven days. This was followed by a feeding trial where feed intake and body weight change of the animals were evaluated for 90 days.

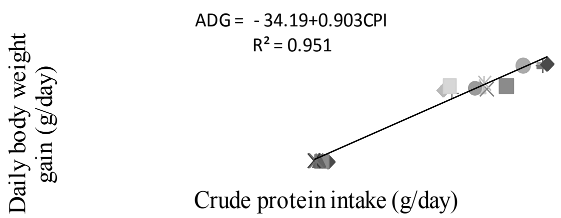
Representative samples of feed offered and refused as well as feces were taken and analyzed for different nutrients. In both trials, the basal



FSL=*F. sycomorus* Leaf; FSF=*F. sycomorus* Fruit; T_1=Natural Pasture Hay; T_2=hay+300 g 1FSL DM; T_3=hay+300 g 1FSL:1 FSF DM mix; T4=hay+300 g FSF DM.

Source: Awoke and Yoseph [26]

Figure 3: Trends in body weight change across the feeding period for Washera sheep fed natural pasture hay alone and natural hay supplemented with *F. sycomorus* leaf, fruit and their mixtures.



ADG=Average Daily Body Weight Gain; CPI=Crude Protein Intake; R^2=coefficient of determination.

Source: Awoke and Yoseph [26]

Figure 4: Regression of body weight gain on crude protein intake of Washera sheep fed natural pasture hay alone and supplemented with *F. sycomorus* leaf, fruit and their mixtures.

diet was natural pasture hay. Dietary treatments comprised feeding natural pasture hay alone (T_1) or natural pasture hay supplemented with either leaf (T_2), mixture of leaf and fruit (at a ratio of 1:1; T_3) or fruit (T_4) of *F. sycomorus*. The amount of supplement was 300 g/day on DM basis. The basal diet was offered on average at 25% refusal rate. Water and mineral salt were provided free choice to the animals all the time and body weight was measured at an interval of ten days. At the end of the feeding trial, all the sheep were slaughtered to evaluate carcass parameters. The chemical composition analysis result of the experimental feeds indicated that CP and OM contents of grass hay were 7.8% and 92.6%, respectively. The CP contents of leaf and fruit of *F. sycomorus* were 17.9% and 11.8%, respectively. The study demonstrated that supplementation decreased ($P<0.05$) basal dry matter intake, but increased the rate of substitution. The total DMI was significantly ($P<0.001$) increased with supplementation. Total CP, OM and NDF intakes were also significantly higher ($P<0.001$) in the supplemented groups as compared to the un-supplemented sheep. The estimated metabolisable energy intake was significantly higher ($P<0.001$) for supplemented groups than that of the un-supplemented in the order of $T_2>T_3>T_4>T_1$.

Supplementation resulted in significantly higher ($P<0.001$) coefficient of DM and OM digestibility. Sheep in the un-supplemented treatments had significantly lower ($P<0.001$) CP digestibility than the supplemented groups. However, there was no significant difference ($P>0.05$) between T_3 and T_4 in DM and OM digestibility coefficient. Digestibility coefficient of NDF and ADF was significant ($P>0.001$) between the supplemented and un-supplemented groups. These could be attributed to satisfactory nitrogen intake and degradability of fiber content of the hay.

The ADG, final body weight (FBW) and FCE were significantly higher ($P<0.001$) in the supplemented than that of the un-supplemented group. Un-supplemented treatment had significantly lower ($P<0.01$) dressing percentage (32.7%) calculated on slaughter weight basis and empty body weight basis (52.2%) than supplemented groups. The study showed that supplementation with *F. sycomorus* leaf, fruit and their mixture (1FSL: FSF) resulted in better utilization of nutrients and animal performance for intact male yearling Washera sheep. Supplementation with 300 g DM per head /day had higher effect on total CP intake and ADG. There was significantly higher ($P<0.001$) FCE in un-supplemented group (0.01) compared to supplemented treatments (0.06, 0.05 and 0.05) in T_2, T_3 and T_4, respectively.

However, significant difference ($P>0.001$) was observed among supplemented treatments in this parameter. The average body weight gain, empty body weight and hot carcass weight were positively ($P<0.001$) correlated with total DM intake and total CP intake. The rib-eye muscle area (REMA) in supplemented treatments was significantly higher ($P<0.001$) for T_2 (7.4 cm^2) compared to T_1 (5.5 cm^2). Sheep in T_3 and $T_{4,}$ however, were similar ($P<0.01$) in REMA compared with the un-supplemented group. The total non-edible offal (TNEO) was numerically higher ($P>0.01$) but Total edible offal content (TEOC) was significantly ($P<0.001$) increased with increased level of supplemented. In general, supplementation with 300 g FSL, FSF and their mixture (FSL: FSL) improved the performance of sheep compared to the un-supplemented. Among the feeding strategy employed, supplementing sheep with T_2 becomes biologically optimum and economically feasible.

References

1. Adugna T (2008) Livestock Feed Supply Situation In Ethiopia: Commercialition of Livestock Agriculture in Ethiopia. Addis Ababa, Ethiopia.
2. Orwa C, Mutua A, Kindt R, Jamnadass R, Anthony S (2009) Agroforestry database: a tree reference and selection guide version 4.0.
3. Teferi A, Solomon M, Lisanework N (2008) Management and utilization of browse species as livestock feed in semi-arid Woreda of North Ethiopia.
4. Devendra C (1990) The use of shrubs and tree fodders by ruminants. In: Devendra C (ed.) Shrubs and Tree Fodders for Farm Animals. International Development Research Centre Ottawa, Canada.
5. Anugwa, FOI, Okori AU (1987) The nutritive value of three Nigerian browse plants eaten by sheep. Bulletin of Animal Health and Production in Africa 35: 23-228.
6. Sibanda S (1993) Cattle food resources and their use in communal lands. Journal of Zimbabwe Society Animal Production 5: 37-42.
7. Topps JH (1992) Potential, composition and use of legume shrubs and trees as fodder for livestock in the tropics (a review). Journal of Agricultural Science in Cambridge 118: 1-8.
8. Russel JB, Baldwin RL (1978) Substrate preference in rumen bacteria: evidence of cataboliet regularity mechanisms. Journal of Applied Environmental and Microbial 36: 319-329.
9. Egan AR (1985) Principles of supplementation of poor quality roughages with nitrogen. In: Dixon R M (ed), Ruminant feeding systems utilizing fibrous agricultural residues 1985. IDP (International Development Programme of Australian Universities and Cilleges Ltd), Canberra, Australia pp: 49-58.
10. Van Soest PJ (1982) Nutritional ecology of the ruminant: O and B books, Corvallis, Oregon, USA.
11. Ndlovu LR (1992) Complementarily of forages in ruminant digestion: Theoretical consideration. In: Stares JES, Said AN, Kategile JA The complementarities of White feed resources for animal production 18-21.
12. Pamo TE, Tendonkeng F, Kana JR, Boukila B and Nanda AS (2006) Effects of *Calliandra calothyrsus* and *Leucaena leucocephala* supplementary feeding on goat production in Cameroon. Journal of Small Ruminant Research, 65: 31-37.
13. Pamo TE, Boukila B, Fonteh FA, Tendonkeng F, Kana JR, et al. (2007) Nutritive values of some basic grasses and leguminous tree foliage of the Central region of Africa. Journal of Animal Feed Science and Technology 135: 273-282.
14. Gatenby RM, Mahato SN, Shrestha NP (1989) Animal Production in the Hills of Nepal. *PAC* Technical Paper 112. Dhankuta, Nepal.
15. Larbi A, Thomas D, Hanson J (1993) Forage potential of *Erythrina abyssinica*: Intake, digestibility and growth rates for stall-fed sheep and goats in southern Ethiopia. Journal of agro forestry systems 21: 263-270.
16. Gatenby RM (2002) Sheep. The tropical Agriculturalist Series. MacMillan publishers.178.
17. Devendra C (1988) Forage supplements: nutritional significance and utilization for draught, meat and milk production in buffaloes. Proceedings II World Buffalo Congress, New Delhi, India.
18. Andre VT (2004) Fodder Trees.
19. Kubmarawa D, Andeyang IFH, Magomya, (2008) Amino Acid Profile of Two Non- conventional Leafy Vegetable, *Sesamum* and *Balanites* aegyptiaca. Afr. Journal of Biotechnology 7: 3502-3504.
20. Purohit AN (1989) Indians testing Ficus as high altitude MPT. Journal of Agro forestry Today 1: 19-20.
21. Bayafers T, Tamrat B, Ensermu K (2002) An ethno botanical study of the Semi wetland Vegetation of Cheffa.
22. Rajan A, (1985) Experimental studies on chela leaf (*Ficus tsiela* Roxb) poisoning in calves. Kerala Journal of Veterinary Science, 16:94-99.
23. Knipscheer HC, Hart RD, Baker D (1987) Socio-economic aspects of small Ruminant activity Proceedings. Fourth International Conference on goats, Brasilia, March 8–13.
24. Lemlem A, Fassil D (2006) Socio-economic survey of Arba-Minch riverine forest and woodland. Journal of the Dry lands 1: 194-205.
25. Kinnaird MF (1992) Phenology of flowering and fruiting of an East African riverine forest co system. Journal of Biotropical 24: 187-194.
26. Kassa A, Mekasha Y (2014) Effects Of Supplementation with Sycamore Fig (*Ficus sycomorus*) on Performances of Washera Sheep Fed Natural Pasture Hay and Its Economic Benefit. Global Journal of Animal Scientific Research 2:130-142.

27. Njidda AA, Ikhimiaya I (2010) Correlation between chemical composition and *In Vitro* Dry matter digestibility of leaf of semi-arid browse of north–eastern Nigeria. American - eurasaian Journal of Agriculture and Environmental science 9:169-175.

28. Nkafamiya II, Osemeahon SA, Modibbo UU, Aminu A (2010) Nutritional status of non- conventional leafy vegetables, *Ficus asperifolia* and *Ficus sycomorus*. African Journal of Food Science 4:104-108.

29. Lorenzo M (2002) Feeding ecology and human evolution.

30. Alyssa NC (2009) Allomaternal Care and Juvenile Foraging among the Hadza: Implications for the Evolution of Cooperative Breeding in Humans. San Diego Pp.38-47.

31. Gurr MI, Mawson R, Rothwell NJ, Stock MJ (1980) Effects of manipulating dietary protein and energy intake on energy balance and thermogenesis in the pig. Journal of America clinical Nutrition 110: 532-42.

32. Saka JDK, Msonthi JD (1994) Nutritional value of indigenous wild trees in Malawi. Journal Forest Ecology Management 64: 245-248.

33. Le Houerou HN, Cobra M (1980) Some browse plants of Ethiopia. In: Le Houerou HN (ed) Browse in Africa: the Current State of Knowledge. Addis Ababa, Ethiopia: International Livestock Centre for Africa (ILCA).

34. Asiegbu JE, Anugwa FOI (1988) Seasonal availability, physical and chemical characteristics of four major browse plants used for stall-feeding of livestock in Eastern Nigeria. Bulletin of Animal Health and Production in Africa 36: 221-228.

35. Gohl B (1981) Tropical feeds: feed information summaries and nutritive values. FAO, Animal Production and Health Series, Rome.

36. Gupta HK, Balaraman N (1989) Nutritive value of nevaro (*Ficus hookerii*) leaves for goats. Indian Journal of Animal Sciences 59: 186-187.

37. Nkafamiya II, Manji AJ (2006) A Study of cyanogenetic glucoside contents of some edible nuts and seeds. Journal of Chemistry Society of Nigeria 31: 12-14.

38. Rajan A, Divakaran N, Valsala KV, Maryamma KI, Amachandran KM (1986) Pathology of a nervous disorder in cattle caused by the toxicity of the leaf of the tree *Ficus tseila* Roxb. Ludian Veterinary Journal 63: 184-186.

39. Kassa A (2015) Effects of Supplementation with *Ficus sycomorus* (Shola) on Performances of Washera Sheep Fed Natural Pasture Hay. Global Journal of Animal Scientific Research 3: 370-382.

40. Topps JH (1995) Forage legumes as protein supplement to poor quality diets in the semi-arid tropics. Rumen Ecology Research Planning. Proceeding of a workshop held at ILRI, Addis Ababa, Ethiopia.

41. Osuji PO, Fernandez-Rivera S, Odenyo A (1995) Improving fiber utilization and protein supply in animals fed poor quality roughages: ILRI nutrition research and plans. In: Rumen Ecology Research Planning. Proceedings of a Workshop Held at ILRI, Addis Ababa, Ethiopia.

42. Hirut Y (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 M.Sc Thesis Presented to the School of Graduate Studies of Haramaya University 75.

43. Wondwosen A (2008) Effect of supplementing hay from natural pasture with oil seed cakes on feed intake, digestibility and live weight change of Sidama goats. An M.Sc. Thesis Presented to School of Graduate Studies, Haramaya University, and Ethiopia 27.

44. Minson DJ (1990) Nutritional differences between Tropical and Temperate pastures. In: Grazing animals. Editon. Morley FHW, CAB, Furnham R, Slough, UK 167-182.

45. Adugna T, Sundstøl F (2000) Supplementation of graded levels of *Desmodium intortum* hay to sheep feeding on maize stover harvested at three stages of maturity. Feed intake, digestibility and body weight change. Animal Feed Science and Technology 85: 239-257.

46. Kempton TJ, Nolan JV, Leng AR (1979) Principles for the use of non- protein and by- pass protein in diets of ruminants. FAO Anim, Production and Health paper, FAO, Rome.

47. Montaldo A (1972) Cultivo de raicesy tubercoles tropicalse. Lima Peru insituto Interamericano de Ciencias Agricolas de la OEA.

48. Emebet L (2008) Supplementation of Blackhead Ogaden Sheep Fed Haricot Bean (*Phaseolu svulgaris*) Haulms with Mixtures of Wheat Bran and Brewers Dried Grain: Effects on Feed Utilization, Live Weight Gain and Carcass Parameters. An M.Sc. Thesis Presented to the School of Graduate Studies of Haramaya University 1-69.

49. Abdulrazak SA, Njuguna NJ, Karau PK (2005) The effect of supplementing Rhodes grass (*Chloris gayana*) hay with *Acacia tortilis* leaves and pods mixture on intake, digestibility and growth performance of goats. Livestock Research for Rural Development 17.

50. Devendra C, Burns M (1970) Feeding and nutrition. In: Goat production in the tropics. CAB (Common wealth Agriculture Bureaux), London, UK.

51. Doyle PT, Dove H, Freer M (1988) Effects of a concentrate supplement on the intake and digestibility of low- quality roughage by lambs. Journal of Agricultural Sciences 111: 503-511.

52. Nsahalai IV, Ummuna NN (1996) Sesbania and Lablab supplementation of oat hay basal diet fed to sheep with or without maize grain. Journal of Animal Feed Science and Technology 61: 275-289.

53. Huston JE (1994) Effects of supplemental feeding on intake by kid, yearling, and adult Angora goat son rangeland. Journal of Animal Science 72: 768-773.

54. Osuji PA, Odenyo AA (1997) The role of legume forages as supplements to low quality forages-ILRI experience. Journal of Animal Feed Science and Technology 69: 27-38.

55. McDonald RE, Edward RA, Greenhalgh JFD, Morgan GA (2002) Animal nutrition 6th edition. Longman scientific and technical Co-published in the USA, John Wiley and Sons incorporated New York.

56. Tegbe TSB, Adeyinka IA, Baye KD, Alawa JP (2006) Evaluation of Feeding Graded Levels of Dried and Milled *Ficus thonningii* Leaves on Growth Performance, Carcass Characteristics and Organs of Weaner Rabbits. Pakistan Journal of Nutrition 5: 548-550.

57. Skarpe C, Bergstrom R (1986) Nutrient content and digestibility of forage plants in relation to plant phenology and rainfall in the Kalahari, Botswana. Journal of Arid Environments 11: 147-164.

58. Ahn JH, Robertson BM, Elliott R, Gutteridge RC, Ford CW (1989) Quality assessment of tropical browse legumes: tannin content and protein degradation. Journal of Animal Feed Science and Technology 27: 147-156.

59. Solomon M, Petes KJ, Azage T (2004) Effect of supplementation with foilage of selected multipurpose trees, their mixtures or wheat bran and feed intake, plasma enzyme activities, live weight and scrotal surcumfrances gain in Menze sheep. Journal of Livestock Production Science 89: 253-264.

60. Badamana MS, Oldman JD, Mowlem A (1990) The effect of amount of protein in the concentrate on hay intake and rate of passage, diet digestibility and milk production in British Saanen goat. Journal of Animal Production 51: 333-342.

61. Yahaya MS, Kibon A, Aregheore EM, Abdulrazak SA, Takahashi J, et al. (2001) The evaluation of nutritive value of three tropical browse Species for sheep using *in vitro* and *in vivo* digestibility. Asian-Australasian Journal of Animal Sciences 14: 496-500.

62. Tesfay H, Solomon M (2008) Feed intake, digestibility, and body weight and carcass parameters of Afar rams fed tef (*Eragrostis tef*) straw supplemented with graded levels of concentrate mix. Journal of Animal health and production 41: 599-606.

63. Adebowale EA, Orskov ER, Shand WJ (1991) Use of ash cocoa pod husk as source of alkali for up grading crop residues with or without hydrogen peroxide. Journal of Tropical Agricultural 68: 27-32.

64. Solomon M, Simret B (2008) Bodyweight and carcass characteristics of Somali goats fed hay supplemented with graded levels of peanut cake and wheat bran mixture. Journal of Tropical Animal Health and Production 40: 553-560.

65. Reed JD, Soller H, Woodward A (1990) Fodder tree and Stover diets for sheep: Intake, growth, digestibility and the effect of phenolics on nitrogen utilization. Journal of Animal Feed Science and Technology 30: 39-50.

66. Nitis IM (1989) Fodder trees and livestock production under harsh environment. Journal of Asian Livestock 116-120.

67. Atta-Krah AN (1990) Fodder trees and Shrubs in Tropical Africa: Importance, availability and pattern of utilization. Centre for Agricultural and Rural Cooperation, Wageningen, and the Netherlands 118-138.

68. Kaitho RJ, Umunna NN, Nsahlai IV, Tamminga S, Bruchem JV (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. Journal of Animal Feed Science and Technology 72: 355-366.

69. Bruh W (2008) Supplementation with dried foliages of selected indigenous browses: effects on feed intake, digestibility, and body weight gain and carcass characteristics of Abergelle goats offered hay. An M. Sc. Thesis Presented to the School of Graduate Studies, Haramaya University, Ethiopia 27-39.

70. Aynalem H, Taye T (2008) The feed values of indigenous multipurpose trees for sheep in Ethiopia: The case of *Vernonia amygdalina, Buddleja polystachya* andMaesa *lanceolata*. Journal of Livestock Research for Rural Development 20: 1-7.

71. Solomon M (2001) Evaluation of Selected Multipurpose trees as Feed Supplements in teff (*Eragrostis tef*) straw based feeding of Menz Sheep. Berlin, Germany.

72. Leng R (1997) Tree foliage in ruminant nutrition. FAO Animal production and health paper, Rome, Italy.

73. Matiwos S, Solomon M, Adugna T (2008) The effect of different levels of cottonseed meal supplementation on feed intake, digestibility, live weight changes, and carcass parameters of Sidama Goats. Journal of livestock Science.

74. Wogenie B (2008) Effects on increasing levels of energy and protein supplementation on feed intake, body weight change and carcass composition of Blackhead Somali sheep fed on grass hay. An M.Sc. Thesis Presented to School of Graduate Studies, Haramaya University, Ethiopia.

75. Mulu M, Berehan T, Alemu Y (2008) The effect of grass hay with different level of Brewer's Dried Grain on feed intake, digestibility and body weight gain intact Wogera lambs. East African Journal of Science 2: 105-110.

76. Abebe H (2008) Supplementation of graded levels of concentrate mix on feed intake digestibility, live weight change and carcass characteristics of Washera sheep fed urea treated rice straw. An MSc. Thesis Presented to School of Graduate Studies, Haramaya University, Ethiopia.

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