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Identification and Nutritional Evaluation of Potential Indigenous Browse Species in Guba Lafto District, North Wollo, Ethiopia

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Abstract

The study was carried out in Guba lafto district, North Wollo zone of Amhara regional states of Ethiopia with the objective of identifying and nutritional evaluation of potential indigenous browse species. For the study the district was stratified in to three based on the altitude (low land, mid-high land and high land). Knowledgeable farmers of the three agro-ecologies were consulted to identify and describe major browse species of the areas. Foliage samples were collected and analyzed for their biomass yield and nutritional contents. Upon the study, 21 major browses were identified, of which 14 species were trees and 7 species were shrubs. Among identified species *Acacia seyal, Acacia brevispica, Acacia asak, Oleaeuropea, Ziziphus mauritiana, Dodonia viscosa* were the most dominant species of the district. The average nutrient composition of browse species was not significantly different among the three agro-ecologies ($p>0.05$). But, there were significant differences among species of the same agro ecologies. *Dodonia viscosa, Acacia asak, Grewia bicolor, Combretem molle, Dracentastewdneri, Ziziphus mourtiana, Cordia africana, Acacia previspica, Croton machrostachyus, Salix subserrata, Helichrysumcitrispinum, Croton dichgamus and Maesalanceolata*) had a greater CP content than the average CP content 20.40% reported in present study. Ash value ranged from 5.2-12.63%. Higher NDF content was observed in browses of low lands and mid-high lands (Grewia bicolor, 72% and *Cordia africana* 60.8%) respectively. Generally higher crude protein, low Ash, low NDF, low ADF and low ADL content was observed from highland. Lower CP, high NDF, high ADF and high ADL content was recorded from low land and mid-highland areas. The study result also indicated that the browse species identified could be used as protein supplement for dry seasons and therefore, detailed study on raising the species and further animal feeding experiment is required for better justification of their importance.

Keywords: Browse species; Guba lafto; Identification; Nutritional value; Indigenous

Introduction

In Ethiopia agriculture is the most important economic activity; accounting for about 50% of the Gross Domestic Product (GDP) of the country engaging more than 80% the population [1] and the sector generates 90% of export earnings [2]. Livestock which is an integral part of the agriculture contributes about 47% of agricultural economy [3]. This sub-sector adds significantly to the national food security and nutritional balance, provides raw materials such as milk and meat for the agro-processing industry, foreign exchange from the export of hides and skins, farm-yard manure, and draught oxen power for crop production.

Livestock in Ethiopia, as in many other parts of the world, is grazed on natural grass-based communal pastures, in land use systems that include forests, woodlands and swamps, and fallow lands. Many of the pasturelands located in these land use systems are declining in area because of conversion of land to crop agriculture and settlements [4-7]. Feeding of livestock in natural systems is therefore becoming a challenge and is partly limiting growth in the livestock sub-sector. Seasonal availability of quality feed, high costs of supplementary concentrates and little knowledge about plantation of improved browse feed species also limits livestock productivity. The most contribution of browse species as animal feed is that it serves as a source of crude protein as well as ability of being green for longer time during the dry season [6,8]. Therefore, study on identification of indigenous browse plants feed types and their nutritive value, their spacial and temporal distribution is very important for sustainable feeding of livestock.

The first step in this direction is to generate information that will assist in making management decisions for pasture improvement leading to improved production from cattle. Such information includes knowledge of which species are currently exploited as fodder. Therefore, the present study was designed with the objective of identifying and evaluation of the nutritive value of potential indigenous Browse species of the district.

Materials and Methods

Description of the study area

The Study was conducted in Guba lafto District, North Wollo zone of Amhara Regional state of Ethiopia. It is located at 9.11°, 14.59° North latitude and 36.31°, 39.81° East longitude and at distance of 520 km from Addis Ababa the capital city of Ethiopia. The District is bordered on the North Giddan District, North West by Meket district, North east by Kobbo district, South East by Habru district and in the West by Delanta and Wadila district. The district consists of 34 rural kebeles (The lowest administrative unit of Ethiopia) and 2 special urban administrative kebeles making a total of 36 kebeles.

Topography of the Woreda is made up of chain of mountains, hills, valleys and altitude ranging from 1379- 3809 meter above sea level (m.a.s.l), exposed for sever natural resource degradation mainly soil erosion and deforestation. Agriculture is predominant activity of livelihood characterized by both crop and livestock production [9].

Data collection

Selection of the study areas and sampling: Stratified random sampling was employed to select respondent households following kebeles (the smallest administrative unit of Ethiopia) and agro-ecology (highland, mid highland and low land) as unit of strata. For each agro ecology 2 kebeles were selected of which 30 households with a total of 240 were selected randomly. We used semi-structured interviews, guided questionnaires, and direct observations to collect the data on general household characteristics of the District. For the study and identification of indigenous browse plants three types of grazing land types; bushed grassland, at least two years fallowed grass land and river banks were included. Then we employed an ethno botanical approach to document traditional knowledge associated with identification and use of indigenous multipurpose browse species (IMBS) by the local community of the District [6,10,11]. Accordingly, those plants listed as important for livestock feed were considered for assessment of their distribution in different grazing sites and for chemical analysis. Nine plots, each 10 m × 10 m and 50 m apart, arranged along a transect line was used to score the frequency of occurrence of the browse plants in each grazing site for each Kebele. The frequency of occurrence of each plant was determined by considering the number of plots in which it was recorded, as a percentage of the total plots in the respective grazing site. Foliage samples of the listed species were taken, then pressed by plant presser and preserved until sent for scientific identification at Addis Ababa University.

Determination of chemical composition

For chemical analysis fresh leaves and twigs of each browse species weighing about 300 g was collected and then oven-dried. The oven dried samples were ground in a Willey Mill to pass through 1mm sieve for the determination of chemical composition. Feed samples were analyzed for DM and ash using the method of [12]. Nitrogen was determined using the micro Kjeldehl method. Crude Protein (CP) was calculated as N × 6.25. Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Acid Detergent Lignin (ADL) Contents were analyzed according to Van Soest PJ [13].

Data analysis

The data were organized, summarized and analyzed using the SAS statistical package (SAS, 2001) [14]. For data involving frequencies, descriptive statistics were employed; whereas quantitative variables were analyzed using analysis of variance procedures and when the F-test showed significant differences, the Turkey test was used to separate group means.

Results

Livestock and constraints

The present study revealed three types of economic activities of the district. These were; Crop livestock production, only Livestock production and only crop production. Large number of surveyed households of the three agro-ecologies are engaged in crop livestock production which actually highest in highland areas, whereas, the largest livestock production was observed in lowland area (Figure 1). From participant observations and informal conversations we determined that cattle and other ruminant livestock are reared essentially, for economic reasons, i.e., to earn income from the sale of meat, dairy products, and hides and Skins, and the sale of live animals. Most of households keep oxen for their draught power. Livestock also feature highly in the cultural and social life of the Guba lafto district. Ruminant animals are killed during cultural rituals and local festivities such as weddings, and burials.

Major livestock production constraints are presented in figure 2. In the study district, livestock feed shortage was the major problem, especially in dry season. Among the constraints of livestock, feed shortage accounts about 61.7% in low land, 55% mid-highland and 48.3% high land areas. The study showed that the problem of feed shortage is followed by water shortage, animal diseases and predators in the district.

Identified indigenous multipurpose browse Species

Identified browse species: The list of indigenous multipurpose indigenous browse species identified with their vernacular and scientific names are indicated in table 1. Twenty one indigenous browse species were identified from the three agro-ecologies of the study

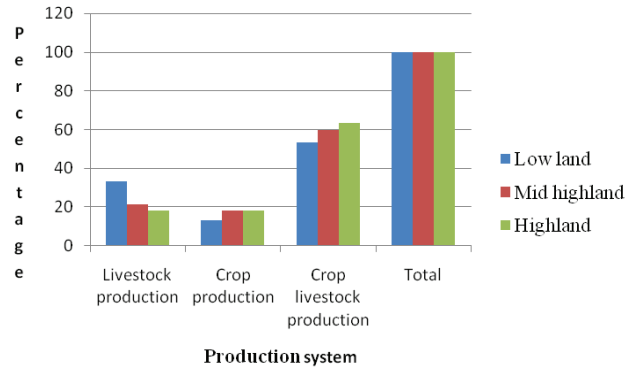

Figure 1: Economic activities of households of Guba lafto district.

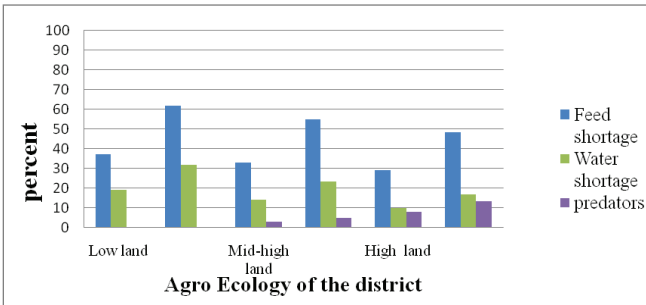

Figure 2: Constraints of livestock production in Guba lafto district.

Table 1: Identified browse trees /bushes of the district.

Scientific name	Local name (Amharic)	Family name	Presence		
			High land	Mid altitude	Low land
Acacia seyal	Wacho	Fabaceae		✓	✓
Acacia asak	Seben	Fabaceae			✓
Combretum molle	Aballo	Combretaceae			✓
Oleaeuropea	Weira	Oleaceae			✓
Dodoniaviscosa	Kitkita	Sapinadaceae		✓	✓
Carissa edulis	Agam	Apocynaceae		✓	✓
Ziziphusmauritiana	Kurkura	Rhomnaceae		✓	✓
Dracaena steudneri	Moata	Febaceae			✓
Grewia bicolor	Sefa (Awrarisse)	Tiliaceae			✓
Euclearacemosa	Dedeho	Ebenaceae			✓
Allophylus abyssinicus	Tikur Embis	Sapindaceae			✓
Cordia Africana	Wanza	Boraginaceae		✓	
Acacia brevispica	Kentafa	Fabaceae		✓	
Allophylus abyssinicus	Tikur Embis	Sapindaceae		✓	
Ehretiacymosa	Wulagga	Boraginaceae		✓	
Rhusglutinosa	AkakimaEmbis (Talembus)	Anacardiaceae	✓	✓	
Hagenia abyssinica	Kosso	Rosaceae	✓		
Salix subserata	Ahaya(Rigga)	Salicoceae	✓		
Helichrysum citrispinum	Nechilo	Asteraceae	✓		
Croton dichogamus	Fiyelefeji	Euphorbiaceae	✓		
Croton macrostachyus	Bisana	Euphorbiaceae	✓		
Maesa lanceolata	Kelewo	Myrisinaceae	✓		

✓ =Show the presence of the plant

district of which eleven were found in lowland, nine in mid altitude and seven were identified in highland areas of the district. Most of browse plants identified from low land and mid-high land areas were shrub type while, more tree species were observed in the high land.

Distribution of identified browse species across types of grazing lands

The frequency of occurrence of each plant species in different agro ecologies and three types of grazing lands of the study areas are presented in tables 2-4. The result indicate that the distribution of each species vary according to the type of grazing land and agro ecology. In highland *Helichrysum citrispinum* is the most frequently observed species on grazing area (12 individual/10 m^2) and the list recorded (1 plant/10 m^2) was *Salix subserata* from grazing land. On average ten *Acacia seyal* trees per 10 m^2 were observed in grazing lands of low land areas and on average 9 *Carissa edulisin* per m^2 were observed around river bank areas of mid altitude. However *Salix subs errata* was the least frequently found species (Table 2).

Chemical composition of identified browse feed resources

The average CP, Ash, NDF, ADF and ADL contents of identified indigenous browse species is presented in below tables 5-7. The comparison among the species found in each agro ecologies didn't have shown impressive ($P>0.05$) differences in nutrient but, the differences were significant ($P<0.05$) among the species.

The CP content of the browse species ranged from 7.6% in *Euclearacemosa* to 37.8 in *Croton machrostachyus*. The overall average fiber NDF, ADF and ADL contents of selected indigenous browse species in different agro ecologies is presented in tables 5-8. The average NDF, ADF and ADL contents of identified indigenous browse species were comparable ($P>0.05$) along agro-ecologies but, wider ($P<0.05$) differences were recorded among the species.

However numerical difference was observed in *Euclea racemosa* in low land. This could be due to higher temperature of low land and time of harvest of sample as it was taken at dry season.

Discussion

The present study revealed feed shortage, water shortage, disease and predators as the major constraints of livestock production in Guba Lafto District. Among these feed shortages is said to be the first constraint especially during dry season in all agro-ecologies of the study areas. Similar problems of livestock production was reported in different agro-ecologies of the country [4-7] and elsewhere in

Table 2: Distribution of browse species in grazing land type of lowland /10m².

Browse species	RB/10m²	AHS/10m²	GA/10m²	Total
Acacia seyal	2	2	4	8
Acacia asak	2	-	3	5
Combretum molle	-	-	3	3
Oleaeuropea	1	2	2	5
Dodoniaviscosa	-	-	4	4
Carissa edulis	3	-	6	9
Ziziphusmauritiana	1	3	3	7
Dracaena steudneri	-	-	4	4
Grewia bicolor	-	-	2	2
Euclearacemosa	3	-	3	6
Allophylus abyssinicus	-	-	2	2

RB=River Banks; AHS=Around Home Stead; GA=Grazing Area; m²= meter square

Table 3: Distribution of browse species in grazing land type of mid-high land/10m².

Browse species	RB/10m²	AHS/10m²	GA/10m²	Total
Dodoniaviscosa	-	2	4	6
Carissa edulis	2	-	5	7
Ziziphusmauritiana	-	3	3	6
Cordia Africana	-	2	-	2
Acacia seyal	3	2	3	8
Acacia brevispica	-	2	-	2
Allophylus abyssinicus	1	-	2	3
Ehretiacymosa	-	3	1	4
Rhusglutinosa	-	1	1	2

RB=River Banks; AHH=Around Home Stead; GA=Grazing Area; m²=meter square

Table 4: Distribution of browse species in grazing land type of highland/10m².

Browse species	RB/10m²	AHS/10m²	GA/10m²	Total
Hagenia abyssinica	-	2	-	2
Salix subserata	-	-	1	1
Rhusglutinosa	-	1	3	4
Helichrysumcitrispinum	-	5	7	12
Croton dichogamus	2	-	6	8
Croton macrostachyus	1	3	1	5
Maesalanceolata	-	3	-	3

RB=River Banks; AHH=Around Home Stead; GA=Grazing Area; m²=meter square

Table 5: Chemical composition of browse plants in low land areas of Guba lafto district.

Browse species	DM (%)	Ash (%)	CP (%)	NDF (%)	ADF (%)	ADL (%)
Allophylus abyssinicus	94	7.44^{c}	14.92^{h}	40^{de}	29.78^{f}	6.66^{f}
Dodoniaviscosa	95	6.31^{ef}	19.15^{e}	38.79^{e}	27.36^{g}	5.71^{g}
Ziziphusmauritiana	96	9.37^{a}	16.97^{g}	35.55^{f}	25^{j}	5.55^{h}
Euclearacemosa	96	6.25^{f}	7.61^{k}	56.31^{b}	45.83^{b}	11.23^{b}
Acacia seyal	95	7.36^{c}	27.3^{b}	33.47^{g}	23.15^{k}	5.57^{h}
Carissa edulis	95	8.42^{b}	9.85^{i}	56.72^{b}	44.21^{c}	11.15^{b}
Oleaeuropea	96	5.2^{g}	8.84^{j}	41.46^{d}	31.25^{e}	7.54^{d}
Acacia asak	94	6.38^{de}	28.18^{a}	46.36^{c}	36.17^{d}	7.68^{c}
Grewia bicolor	93	6.45^{d}	20.35^{d}	72.47^{a}	60.21^{a}	17.58^{a}
Combretum molle	95	6.31^{ef}	18.26^{f}	35.36^{f}	25.26^{i}	5.71^{g}
Dracaena steudneri	96	9.37^{a}	24.19^{c}	38.46^{e}	27.0^{h}	6.82^{e}
Mean	95 ± 0.4	7.17 ± 0.7	17.78 ± 0.7	45 ± 3.4	34.11 ± 3.1	8.29 ± 0.95
Significance	NS	***	***	***	***	***

DM=Dry Matter; CP= Crud Protein; NDF=Neutral Detergent Fiber; ADF=Acid Detergent Fiber; ADL=Acid Detergent Lignin; %=Percent; ***=significant at ≤0.001; NS=Not Significant

Table 6: Chemical composition of browse plants in mid- high land areas of Guba lafto district.

Browse species	DM (%)	Ash (%)	CP (%)	NDF (%)	ADF (%)	ADL (%)
Allophylus abyssinicus	96	11.45^{b}	10.4^{g}	36.67^{e}	25^{e}	5.55^{e}
Dodoniaviscosa	96	5.2^{f}	17.43^{e}	31.24^{g}	22.91^{g}	5.58^{e}
Ziziphusmauritiana	95	7.36^{c}	28.55^{b}	27.12^{h}	18.94^{i}	3.41^{g}
Acacia seyal	94	6.38^{d}	22.87^{c}	40.36^{d}	31.91^{d}	7.78^{d}
Cordia Africana	96	12.5^{a}	30.0^{a}	60.08^{a}	47.91^{a}	12.36^{a}
Carissa edulis	97	6.18^{e}	8.75^{h}	54.32^{b}	41.23^{b}	10.31^{b}
Rhusglutinosa	97	6.18^{e}	17.0^{e}	33.45^{f}	22.68^{h}	4.47^{f}
Ehretiasymosa	95	12.63^{a}	16.7^{f}	31.27^{g}	23.15^{f}	4.47^{f}
Acacia brevispica	94	7.44^{c}	19.8^{d}	52.24^{c}	40.42^{c}	8.92^{c}
Mean	95.6 ± 0.4	8.37 ± 0.8	19.06 ± 0.1	40.75 ± 0.02	30.46	6.98 ± 1.1
Significance	NS	***	***	***	***	***

DM=Dry Matter; CP= Crud Protein; NDF=Neutral Detergent Fiber; ADF=Acid Detergent Fiber; ADL=Acid Detergent Lignin; %=Percent, ***=significant at ≤0.001; NS=Not Significant

Table 7: Chemical composition of browse plants in high land areas of Guba lafto district.

Browse species	DM (%)	Ash (%)	CP (%)	NDF (%)	ADF (%)	ADL (%)
Croton machrostachyus	93	9.67^{b}	37.83^{a}	40.31^{b}	30.1^{b}	6.72^{b}
Salix subserata	94	7.44^{d}	22.78^{e}	53.46^{a}	42.55^{a}	10^{a}
Helichrysumcitrispinum	95	9.47^{c}	25.48^{d}	30.25^{d}	21.0^{de}	4.47^{c}
Hageniaabbyssinica	91	5.49^{f}	17.37^{f}	35.41^{c}	24.17^{cde}	5.57^{c}
Croton dichogamus	91	5.49^{f}	29.1^{c}	29.73^{d}	19.78^{e}	3.41^{d}
Maesalanceolata	93	11.82^{a}	33.89^{b}	38.57^{b}	27.95^{bcd}	5.47^{c}
Rhusglutinosa	93	6.45^{e}	17.19^{g}	38.86^{b}	27.95^{bc}	5.46^{c}
Mean	92.7 ± 0.9	7.98 ± 0.6	26.23 ±0.1	38.08 ± 0.4	27.64 ± 0.9	5.87 ± 1.2
Significance	**NS**	***	***	***	***	***

DM=Dry Matter; CP= Crud Protein; NDF=Neutral Deteregent Fiber; ADF=Acid Detergent Fiber; ADL=Acid Detergent Lignin; %=Percent; ***=significant at P ≤ 0.001

Table 8: Average Chemical composition of browse species along altitude.

Altitude	DM (%)	Ash (%)	CP (%)	NDF (%)	AD F (%)	ADL (%)
Lowland	95 ± 0.4	7.17 ± 0.68	17.78 ± 0.7	45 ± 3.4	34.11 ± 3.1	8.29 ± 0.95
Mid-high land	95.6 ± 0.4	8.37 ± 0.76	19.06 ± 2.5	40.75 ± 3.7	30.5 ± 3.4	6.98 ± 1.1
Highland	92.7 ± 0.9	7.98 ± 0.59	26.23 ±.1	38.08 ± 04	27.64 ± 0.9	5.87 ± 1.2
Mean	94.63	7.78	20.40	41.79	31.22	7.23
Significance	NS	NS	NS	NS	NS	NS

DM=Dry Matter; CP= Crud Protein; NDF=Neutral Detergent Fiber; ADF=Acid Detergent Fiber; ADL=Acid Detergent Lignin; %=Percent; NS=Not Significant

other countries [15] who reported that feed shortages and nutrient deficiencies as more acute in dry seasons. The study also revealed water shortage is the second most important constraints of livestock which more severely observed in lowland. Similar results were reported in the country [16]. Generally feed shortage was the major constraint of households in the district followed by water shortage, animal diseases and predators. This is in agreement with other studies [17-19] also reported that, the low veterinary service performance in the lowlands is the outcome of the government-monopolized services. Government veterinary staffs are few in number and cannot cover such a vast area to adequately address the veterinary needs. Besides government staffs need adequate mobile facilities for which currently the government does not have the capacity to provide [19]. Twenty one indigenous browse species were identified from the three agro-ecologies of the study district of which eleven were found in lowland, nine in mid altitude and seven were identified in highland areas of the district. Most of browse plants identified from low land and mid-high land areas were shrub type while, more tree species were observed in the high land. The fairly high number of bushes and shrubs types reported in low and mid altitude, indicates that the use of IMBS is more common and the reason for more browse species of animals are kept. This scenario agrees with reported studies in other similar areas of the country [7,20]. Among identified browse species, *Acacia seyal, Acacia brevispica, Acacia asak, Oleaeuropea, Ziziphus mauritiana, Dodonia viscosa* were dominant. With the agreement to this, similar species of browses were identified in other parts of the lowland areas of the country [21-24]. Overall, the respondents reported that it was becoming hard to find fodder for ruminants because of reductions in grazing areas. Farmers attributed the decline in pastoral area to several causes: conversion of communal grazing lands to agricultural use, shortening of fallow periods or absence of fallowing, short and erratic rainfall, and weed and other noxious plant invasion. The allocation of more land to crop agriculture to increase agricultural production and the shortening of fallow periods by farmers has made animal herding difficult, because animals stray into crop fields to feed fibrous crop residues. The average CP, Ash, NDF, ADF and ADL contents of identified indigenous browse species didn't have showed impressive ($P>0.05$) differences but, the differences were significant ($P<0.05$) among the species. This could be resulted due to several factors which are said to be the basic contributors towards the variation in nutritive value of forages which include species, plant part and stage of maturity [25-27]. Other surveys on fodder trees also observed and reported this heterogeneity in nutrient composition in Ethiopia and elsewhere in other countries [6,7,28]. The CP content of the browse species ranged from 7.6% in *Euclearacemosa* to 37.8 in *Croton machrostachyus*. According to Topps JH, [29] Raj CU, et al., [30] and Kazemi M, et al. [31], feeds containing greater than 19% CP are rated as having prime standard and those with CP values lower than 8% are considered to be of inferior quality. Browse species like *Dodoniaviscosa, Acacia asak, Grewiabicolor, Combretem molle, Dracentastewdneri, Ziziphusmourtiana, Cordia africana, Acacia previspica, Croton machrostachyus, Salix subserrata, Helichrysumcitrispinum*, *Croton dichogamus* and *Maesalanceolata* had a CP content greater than 18%, suggesting the possibility of considering their use as an alternative plant protein sources to improve the nutritive values of poor quality feeds in the study area.

Conclusion

Livestock production is the major economic activity of Guba Lafto District. To counter the long term impact of declining feed resources in the country and study area in particular indigenous multipurpose browse plants with higher CP and lower fiber contents recorded in Guba Lafto district could be used to improve the fibrous less nutritious feed resources of dry season.

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