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Identification and Nutritional Value Assessment of the Major Browse Species in Chilega District, North Gondar

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Abstract: The study was conducted in Chilga district of North Gondar Zone of the Amhara National Regional State to identify the major browse species, their importance as feed for livestock and their potential estimated biomass yield, their chemical composition, *in vitro* digestibility and in sacco degradability of the major browse species. During the study period 20 browse species were identified; - out of which twelve were selected based on their abundance in the district, preference by livestock, ease of browsing and additional uses other than livestock feed. According to the respondents, nearly all the domesticated ruminants in the survey area consumed browse species. Browses were utilized in both wet and dry seasons. Some browse species shed leaves early, while others retained leaves late into the dry season. Leaves, pods, twigs and flowers were the plant parts utilized by livestock. However, leaves were the most preferred part. The browse species were found on grazing land, crop land, in home compounds or grown as boundary plant species between farm lands. The farmers did not give great attention to the fodder value of the browse species and so do not manage them well. Significant difference (P<0.05) in potential biomass yield was observed among browse species. There is a wide variation in CP, NDF, ADF, ADL and ash contents. The IVDMD value varied ranging from 21.16 to71.07. There was a significant difference (P< 0.05) in DM and CP in sacco degradability among browse species. The result showed that there was relatively better digestibility and CP composition in browse species such as *Helinus mystacium*, *Blecarcites aegyptica* and *Ficus thonningii*, implying that, these browse species could be used to improve animal performance through improving the nutritive value of low quality feed resources.

Key words: Biomass Yield · Chemical Composition · In Saco And *in vitro* Degradabilit

INTRODUCTION

Agriculture, which accounts for more than 80% of the population income, is the back bone of Ethiopia's national economy. Livestock production is one of the major areas in the agricultural sector that plays a role in the socio-economic development of the people since it provides draught power, meat, milk and other products [1]. However livestock productivity in Ethiopia is low and the contribution of animal products to national economies is not substantial [2]. Alemayehu [3] reported that even though, livestock production in Ethiopia contributes 80% of farmer's income its contribution to GDP is limited to 20%. One of the major constraints that are responsible for such low productivity is inadequate year round feed supply (both in terms of quantity and quality) [4].

It is generally true that human population of the country, similar to other sub Saharan African countries, is increasing alarmingly. These increase demands for more arable land to produce more food for humans, which constantly reduces the amount of land available for grazing and browsing. Thus, soil fertility declines and its structure deteriorates resulting in decreased productivity and increased erosion and general degradation of the natural resources upon which the Ethiopia's economy depends.

Apart from decreased productivity, reduced carrying capacity of the grazing land is also a challenge. Besides feed resource availability is influenced by seasonal fluctuation of rainfall. In some areas feed is available relatively in higher quantity and better quality during the rainy season and early dry season compared to the long

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dry season. This calls for strategies to bridge the gap between the dry and wet seasons. Browse species could be used as a "stop gap" measure during the transition period from dry to wet seasons since they stay green. Browse pods are also high in nutritive value and can be used as supplements to low quality roughages [5].

Devendra [6] reported that browses are important for two major purposes. The first, environmental protection (including soil fertility maintenance), is conservation oriented. Watersheds, windbreaks, erosion barriers and forest reserves are all strategies of conservation. The second purpose is produce-oriented and demands that trees be exploited. This, therefore, includes the harvest of trees for fodder, timber, poles and fuel wood. Multipurpose leguminous trees can increase the fire wood supply for farming household and decrease the need to use dung as fuel so, the dung can be used as fertilizers.

The quantity, quality and continuity of feed supply throughout the year promote a favorable level of animal production in any environment. Most tropical grass species have low dry matter digestibility and intake. During the dry season, when plant growth is highly suppressed, shortage of forages availability reduces growth of grazing animals. This also affects nutrient requirements and bioavailability of minerals in grazing animals [7]. Furthermore, in the dry season, most ruminants reared on grass alone have problems in meeting their maintenance requirements and consequently lose weight gained during the wet season [8]. To overcome this situation it is, therefore, imperative to meet their nutrient requirement through the introduction and use of browse species as animal feed. Introduction of browses could be done by growing them in forage banks or as hedges, between crops (alley farming) or as components of pasture and also shed trees (Moog, 1991). The most significant contribution of browse species as animal feed is that it serves as a source of crude protein as well as its ability of being green for longer time during the dry season [6]. This needs assessment of the type, amount, quality, seasonal performance and over all utilization of existing local browse trees in a given locality. Moreover, in areas where browse trees are scarce evaluation of their adaptation and performance of introduced browse trees is also necessary.

Chilga district where this study was conducted has mixed crop-livestock production system with estimated livestock population of 228,654 cattle, 105,672 goats, 20,250 sheep, 19,199 donkeys, 161 horses, 99 mules and 17 camels. Chilga District Agricultural and Rural Development Office (CDARDO). The district is dominated by semi arid climatic conditions and browse species are the dominant vegetation in the district. In spite of the availability and wide use of the indigenous browse species, however, studies has not yet been well done with regard to the extent of its utilization, the major species found in the district and their nutritive value.

Therefore, this study was initiated with the following objectives;

- To identify the major browse species, their importance as feed for livestock and their potential estimated biomass yield in Chilga district.
- To evaluate chemical composition, *in vitro* digestibility and in sacco degradability of the major browse species important as feed for livestock in the study area.

MATERIALS AND METHODS

Description of the Study Area: The study was conducted in Chilega Woreda, which is found in North Gondar zone of Amhara National Regional state (ANRS). Chilega is located at 63km west of north Gondar zone and 230km west of Bahir Dar the capital of Amhara National Regional State. It is situated at an altitude ranging from 900 to 2250m.a.s.l. The Woreda covers about 322,264.08 ha of land of which 33% is highland while 67% is low land. Chilga Woreda is characterized by a uni-modal type of rainfall pattern with annual average rainfall of 995-1179mm and air temperature of 11-32°C.

Selection of the Study Site and Sampling Methods: The study site (Chilega district) has 30 farmer kebeles (FK) out of which 5 FKs were selected purposively based on the abundance of browse species, altitudinal ranges and accessibility. From each farmer kebele (FKs) 10 farmers were randomly selected (50 total farmers). Structured questionnaire was developed to collect data on animal feed resource of the area, types of browse species, feeding practice of browse species, season and parts of browse species preferred. In addition secondary information from agricultural and rural development office and Sustainable natural resource development and utilization program was collected.

Sampling Browse Species: Samples of browse species were collected, pressed, labeled, dried and transported to the National Herbarium of Addis Ababa University for identification and nomenclature. Identification of browse species was made following the flora of Ethiopia [9]. Out of the total identified species, the top 60% (in terms of importance as livestock feed) were evaluated for chemical

composition and *in vitro* digestibility. Similarly degradability of forages of the top 20% species was evaluated through *in sacco* (*in situ*) techniques. The importance of the forage species as feed for livestock was determined based on their abundance in the Woreda, preference by livestock, ease of browsing and additional use other than livestock feed. Harvesting of specimen was carried out during early dry season (October-late November) when the browse species are matured.

Predicting Potential Yield of Browse Species: Potential yield of browse species is the foliage available for defoliation [10]. Using measuring tape the circumference of the stem of the browse species was measured. Data on circumference were taken for 12 species in each farmer kebeles 10 measurements per species. The diameter was calculated by using the following equation:

D=0.636c

Where,
D=diameter
C=circumference according to Petmak [11]

The potential foliage yield of the browse species there after was estimated by entering the diameter in the equation developed by Petmak [11] as given below:

Log W =2.24logDS-1.50

where
W= leaf yield in kilogram of dry weight,
DT= trunk diameter (cm) at 30cm height above the ground and
The allometric equation for leaf yield of shrubs is

Log W=2.62logDS-2.45,

where
DS= the stem diameter (cm) at 30cm height above the ground.

For shrubs with many primary branches, the stem diameter was the total diameter ojZe stem of all the primaj Zranches.

Browj Zoliage Sample Collectiojjd Preparation for Chemical Analysis: The leaves and twig samples of the selected browse species were collected for analysis. The samples were air dried in a well ventilated room until transported to the laboratory. Upon arrival at laboratory part of the sample was dried at 65°C to constant weight for chemical analysis. Thereafter, the sample was separately ground in a Willey mill to pass through 1mm sieve (for chemical analysis) and 2mm sieve (for in sacco degradability) and equilibrated to room temperature for 24 hours. Then the samples were kept in plastic bags pending chemical analysis.

Chemical Analysis: The dry matter content of browse species (leaves and twigs) was determined by drying the sample in oven at 105°c overnight. Total nitrogen was determined by kjeldahl method [12]. Crude protein (CP) was calculated as N x 6.25. Ash was determined by complete burning of the feed samples in a muffle furnace at 500°C overnight according to the procedure of AOAC, [12]. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were analyzed using the detergent extraction method [13].

***In vitro* Dry matter Digestibility:** *In vitro* dry matter digestibility (IVDMD) of foliage of each browse species was determined by the method of Tilley and Terry [14] as modified by Van Soest and Robertson [15]. The samples, which were dried at 65°c to constant weight, were ground to pass through a 1mm sieve. About 0.5g of the sample was incubated in 125ml Erlenmeyer flasks containing rumen fluid-medium mixture for 48 hours in incubator at 39°C. The microbial digestion then was followed by neutral detergent refraction for the following 48 hrs. The rumen fluid was obtained from three rumen fistulated Boran x Friesian crossbred steers kept at maintenance diet.

In Sacco Degradability: The dried forage sample of selected browse species was ground to pass through a 2mm screen to determine DM and CP degradability. Selection of the browse species were made based on their importance as forage for livestock in the survey area. Rumen degradability of the samples was determined by incubating about 3 g of sample in nylon bag (41µm pore size and 6.5 ×14cm) in rumen fistulated steers kept under maintenance diet. The browse samples were incubated for 0, 6, 12, 24, 48, 72 and 92 hours. Replicated nylon bags containing the sample were incubated in three rumen fistulated animals for different length of hours. After incubation for respective length of hours bags were removed and washed by tap water until the rinsing water looks clean. Zero hour wash losses were rinsed and cleaned by tape water similar to that of the incubated

bags. The washed bags were then dried in an oven at 60°C for 72 hours. The dried bags were taken out of the oven and cooled and weighed immediately. The percentage disappearance of DM and CP was determined by using the following formula. The residues were then analyzed for their crude protein content in the laboratory according to the procedures of AOAC [12].

$$\text{Dry matter degradability (DMD)} = \frac{\text{(DM in browse species-DM in residue)}}{\text{(DM in browse species)}} \times 100$$

$$\text{Crud Protein degradability (CPD)} = \frac{\text{(CP in browse species –CP in residue)}}{\text{(CP in browse species)}} \times 100$$

The DMD and CPD data were fitted to the equation described by Ørskov and McDonald [16] using the Neway Excel program

$Y= a+b (1-e^{-ct})$, where
Y= the potential disappearance of DM at time t
a= rapidly degradable fraction
b = the potentially, but slowly degradable fraction
c = the rate of degradation of b
e = the natural logarithm
t = time

Effective degradability (ED) was calculated following the method of Ørskov and McDonald [16], a passage rate of 4 %/h.

The potential degradability (PD) was calculated as follow

PD = a+b
ED = a + bc / k+c where
k = passage rate c=
Statistical Analysis

The data collected from the survey was analyzed by using descriptive statistics in SPSS statistical soft ware (SPSS, version 15). *In sacco* DMD and nitrogen (ND) was analyzed by using the Neway Excel program. The model for analysis of potential biomass yield is as follow

$$y_{ij}=\mu + b_i + e_{ij},$$

where,
y_{ij}= response variable
μ= overall mean
b_i= browse species
e_{ij}= the random error

The model used for analysis of the nylon bag data was;

$$y_{ijk} = \mu+A_i +R_k +e_{ijk.,}$$

where;
y_{ijk} = response variable
μ = overall mean
A_i = animal effect
R_k= sample effect
e_{ijk}= random error

RESULTS AND DISCUSSION

The Major Available Browse Species in Chilga District: In this study it was observed that farmers were able to identify the type of tree/shrubs species and their vegetative part favored by different class of livestock. The farmers, however, named these trees and shrubs in their vernacular language and secondary information about the botanical name of these indigenous trees and shrubs is given in (Table 1).

The interviewed farmers further explained that the distributions of browse species through out the selected kebeles within Chilga district are not even. In some part of the study area there are many browse species in type as well as in abundance (Table2). The result is in agreement with that reported by Brinkman *et al.* [17]. The same author suggested that the existence of different types of browse species between and within localities and their distribution tendencies with any spatial arrangement, could be explained by lack of proper management and by the characteristics of their reproductive structures.

Animal Preference of Browse Species: The interviewed farmers explained that, goats are active and inquisitive in their foraging behavior. Although goats consume a wide diversity of foliages found in the area, they particularly prefer browsing to grazing and are attracted to trees and shrubs. This is the behavioral characteristic of goats unlike other groups of domestic ruminants like cattle and sheep. Cattle were more selective in feeding on browse species than goat. According to the respondents cattle didn't need thorny and rough browse species, like *Acaicia* and *ziziphus spina chiristi* because of their thorniness. They are not highly preferred by cattle, especially when there is adequate feed supply. Rather cattle showed a marked preference on browses, which has soft leaves and thornless species like *Ficus thonningii, Bridelia cathartica, Terminalia schimperiana,*

Table 1: The major available browse species identified in the study area

No.	Browse species	Family name	Local name
1	*Acaicia bussei*	LEGUMINASAE	*Girar*
2	Acaicia spp	FABACEAE	*Guaria*
3	*Anogeissus leiocarpa*	COMBRETACEAE	*Kikira*
4	*Blecarcites aegyptica*	COMBRETACEAE	*Kudkuda*
5	*Bridelia cathartica*	EUPHORBIACEA	*Charia*
6	*Combretum collinum*	COMBRETACEAE	*Ferwuha*
7	*Combretum molle*	COMBRETACEAE	*Fongera*
8	*Dombeya torrid*	STERULIACEAE	*Welkif*
9	*Ficus sur*	MORACEAE	*Shola*
10	*Ficus sycomorus*	MORACEAE	*Bamba*
11	*Ficus thonningii*	MORACEAE	*Chibaha*
12	*Grewia villosa*	MORACEAE	*Lenquata*
13	*Helinus mystaciunu*	RHAMNACEAE	*Shasha*
14	*Hypericum pennpurum*	SAPIDACEAE	*Amija*
15	*Lecaniodicus fraxinifolius*	SAPIDACEAE	*durgaja*
16	*Piliostigma thonningii*	FABACEAE	*Darle*
17	*Rosa abyssinica*	ROSACEAE	*Kega*
18	*Stereospermum kanthianum*	BIGNONIACEAE	*Zana*
19	*Terminalia schimperiana*	COMBRETACEAE	*Wenbela*
20	*Ziziphus spina chiristi*	RHAMNACEAE	*Qurqura*

Table 2: Availability of browse species in the five farmers' kebeles with in Chilga district

No	Species	Alemtsihay	Maruna	Negadie bahir	Tembera	Walideva
1	*Acaicia bussei*	+	_	_	_	_
2	Acaicia spp	+	+	+	+	+
3	*Anogeissus leiocarpa*	_	+	_	_	_
4	*Blecarcites aegyptica*	_	+	+	+	+
5	*Bridelia cathartica*	_	+	+	+	+
6	*Combretum collinum*	_	+	+	+	+
7	*Combretum molle*	_	+	+	+	+
8	*Dombeya torrida*	+	_	_	_	_
9	*Ficus sur*	+	+	_	_	_
10	*Ficus sycomorus*	+	+	+	_	+
11	*Ficus thonningii*	+	+	+	+	+
12	*Grewia villosa*	+	_	_	_	_
13	*Helinus mystaciunu*	_	+	+	+	+
14	*Hypericum pennpurum*	_	+	+	+	+
15	*Lecaniodicus fraxinifolius*	_	+	+	+	+
16	*Piliostigma thonningii*	_	+	+	+	+
17	*Rosa abyssinica*	+	_	_	_	+
18	*Stereospermum kanthianum*	_	+	+	+	+
19	*Terminalia schimperiana*	_	+	+	+	+
20	*Ziziphus spina chiristi*	_	+	+	+	+

+=available; - = not available

Table 3: Availability of green foliages from different browse species over the different months of the year in Chilga district

	Months of the year (2010)											
Species	J	F	M	A	M	J	J	A	S	O	N	D
Acaicia spp	+	+	+	+	+	+	+	+	+	+	+	+
Blecarcites aegyptica	+	_	_	_	+	+	+	+	+	+	+	+
Bridelia cathartica	+	_	_	_	+	+	+	+	+	+	+	+
Combretum collinum	_	_	_	_	+	+	+	+	+	+	+	+
Combretum molle	_	_	_	_	+	+	+	+	+	+	+	+
Ficus sycomorus	+	+	_	_	+	+	+	+	+	+	+	+
Ficus thonningii	+	+	+	+	+	+	+	+	+	+	+	+
Helinus mystacium	_	_	_	+	+	+	+	+	+	+	+	+
Lecaniodicus fraxinifolius	+	_	_	+	+	+	+	+	+	+	+	+
Piliostigma thonningii	_	_	_	_	+	+	+	+	+	+	+	+
Stereospermum kanthianum	_	_	_	_	+	+	+	+	+	+	+	+
Terminalia schimperiana	+	+	_	_	+	+	+	+	+	+	+	+

+=available, - = not available

June – August are rainy season; September – May are dry season.

Combretum colinum and Sheep prefer grazing but when feed is scarce they shift to browsing. The present result agreed with Jensen [18].

Availability of Browse Foliage: As presented in Table (3) nearly all respondents reported that, even if most browse species lost their leaves during the dry season, some browse species like *Ficus thonningii and Acaicia spp* stayed green through out the year. Some browse trees like *Combretum molle, Combretum collinum, Stereospermum kanthianum* and *Piliostigma thoninngii* shed their leaves early in the dry season in December-January and some others like *Helinus mystaciunu* and *Lecaniodicus fraxinifolius* rejuvenate their leaves as soon as the rain begin to fall before other species started. According to the respondents explanation the browse species, which stayed green throughout the year are much more useful than those species which shed their leaves during the dry season. The ever green browse species provide green forage whenever farmers need to feed their livestock. This is in agreement with the report of Teferi [19]. About 48% of the farmers reported that *Ficus thoninngii* is the most preferred in terms of providing very green forage throughout the year. According to their explanation in addition to ever greenness it is easy for management and re growth. It need only cutting of the plant at the exact season and seedling of the branch that they have cut early before the rain begin to fall and before the soil becomes too wet and cold. Farmers explained that cuttings should be planted in slunt position on a well drained field and optimum time of planting for successful establishment.

Other Uses of Available Browse Species: As presented in Table (4) all browse species are used as source of fuel wood for cooking in addition to their use as livestock feed. Most of these species are also used for construction and 35% of the browse species were used for traditional medicine. But, none of the browse species are used for incense rather 60% and 30% of the browse species are important source of flowers for bee keeping and edible fruit, respectively. This result is in agreement with Thijssen *et al*. [20]. Moreover, farmers reported that even though, communal lands are decreasing overtime due to expansion of crop cultivation, browse species were able to be grown around homesteads and farm land boundaries. The advantage of fodder trees and shrubs is that they can be grown as fodder hedges around crop land boundaries and so do not compete for scarce land resource as reported earlier [21].

Browse species have diversified uses, however, farmers were not using these potential uses of browse species properly due to limited management and knowhow. According to the respondents farmers didn't involved much in planting and growing browse trees. They are only exploiting the naturally grown and regenerating browse trees in the area. More over, they even hardly properly managed the naturally growing browse trees. Alemayehu [3] reported that, human population pressure has resulted in conversion of grazing

Table 4: Major and selected uses of browse species in Chilga district

Browse species	Fuel wood (N=50)	Construction (N=50)	Traditional medicine (N=50)	Farm utility(N=50)	Edible fruit (N=50)	Bee forage (N=50)
Acaicia bussei	100.0	75.0	0.0	100.0	0.0	100.0
Acaicia spp	100.0	100.0	0.0	100.0	0.0	100.0
Anogeissus leiocarpa	100.0	50.0	50.0	50.0	0.0	50.0
Blecarcites aegyptica	100.0	93.8	12.5	56.3	12.5	12.5
Bridelia cathartica	100.0	92.1	0.0	92.1	0.0	100.0
Combretum collinum	100.0	85.0	0.0	75.0	5.0	45.0
Combretum molle	100.0	55.5	11.1	44.4	0.0	0.0
Dombeya torrid	100.0	0.0	0.0	0.0	0.0	0.0
Ficus sur	75.0	25.0	0.0	25.0	0.0	0.0
Ficus sycomorus	80.0	10.0	0.0	10.0	0.0	10.0
Ficus thonningii	82.6	17.3	0.0	13.0	0.0	0.0
Grewia villosa	100.0	0.0	0.0	60.0	20.0	20.0
Helinus mystaciunu	100.0	31.4	33.5	49.4	50.1	87.4
Hypericum pennpurum	85.7	85.7	0.0	57.1	0.0	0.0
Lecaniodicus fraxinifolius	100.0	92.3	7.7	41.6	53.9	52.9
Piliostigma thonningii	55.6	11.1	11.0	11.1	0.0	33.3
Rosa abyssinica	100.0	100.0	0.0	100.0	0.0	0.0
Stereospermum kanthianum	23.1	69.3	0.0	53.9	0.0	7.7
Terminalia schimperiana	100.0	59.0	45.5	45.4	4.5.0	22.7
Ziziphus spina chiristi	33.3	33.3	0.0	33.3	0.0	33.3

Table 5: Use of browse species and plant parts as forage by the different species of domestic ruminant animals as percent of the respondents in Chilga district

	Species of animals Browse parts consumed					
Browse species	Goats (N=50)	Cattle (N=50)	Sheep (50)	Leaves (N=50)	Leaf and twig (N=50)	Pods or fruits (N=50)
Acaicia bussei	100	20	80	100	100	100
Acaicia spp	100	85	70	90	10	90
Anogeissus leiocarpa	100	100	100	100	100	100
Blecarcites aegyptica	100	100	25	69	69	100
Bridelia cathartica	100	100	71	0	100	3
Combretum collinum	100	100	30	5	95	0
Combretum molle	100	100	27	10	90	0
Dombeya torrida	100	100	00	50	50	0
Ficus sur	50	100	50	100	75	100
Ficus sycomorus	100	100	38	100	80	100
Ficus thonningii	96	100	61	13	87	0
Grewia villosa	100	100	60	100	80	80
Helinus mystaciunu	100	100	94	0	100	71
Hypericum pennpurum	100	100	14	0	100	0
Lecaniodicus fraxinifolius	100	100	58	69.2	31	69
Piliostigma thonningii	100	100	27	18.2	82	00
Rosa abyssinica	100	100	50	0	100	0
Stereospermum kanthianum	100	100	21	15	85	15
Terminalia schimperiana	100	100	31.8	00	100	0
Ziziphus spina chiristi	100	83	83	67	34	67

pasturelands to crop land. This increasing demand for crop land to produce food for human population reduced the area available for natural pasture grazing and browses and getting diminished in size. Therefore, if their management practices going on in this way after a time there will not browse except *ficus thonningii* in the study area.

Utilization and Niches of Browse Species in the Study Area: The interviewed farmers reported that browse species used as animal feed in both dry and wet season whenever browses trees have foliage to be used as forage. They also used cut and carry system for sick and weak animals, which are kept around the homesteads. Mature pods of trees and shrubs naturally fallen under

Table 6: Growing niches in the farming system and feeding practice of the different browse species expressed as percent of the respondents in Chilga district

	Feeding practice				Niches in the farming system		
Browse species	Browsing (N=50)	Cut and carry (N=50)	Falling leaves and pods (N=50)	Grazing land (N=50)	In crop land (N=50)	Home compound (N=50)	As boundary in crop fields (N=50)
Acaicia bussei	100	75	0	100	75	25	75
Acaicia spp	90	95	5	90	100	15	95
Anogeissus leiocarpa	46	100	0	100	100	0	100
Blecarcites aegyptica	93	93.8	6.3	93.3	93.3	0	93.3
Bridelia cathartica	70	97.4	2.6	84.2	100	34.2	94.7
Combretum collinum	75	100	0	85	95	0	85
Combretum molle	70	100	0	100	100	0	100
Dombeya torrida	0	100	0	0	50	0	50
Ficus sur	0	100	0	25	100	25	25
Ficus sycomorus	10	100	10	30	80	30	30
Ficus thonningii	52.2	100	0	34.7	100	95.7	95.7
Grewia villosa	80	80	20	20	100	0	60
Helinus mystaciunu	100	23	0	100	93.8	0	6.3
Hypericum pennpurum	14.3	71.4	14.3	85.7	85.7	0	85.7
Lecaniodicus fraxinifolius	92.3	92.3	7.7	84.7	92.3	7.7	84.7
Piliostigma thonningii	30	100	0	70	90	20	90
Rosa abyssinica	66.7	100	0	33.3	66.7	33.3	33.3
Stereospermum kanthianum	53.8	100	0	50	91.7	16.7	91.7
Terminalia schimperiana	59	100	0	90.9	81.8	4.5	90.9
Ziziphus spina chiristi	100	50	0	83.3	66.7	0	100

Table 7: Estimated potential biomass yield of browse species in Chilga district

Species (N= 10)	Browse type (N= 10)	Trunk diameter(cm) (N= 10)	Trunk circumference(cm) (N= 10)	Estimated (kg/plant) (N=10)
Ficus sycomorus	tree	126	198	1604[a]
Ficus thonningii	tree	106	166	1081[b]
Terminalia schimperiana	tree	100	156	950[c]
Bridelia cathartica	tree	98	153	904[c]
Combretum collinum	tree	89	140	743[d]
Acaicia spp	tree	81	127	597[e]
Piliostigma thonningii	tree	78	122	544[e]
Combretum molle	tree	70	111	437[f]
Stereospermum kanthianum	tree	66	105	384[f]
Lecaniodicus fraxinifolius	tree	57	90	274[g]
Blecarcites aegyptica	Shrub	40	62	57[h]
Helinus mystaciunu	Shrub	33	52	35[h]

trees are normally consumed by animals. Some browse species like *Grewia villosa* also offered for pregnant cows to help during parturition. This is because farmers perceive that if cows eat *Grewia villosa* they don't face a problem related to expulsion of placenta after delivery of a calf.

As presented in Table (6) the respondents reported that the niches of browse species were different in the farming system. Most of the browse species were found around farm land boundaries and grazing lands. Certain browse species were also available in the farm lands and around the homesteads. Farmers manage browse species through controlling field fire and keeping of them from livestock damage especially for those browse species which were found around the residence area. The management of browses by farmers may not start from establishment except for *Ficus thonningii* as suggested by Teferi [19]. The rest of the browse species are usually managed after they regenerate naturally. But, for *ficus thonningii* they cut the plant at the appropriate season and planting of the branch that they have cut early when the rain begin to fall and before the land becomes muddier, since the plant can not be develop if the hall filed by more water.

Estimated Potential Biomass Yield of Browses in Chilga District: The biomass yield of 12 browse species from the study area are presented in Table 7. The result indicated

Table 8: Chemical composition of browse species leaves and twigs harvested during early dry season at Chilga district

				DM%			
Browse species	DM	Ash	OM	CP	NDF	ADF	ADL
Bridelia cathartica	93.12	8.54	91.46	15.77	53.92	38.88	12.36
Ficus thonningii	92.79	16.6	83.43	14.43	47.61	39.49	20.28
Acaicia spp	94.23	7.27	92.73	23.34	65.53	43.26	11.76
Terminalia schimperiana	92.84	6.25	93.75	14.99	50.46	23.81	15.5
Combretum collinum	94.16	11.1	88.89	13.78	48.81	43.45	15.35
Helinus mystaciunu	94.85	8.12	91.88	13.83	32.53	19.63	7.23
Blecarcites aegyptica	94.06	9.86	90.14	15.80	51.72	38.53	13.61
Lecaniodicus fraxinifolius	94.30	8.86	91.14	12.24	49.01	41.27	18.42
Stereospermum kanthianum	93.46	12.7	87.31	10.53	62.34	52.68	12.18
Lecaniodicus fraxinifolius i	94.43	13.4	86.65	12.20	85.45	40.02	9.57
Ficus sycomorus	94.29	21.0	79.04	11.13	60.46	48.9	13.25
Combretum molle	92.76	7.88	92.12	11.09	51.99	43.65	16.76

DM= dry matter, OM= organic matter, CP= crude protein, NDF= neutral detergent fiber, ADF= acid detergent fiber, ADL= acid detergent lignin

that there was significant difference (P<0.05) in biomass yield among the browse species compared. Thus, *Ficus sycomorus* was superior in biomass yield (1604 kg DM/plant) followed by *Ficus thonningii* (1081 kg DM/plant) while *Helinus mystaciunu* had the lowest yield 35 kg DM/plant in. There was no difference (*P*<0.05) in biomass yield between *Terminalia schimperiana* and *Bridelia cathartica*, *Acaicia spp*. and *Piliostigma thonningii* and *Combretum molle* and *Stereospermum kanthianum*. It has been documented that the biomass yield of browses could be influenced by soil fertility, rain fall and age of the plant. It was further demonstrated that the leaf, stem and total biomass production manipulated by tree density and cutting interval [22]. Low cutting interval might have also resulted in high dry matter (DM) yield. The difference among the browse species detected in this study could also be attributed to the differences in anatomical, morphological and physiological characteristics associated with acquisition of light, moisture and nutrients for biomass production [19].

Chemical Composition of Browse Species Leaves and Twigs Harvested During Early Dry Season at Chilga Wdistrict: The dry matter (DM), ash, crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) of the browse species sampled from the study area is presented in Table 13. The ash content of browse species considered was ranged from 7.27% in *Acaicia spp* to 21% in *Ficus sycomorus*. The CP composition of browse species was highly varied from 10.53% in *Stereospermum kanthianum* to 23.34% in *Acaicia spp*. The browses like *Acacia spp, Blecarcites aegyptica, Bridelia cathartica, Terminalia schimperiana, Ficus thonningii, Combretum collinum* and *Helinus mystacium* have better CP content than those browse species such as *Lecaniodicus fraxinifolius, Lecaniodicus fraxinifolius, Ficus sycomorus, Combretum molle* and *Stereospermum kanthianum.* The CP content of browse species recorded in the present study was lower than the findings of Solomon [23] who reported 25.3% in *Sesbania sesban,* However, the current result was in agreement with other reports [22, 19]. The browse species which had high CP content are suitable as protein supplements to poor quality pasture and fibrous crop residues for goats, sheep and cattle which are dominant in the study area. The range of NDF in the present study was recorded between 32.53% in *Helinus mystaciunu* to 85.45% in *Piliostgima thonningii.* The high content of NDF affects the intake of feed, since when the content of NDF composition increases intake of feed decrease. The ADF content of browse species ranged from 19.63% in *Helinus mystacium* to 52.68% in *Stereospermum kanthianum*. According to Mc Donald *et al.* [24], browse species which have high content of ADF may have lower digestibility since digestibility of feeds and ADF content are negatively correlated. The lowest ADL content was recorded as 7.23% in *Helinus mystacium* and the highest ADL content of 20.28% was found in *Ficus thonningii*. High variability in the nutrient content of browse species could be attributed to within species variability owning to factors like plant part, harvesting regimen, season and location and these factors influence chemical composition, palatability, rumen degradability, digestibility, voluntary intake and nutrient utilization by animals [23].

Table 9: *In vitro* Dry Matter Digestibility (IVDMD) of leaves and twigs of browse species grown in Chilga district and harvested in the early dry season

Browse species	IVDMD%
Bridelia cathartica	35.60
Ficus thonningii	43.28
Acaicia spp	32.15
Terminalia schimperiana	29.45
Combretum collinum	32.75
Helinus mystaciunu	71.07
Blecarcites aegyptica	51.24
Lecaniodicus fraxinifolius	41.96
Stereospermum kanthianum	41.56
Piliostgima thonningii	46.80
Ficus sycomorus	34.40
Combretum molle	21.16

***In vitro* Dry Matter Digestibility (IVDMD) of Browse Species:** The *in vitro* dry matter digestibility in the current study varied within browse species examined, ranging from 21.16% in *Combretum molle* to 71.07% in *Helinus mystacium* (Table 9). Some of the browses such as *Helinus mystaciunm*, *Blecarcites aegyptica, Piliostgima thonningii, Ficus thonningii, Lecaniodicus fraxinifolius and Stereospermum kanthianum* have better IVDMD than *Bridelia cathartica, Ficus sycomorus, Combretum collinum and Combretum molle.* This variation could be attributed to factors like harvesting regimen, season and location (soil fertility). However, differences in degradability among browses could be also due to the different extent of lignification of NDF (Van Soest, 1994). The low *IVDMD* in *Combretum molle* could be due to its high NDF, ADF ADL and low CP contents where as the high *IVDMD* in *Helinus mystacium* could be attributed to high CP content associated with low NDF, ADF, ADL and other anti nutritional factors. Some browses like *Helinus mystaciunu* and *Blecarcites aegyptica* had low fiber content, which resulted in high IVDMD. The current finding is in agreement with previous report Rittner *et al.* [25]. The same author explained that the wide variation of IVDMD in browses might be due to the difference in fiber content; since the high fiber content lowers the digestibility of feeds. The IVDMD recorded in this study was lower than the result reported by Solomon [23] and Teferi [19] and within the range reported by Rittner *et al.* [25]. Browses which have good IVDMD like *Helinus mystaciunu* have better contribution for animals such as goats, sheep and cattle. In addition keeping of the season of harvesting and selection of plant parts improve the nutrient content and its rumen degradability.

In Sacco Dry Matter Degradability: The DM degradability of foliage of browse species is presented in Table 10. The degradation parameters (b, c, ED and PD) for DM varied significantly ($P< 0.05$) among browse species. The rapidly degradable fraction of DM (a) was uniform ($P<0.05$) for all browse species considered, but the values ranged from 6.9% in acaicia spp to 15.19% in ficus thonningii. The slowly degradable fraction of DM, however, exhibited variation ($P<0.05$) among the browse species; the highest degradability (65.33%) was recorded in ficus thonningii while the lowest degradability (27.75%) in acaicia spp. The rate of DM degradability was different ($P<0.05$) among the browses and varied from 0.024% in Terminalia schimperiana to 0.053% in Bridelia cathartica. The potential degradability of browses considered in the current study also showed variation ($P<0.05$), and ranged from 34.65% in Acaicia spp to 80.82% in Ficus thonningii. The effective degradability was found to be 31.36% in Acaicia spp and 48.26% in Ficus thonningii. Generally Ficus thonningii and Terminalia schimperiana have higher in sacco DM degradability than Bridelia cathartica and acaicia spp across all the degradability parameters. The result of in sacco DM degradability of ficus thonningii was similar to literature [19, 23, 26and27]. This shows that it has good nutritional contribution for goats, sheep and cattle, which are dominant species of livestock in the study area. The contributions of the rest browses is not too much, since their degradability was not high, which could be due high tannin content of browse. It has been reported that feed resources with high tannin content

Table 10: In sacco dry matter degradability of leaves and twigs of selected browse species harvested during early dry season in Chilga district

	a	b	PD	ED	c(%h)
Browse species	---------- DM(%) ----------				
Acaicia spp	6.9	27.75^{d}	34.65^{d}	31.36^{b}	0.043^{ab}
Bridelia cathartica	8.99	39.47^{c}	48.46^{c}	32.73^{b}	0.053^{a}
Ficus thonningii	15.19	65.33^{a}	80.82^{a}	48.26^{a}	0.035^{bc}
Terminalia schimperiana	8.82	54.42^{b}	63.24^{b}	34.10^{b}	0.024^{c}

abc = means in a column with different superscripts are significantly different ($P < 0.05$); a = rapidly degradable fraction; b = slowly degradable fraction; c = rate of degradation; PD = potential degradability; ED = effective degradability

Table 11: In sacco crude protein (CP) degradability of leaves and twigs of selected browse species harvested during early the dry season in Chilga district

	a	b	PD	ED	c(%h)
Browse species	----------	----------	DM%	----------	----------
Acaicia spp	25.12[a]	4.83[ab]	29.95[a]	29.00[a]	0.103[a]
Bridelia cathartica	16.60[b]	2.79[b]	19.39[c]	16.80[b]	0.022[b]
Ficus thonningii	14.59[d]	6.07[a]	20.66[bc]	17.46[bc]	0.034[ab]
Terminalia schimperiana	15.08[c]	7.26[a]	22.34[b]	18.13b	0.024[b]

[abc] = means in a column with different superscripts are significantly different (P < 0.05); a = rapidly degradable fraction; b = slowly degradable fraction; c = rate of degradation; PD = potential degradability; ED = effective degradability

have low degradability [26, 23]. The variations in DM degradation found in this study could result in differential intakes of the browse species; because a positive relation between in sacco parameters, voluntary feed intake and digestibility have been reported by Kibon and Ørskov [28, 23].

In Sacco Crude Protein (CP) Degradability: The in sacco CP degradability of leaves and twigs of browse trees harvested during early dry season in Chilga district are presented in Table 11. The rapidly degradable CP varied from 14.59% in *Ficus thonningii* to 25.12% in *Acaicia spp.* The slowly degradable CP varied from 2.79% in *Bridelia cathartica* to 7.26% in *Terminalia schimperliana.* Where as the potential degradability ranged from 19.39% in *Bridelia cathartica* to 29.95% in *Acaicia spp.* The effective degradability variation observed from 16.80% in *Bridelia cathartica* to 29.00% in *Acaicia spp.* While the degradability rate of CP was recorded as 0.022% in *Bridelia cathartica* and 0.103% in *Acaicia spp*. Relatively *Acaicia spp* and *Terminalia schimperiana* have higher degradability than *Bridelia cathartica* and *ficus thonningii*. Generally the result was lower than the findings of Kaitho *et al.* [19, 23, 26], which could be due to high tannin content of browses. The same authors explained that the high tannin content resulted in low degradability. The degradation parameters (a, b, c, ED and PD) for CP varied significantly (P< 0.05) among browse species. The variations in CP degradation found in this study could result in differential intakes of the browse species when given for animals, because a positive relation between *in sacco* parameters, voluntary feed intake and digestibility have been reported by Kibon and Ørskov [23, 28]. Degradability affected by nutrient content of the plant in turn nutrient content influenced by the harvesting season, soil fertility, the amount of rainfall and temperature. There for planting of browse species around homesteads and harvesting at appropriate season will improve their degradability.

Conclusion and Recommendation: The result of this study demonstrated that, among the browse species studied, *Helinus mystacium*., *Blecarcites aegyptica* and *Ficus thonningii* are the browses which have relatively high CP content and low fiber fraction which enables it to have better digestibility. They can correct nutrient deficiencies that exist in low quality livestock feeds such crop residues and natural pasture hay. It could be used in live fences, fodder banks, alley farms and as sources of homegrown supplements to low-quality crop residues, if they are harvested at the right season and planted around the homesteads.

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