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Availability, Biomass Yield, and Nutritional Values of Fodder Tree Leaves in Mirab Abaya District in Southern Ethiopia

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ABSTRACT

The study was carried out to assess the availability; fodder yield and nutritional values of selected fodder tree leaves. Household surveys, field measurements, and laboratory analyses were used to generate the data. Survey data was collected from randomly selected 138 respondents using a pre-tested structured questionnaire. Eleven, 18, and 13 fodder trees respectively in highland, midland, and lowland were identified and ranked. A total of 12 top-ranked fodder tree species were considered for leaf yield estimation and laboratory analysis. The average leaf yields (kg DM) per tree of the selected fodder species ranged from 15.96 for Rhus natalensis in the lowland to 128.43for Erythrinabrucei in the highland and varied significantly (P < 0.05) among the species. The crude protein /CP/ content (g/kg DM) was highest for Erythrinabrucei (198.3) and was least in Psydrax schimperiana (151). The highest Ether Extract /EE/ was observed in Mystroxylon aethiopicum (18.66 g/kg DM) and the lowest was noted in Nuxiacongesta (13.36 g/kg DM). The neutral detergent fiber/ NDF/ was highest for Arundinaria alpine (602g/kg DM) and least in Psydrax schimperiana (297.4g/kg DM). There were no significant differences in condensed tannin content among the fodder trees studied. Oxalate values ranged from 18.4g/kg DM in Terminalia brownii to 36.5 g/kg DM in Balanites aegyptiaca. Generally, the differences in leaf yield and nutrient contents between different fodder species were significant (p<0.05). From the results of this study, it can be concluded that the fodder tree species can be considered a potential source of CP to supplement poor-quality roughages to fill the gap.

Keywords: *Availability, Fodder Yield, Chemical Composition, Anti-nutritional Factors*

INTRODUCTION

Ethiopia has the largest livestock population in Africa (CSA, 2018). Ethiopia has diversified agro-ecological zones and farming systems. Despite the large livestock population, their productivity is low with average carcass weights of 108, 10, 8.5, and 0.8 kg/head for cattle, sheep, goats, and chicken respectively (Asfaw *et al.,* 2010). The low productivity of the sector is mainly due to factors such as poor genetic makeup of local animals, poor nutrition, and poor veterinary care. Among which poor nutrition is the major limiting factor (Yeshitila, 2008).

The chief feed resources are natural pastures and crop residues that are very low in crude protein (CP), low digestibility potential as well as low concentration of minerals(Lema and Yeshambel, 2020; Alemu, 2023). Despite low nutritional values, the availability of these feed resources is limited. Population pressure harms potential feed sources like pasture land, grazing land, and other resources (Rubanza, 2013). To curb the problem of feed availability, the use of fodder trees could be regarded

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as a good option. According to Anele *et al.* (2009), fodder trees are familiar to smallholder farmers, grow with low inputs, and are adaptable to different agro-ecological conditions. Fodder trees are potentially inexpensive, locally produced protein supplements for ruminants, particularly during the critical periods of the year when the quantity and quality of herbage are limited. The use of fodder tree foliage as a feed resource is appealing under the present Ethiopian conditions to increase the production and productivity of livestock (Shapiro *et al.*, 2017). Most fodder tree foliage in Ethiopia has high crude protein content, ranging from 10 to more than 25% on a dry matter basis(Tolera and Abebe, 2007). This reliable protein resource can be used to develop a sustainable feeding system and increase livestock productivity (Lusebaand Vander, 2006).

Despite this, there is a lack of information on fodder yield and nutritional value of fodder tree species in most areas of Ethiopia in general and in Mirab Abaya District in particular. Despite the wider use of fodder tree species as feed by rural families in Mirab Abaya district, no research has been documented on the availability, fodder yield, and nutritive values. This study was therefore initiated to assess the availability of fodder trees in different agro-ecologies of the District and evaluate fodder yield and nutritional values for selected species in terms of nutrient compositions and secondary metabolites which can help farmers to select useful species.

MATERIALS AND METHODS

Description of the Study Area

Mirab Abaya is one of the **districts** in Gamo Zone the Southern Nations, Nationalities, and Peoples' Region of Ethiopia (Figure 1). Its latitude and longitude are 6^0N and 37^0E respectively. The altitude of the woreda ranges from 1100-2900 meters above sea level. Agro ecologically; the woreda is classified as Highland, Midland, and Lowland. The Highland part of the woreda covers 33%, Midland 17%, and Lowland 50%. The annual rainfall varies from 800-1600 mm; the annual mean temperature also varies from 23^0c to 25^0c with a mean value of 24^0C. The area receives a bimodal rainfall where the low rainfall is between March and April while the main rainfall season is from July to September. Crops cultivated in the area include maize, teff, wheat, barley, beans, and sorghum. There are 23 rural kebeles (the lowest administrative unit in Ethiopia) and 1 town kebele. The livestock population of the study area is estimated to have 58613 cattle, 33398 goats, 7573 sheep, 2825 donkeys, 384 mules, 167 horses, 4536 traditional beehives, 136 transitional beehives, 668 modern beehives, and 73864 chickens in the woreda (LFO, 2020).

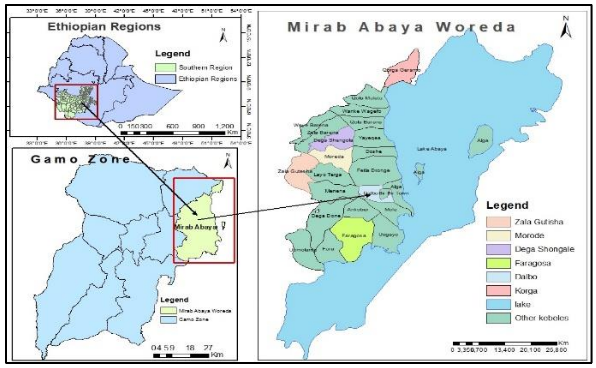

Figure 1. Location map of the study area

Sampling Procedure and Sample Size Determination

The multi-stage sampling procedure was followed at three different stages. In the first stage, the study District was stratified into three distinctive agro-ecologies. These three strata were lowland (<1500 m.a.s.l), midland (1500-2300 m.a.s.l), and highland (>2300 m.a.s.l) (MoARD, 2007). In the second stage, six representative Kebeles were selected proportional to the agroecological variation following a purposive sampling technique based on livestock potential and availability of fodder plants. In the third stage, individual household heads having experience of livestock keeping for at least five years were identified and listed. Sampled households (138) were selected randomly from the list. The sample size required for the survey studies was determined by the formula recommended by Cochran (1977):

$$no = \frac{Z^2 * (P)(q)}{d^2} \rightarrow n_1 = \frac{no}{(1 + no/N)}$$

There is no desired sample size according to Cochran (1977) when a population greater than 10,000

n_1 = finite population correction factors (Cochran's formula, 1977) population less than10, 000

Z = standard normal deviation (1.96 for 95% confidence level), P = 0.16 (proportion of the population to be included in the sample i.e. 16%), q= 1-0.16 i.e. (0.84). d = degree of accuracy desired (0.06), 6% error term

Accordingly, a total of 138 households were sampled.

Data Collection Method

Data was collected with a questionnaire survey, focus group discussions, and field observations. Species identification of fodder trees was done in the field using different plant identification keys (Azene, 2007).

The questionnaire was pre-tested before administering and rearrangements, refining and correcting were made. Information on the socioeconomic characteristics of the farmer's feed resources, availability of fodder trees, and preferences by the browsing animals in different agroecologies were collected during the survey. Focus group discussions were conducted with elders having rich indigenous knowledge of fodder tree species, Kebele leaders, and Kebele development agents (DA) to gain greater insight into the topics during the formal survey and to strengthen the data collected.

Field observation was made to enrich the data on majorly available fodder tree types, their potential yieldsandpreferences by the browsing animals. The four top-ranked fodder tree species per agroecology were selected for fodder yield; chemical composition and analysis of anti-nutritional factor evaluations. The ranking was made by the respondent households based on the following criteria. A total of 5 different parameters were used, including the parameter suggested by the farmers to prepare the selection index for ranking the fodder trees. They were (a) availability (b) duration (c) adverse effect on animal health (i.e. toxicity), (d) preference by Animals, and (e) availability in different ecological belts.

Predicting Fodder Yield of Selected Fodder Trees

The potential yield of fodder trees is the foliage available for defoliation (Nitis, 1992). Using measuring tape, the circumference of the trunk or stem of each selected fodder tree species was measured and recorded. Ten circumference measurements for each selected fodder tree species were taken and the diameter was calculated as DT = 0.636C

Where: DT= trunk diameter C= circumference. Then the fodder yield of the species was estimated by entering the diameter value in the equation developed by Petmak (1983):

$$\text{Log } W = 2.24 \text{ Log } DT - 1.50$$

Where: W= leaf yield in kilograms of dry weight and DT= trunk diameter (cm) at 130cm height.

Chemical Analysis

Yong and matured leaves of fodder trees/shrubs were collected and composite samples were prepared per tree. The collected samples of fresh leaves in each fodder tree/shrub were partially dried ground and kept in plastic bags pending the analysis. Samples were collected during the wet season of the year. Chemical analysis was carried out at Hawassa University Animal Nutrition Laboratory. Dry matter (DM), crude protein (CP), and ether extract (EE) were determined based on the procedures of AOAC (2005). Neutral Detergent Fiber (NDF) is based on the procedures developed by Van Soest *et al.,* 1991. Acid Detergent Fiber (ADF) and Acid Detergent Lignin (ADL) were analyzed using the detergent extraction method (Van Soest and Robertson, 1985).

Analysis of Anti-nutritional Factors

Anti-nutritional factors were analyzed in Arba Minch University Natural Science College/ chemistry laboratory. Oxalate and Cyanide contents were determined following the procedure described by AOAC (2005). Condensed Tannin content was determined according to Maxson and Rooney (1972).

Statistical Analysis

The collected data were checked, coded, and entered into SPSS software every day after administering a questionnaire to prevent loss of data. The percentage values of various parameters were compared between the agro-ecologies. The means of quantitative data among agroecologies were compared by employing one-way ANOVA. Means were separated using the Tukey HSD test whenever they were statistically significant at $P \leq 0.05$.

The statistical model used for analyzing data was:

$Y_{ij} = \mu + \alpha_i + \Sigma_{ij},$

Where: y_{ij}= total observation due to i, and j , μ = is overall mean, α_i =location (agro-ecology)

e_{ij} = random error

For the parameters that require ranking, indices were calculated to provide a ranking of major constraints for the livestock production in the study area, major feed resources available in the study woreda during the dry and wet seasons, and fodder tree availability in the different agroecologies. The indices were calculated as follows:

Index = sum (5 × number of responses for the first rank + 4 × number of responses for the second rank + 3 × number of responses for the third rank + 2 × number of responses for the fourth + 1 × number of responses for the fifth) / (5 × total responses for the first rank +4 × total responses for the second rank +3 × total responses for the third rank + 2 × total responses for the fourth rank + 1 × number of responses for the fifth). Rank 1 = is the most and rank 5 = the least.

Results

Socio-economic characteristics of the respondents

Socioeconomic characteristics of respondent households including age, family size, sex, and educational status of the households were collected and presented in Table 1. A higher proportion of the interviewed household heads were males. The majority of the interviewed households were illiterate.

Table 1. Age, family size, sex, and educational status of the household heads (HH).

Variables		Agro-ecology			Overall(N=138)
		HL (n=55)	ML (n=21)	LL (n=62)	
Age of the HH (years) (mean+SE)		49.18±1.26	46.90±2.89	47.25±1.57	48.07±0.95
Total family size (mean+SE)		6.81±0.27	6.43±0.43	6.73±0.31	6.71±0.18
Sex of the HH (%)	Male	83.9	100	90.1	89.1
	Female	16.1	-	9.9	10.9
Education level (%)	Illiterate	48.5	42.9	41.8	44.9
	Read and write only	14.5	0	0	6.5
	Elementary Education	24.2	38.1	38.2	31.9
	Secondary education	6.4	19	11	10.1
	College Level	6.4	0	9	6.6

HL= highland; ML= midland; LL= lowland; HH =household; N=number of interviewed respondents

Land and livestock holding

The overall mean land and livestock holdings of the interviewed households are presented in Table 2.

Table 2. Land in hectare and livestock holding per household (Mean ± SD)

Variables	Agro-ecology				
	HL (n=55)	ML (n=21)	LL (n=62)	Overall(N=138)	*P-value*
Total average land holding of the HH	2.11^{b}±1.62	1.05^{b}±0.51	2.76^{a}±2.49	2.17±2.00	0.003
Homestead	0.35^{a}±0.17	0.22^{b}±0.07	0.30^{b}±0.17	0.29±0.17	0.002
Cropland	1.43^{b}±1.36	0.73^{b}±0.38	2.05^{a}±1.90	1.40±1.56	0.017
Grazing land	0.09^{b}±0.14	0.08^{b}±0.14	0.18^{a}±0.26	0.11±0.20	0.039
Forest and woodland	0.13±0.19	0.06±0.10	0.20±0.54	0.13±0.37	0.315
Others	0.08±0.33	0.03±0.00	0.04±0.12	0.05±0.23	0.335
Total average livestock holding of the HH	2.780^{b}±1.00	1.96^{b}±0.71	4.20^{a}±2.80	3.23±2.07	0.000
Cattle	2.50^{b}±0.89	1.79^{b}±0.71	3.74^{a}±2.64	2.89±1.90	0.000
Goat	0.06^{b}±0.11	0.11^{b}±0.13	0.33^{a}±0.41	0.17±0.30	0.000
Sheep	0.17^{a}±0.19	0.03^{b}±0.00	0.05^{b}±0.17	0.08±0.18	0.000
Poultry	0.05±0.09	0.06±0. 10	0.09±0.16	0.07±0.13	0.204

HL= highland; ML= midland; LL= lowland; HH = household; N=number of interviewed respondents; SE=standard error, a b c means with the different superscripts across rows are significantly different at ($p<0.05$), ns-not significant ($p>0.05$).

Feed resources

In the study District, during the dry season, crop residues ranked first feed resource in three agroecology with an index value (0.27) followed by fodder tree foliage (0.22) and natural pasture hay (0.19) (Table 3). In wet seasons, the majority of the respondents (0.28) in all agro ecology use natural pasture followed by fodder tree foliage (0.21) and improved forage (0.17) to feed their animals.

Table 3. The major feed resource available in the study was woreda during the dry and wet seasons as ranked by sampled households

Season	Feed Types	**Index**				**Rank**			
		HL	**ML**	**LL**	**OA**	**HL**	**ML**	**LL**	**OA**
Dry	Grazing pasture	0.09	0.12	0.08	0.09	6th	4th	5th	5th
	Crop residue	0.27	0.27	0.28	0.27	1th	1th	1th	1th
	Hay	0.20	0.21	0.18	0.19	3th	3th	3th	3th
	Fodder trees	0.22	0.24	0.21	0.22	2th	2th	2th	2th
	Concentrates	0.10	0.07	0.08	0.09	5th	6th	6th	6th
	Improved forage	0.12	0.10	0.16	0.14	4th	5th	4th	4th
Wet	Natural pasture	0.29	0.28	0.28	0.28	1th	1th	1th	1th
	Crop residue	0.16	0.15	0.13	0.15	3th	4th	5th	4th
	Hay	0.11	0.18	0.15	0.14	5th	3th	4th	5th
	Fodder trees	0.20	0.20	0.22	0.21	2th	2th	2th	2th
	Concentrates	0.08	0.05	0.05	0.06	6th	6th	6th	6th
	Improved forage	0.16	0.14	0.17	0.17	4th	5th	3th	3th

Index = sum of [(5 for rank 1)+(4 for rank 2)+(3 for rank 3)+(2 for rank 4)+(1 for rank 5)] given for an individual reason divided by the sum of [(5 for rank 1)+(4 for rank 2)+(3 for rank 3)+(2 for rank 4)+(1for rank 5)] for overall reasons, HL= highland, ML= midland, LL= lowland; OA= overall

Availability of Major Fodder Tree Species

In the study District, sampled respondents identified the most important fodder trees among others (Table 4).In the lowland, *Balanitesaegyptiaca*ranked first among others and was noted as the best species identified with an index value of 0.136. Similarly, *Terminalia brownii* ranked second (0.127), *Acacia melliferathird* (0.117), and *Rhus natalensis* fourth ranked (0.106). In midland, *Cordia Africa* first with an index value of 0.101. Similarly, *Psydrax schimperiana* ranked second (0.099), *Millettiaferrugineara*nked third (0.096) and *Mystroxylon aethiopicum* ranked fourth (0.085). In the highland, *Erythrinabrucei* ranked first with an index value of 0.157, *Arundinaria alpine* ranked second(0.149), *Dombeyatorrida* ranked third(0.136) and *Nuxiacongesta* fourth-ranked (0.102). The adaptation of the selection index helps, to understand all the nutritional parameters of particular fodder trees and to evaluate their potential for ruminant feeding.

Table 4. Fodder tree species, local name, part of species edible by animals, and type of livestock prefer the species as feed in Mirab Abaya district as ranked by sampled households

AEZ *	Rank	*Scientific name*	*Family name*	*Local name*	Edible part	Preferred by (Livestock)	Index
Lowland	1st	*Balanitesaegyptiaca*	*Balanitaceae*	*Domaine*	Leaf, pod, and twigs	Cattle, goat, and sheep	0.136
	2nd	*Terminalia brownii*	*Combretaceae*	*Gala*	Leaf	Cattle, goat, and sheep	0.127
	3rd	*Acacia mellifera*	*Fabaceae*	*Elanje*	Leaf	Cattle, goat, and sheep	0.117
	4th	*Rhus natalensis*	*Anacardiaceae*	*Ongofira*	Leaf	Cattle, goat, and sheep	0.106
	5th	*Acacia albida*	*Leguminosae/ Fabaceae*	*Odoro*	Leaf and fruits	Cattle, goat, and sheep	0.098
	6th	*Acacia brevispica*	*Fabaceae*	*Hota/wortafa*	Leaf	Sheep and goat	0.086
	7th	*Cordia africana*	*Boraginaceae*	*Moqotha*	Leaf, fruits	Cattle and goat	0.081
	8th	*Maytenus sp.*	*Celestraceae*	*Xuxo*	Leaf	Goat	0.062
	9th	*Acacia tortilis*	*Leguminosae/ Fabaceae*	*Caca*	leaf, and pod	Cattle, goat, and sheep	0.061
	10th	*Acacia Seyal*	*Leguminosae/ Fabaceae*	*Botha caca*	Leaf	Cattle and goat	0.052
Midland	1st	*Cordia africana*	*Boraginaceae*	*Moqotha*	Leaf, fruits	Cattle and goat	0.101
	2nd	*Psydrax schimperiana*	*Rubiaceae*	*Desha ayfe/sulanta*	Leaf	Cattle,goat, and sheep	0.099
	3rd	*Millettiaferruginea*	*Fabaceae*	*Boothazaage*	Leaf	Cattle and goat	0.096
	4th	*Mystroxylon aethiopicum*	*Celestraceae*	*Pissiinge*	Leaf	Cattle and goat	0.085
	5th	*Erythrinabrucei*	*Fabaceae*	*Borto*	Leaf, fruits	Cattle,goat, and sheep	0.069
	6th	*Terminalia brownii*	*Combretaceae*	*Gala*	Leaf	Cattle,goat and sheep	0.068
	7th	*Nuxiacongesta*	*Buddlejaceae*	*Shinka*	Leaf	Cattle and goat	0.065
	8th	*Hypericumquartinianu m*	*Hypericaceae*	*Qirqa*	Leaf and young stems	Cattle and goat	0.063
	9th	*Terminalia schimperiana*	*Combretaceae*	*Ambe*	Leaf	Cattle and goat	0.048
	10th	*Acacia tortilis*	*Leguminosae/ Fabaceae*	*Caca*	leaf, twiges and pod	Cattle, sheep, goats	0.051

Highland	1st	*Erythrinabrucei*	*Fabaceae*	*Borto*	Leaf, fruits and young stems	Cattle , goat and sheep	0.157
	2nd	*Arundinaria alpine*	*Poaceae*	*Woysha*	Leaf	Cattle, sheep and goats	0.149
	3rd	*Dombeyatorrida*	*Sterculiaceae*	*Lolashe*	Leaf	Cattle	0.136
	4th	*Nuxiacongesta*	*Buddlejaceae*	*Shinka*	Leaf	Cattle and goat	0.102
	5th	*Dracaena steudneri*	*Dracaenaceae*	*Elale*	Leaf	Cattle	0.094
	6th	*Hypericumquartinianum*	*Hypericaceae*	*Qirqa*	Leaf and young stems	Cattle and goat	0.090
	7th	*Hibiscus calyphyllus*	*Malvacae*	*Loola*	Leaf and young stems	Cattle,goat and sheep	0.075
	8th	*Millettiaferruginea*	*Fabaceae*	*Boothazaage*	Leaf	Cattle and goat	0.068
	9th	*Vernoniaamygdalina*	*Asteraceae*	*Gara*	Leaf and young stems	Cattle and goat	0.066
	10th	*Maesa lanceolata*	*Myrsinaceae*	*Gergeco*	Leaf	Cattle ,goat and sheep	0.038

AEZ=Agro-ecological zone (HL=highland, ML=midland, LL=lowland).

Fodder Yield of the Selected Fodder Trees

Leaf yield (kgDM/tree/shrub) that can be used for animal feeding differed (P < 0.05) among selected fodder tree species in the study district (Table 5). Comparision were made between fodder trees/shrubs. Leaf yield (kg DM/tree) in the study woreda was greatest (P < 0.05) for *Balanitesaegyptiaca* (115.03) and Erythrinabrucei (94.84).

Table 5. Average leaf yields (kg DM/tree) of selected fodder trees in Mirab Abaya District

Agro-ecology	*Fodder Tree/shrub species*	Yield/Tree/shrub(kg DM)
Lowland	*Balanites aegyptiaca/tree*	148.10^{a}
	Terminalia brownie/tree	68.2^{b}
	Acacia mellifera/tree	48.32^{bcd}
	Rhus natalensis/shrub	15.96^{e}
Midland	*Cordia Africana/tree*	56.29^{bc}
	Psydrax schimperiana/tree	39.02^{abc}
	Millettiaferruginea/tree	31.87^{de}
	Mystroxylon aethiopicum/tree	28.6^{de}
Highland	*Erythrina brucei/tree*	128.43^{a}
	Arundinaria alpine/tree	26.13^{de}
	Dombeyatorrida/tree	34.65^{cde}
	Nuxiacongesta/tree	32.57^{de}
SEM		15.11
P-value		0.000

$^{a,\ b,c}$ mean values in a column having different superscripts differ significantly (P < 0.05); SEM= standard error of the mean, ns-not significant (p>0.05.

Nutritional values of selected fodder trees in Mirab Abaya Woreda

The chemical compositions of different fodder species of the district are shown in Table 6. The average Ash content (g/kg DM) of the species ranged from 53.6 in Nuxiacongesta to 94.3 in Dombeyatorrida indicating that the latter was mineral-rich compared to the other tree species. Similarly, the average CP content (g/kg DM) of the species ranged from 151 in Psydrax schimperiana to 198.3 in Erythrinabrucei. The fiber/NDF/ content (g/kg DM) also ranged from 297.4 in Psydrax schimperiana to 602 in Arundinaria alpine.

Table 6. Chemical composition (g/Kg) of the selected fodder tree leaves in Mirab Abaya Woreda

Fodder species	DM	Ash	CP	EE	NDF	ADF	ADL
Balanites aegyptiaca	916.3[ab]	91.5[ab]	193.6[ab]	14.33	404.5[fg]	233.4[d]	111.5[d]
Terminalia brownii	921.7[a]	85.7[abcd]	183.6[ab]	16.36	412.7[ef]	216.9d[e]	138.7[b]
Acacia mellifera	904.7[bc]	74.5[cd]	167.7[bc]	15.36	433.8[de]	177.5[f]	73.5[g]
Rhus natalensis	900.5[c]	93.6[a]	174.6[abc]	15.70	483.7[c]	315.7[b]	198.3[a]
Cordia africana	900.1[c]	88.8[abc]	190.0[ab]	14.66	496.6[c]	356.6[a]	146.9[b]
Psydrax schimperiana	911.4[abc]	85.8[abcd]	151.0[c]	15.66	297.4[i]	175.3[f]	89.1[f]
Millettiaferruginea	896.3[c]	76.5[cd]	170.4[bc]	15.13	564.3[b]	344.8[a]	197.8[a]
Mystroxylon ethiopicum	908.5[abc]	89.1[abc]	170.0[bc]	18.66	382.1[g]	261.8[c]	188.4[a]
Erythrinabrucei	917.4[ab]	76.6[bcd]	198.3[a]	15.63	454.0[d]	206.9[e]	106.9[de]
Arundinaria alpine	905.4[bc]	72.3[d]	191.6[ab]	17.03	602.0[a]	276.1[c]	83.8[fg]
Dombeyatorrida	900.7[c]	94.3[a]	176.6[abc]	17.03	433.0[de]	217.4[de]	125.2[c]
Nuxiacongesta	906.0b[c]	53.6[e]	185.6[ab]	13.36	333.2[h]	165.0[f]	95.3[ef]
SEM	3.57	3.61	4.02	2.78	4.10	3.71	3.44
P-value	0.01	0.001	0.001	0.06	0.01	0.01	0.02

SD= Standard Deviation

DISCUSSION

The average family size of the respondents was comparable to the value reported for the Wolaita zone (6.9) (Tsedeke and Endrias, 2006). However, it was lower than the average family size of 10.5 reported from the Central Rift Valley of Ethiopia (Zewdie and Yoseph, 2014). The illiteracy rate of the households in the current study was lower than 67.4% and 65% reported by Tesfaye (2009) and Tsedeke (2007), respectively, and higher than 30% reported by Goma District of Jimma Zone (Belete, 2009). The mean land holding of the respondents in the study woreda (2.17) was higher than 1.00 ha reported for smallholder farmers in East Gojjam Zone EnebsieSarMiderworeda (Addisu *et al.*, 2011). However, it was lower than 5.01 ha/hh reported for the Central Rift Valley of Ethiopia (Felekech *et al.*, 2013). The average cropland holding (1.403) in the present study was higher than 0.94 ha/hh reported by Fsahatsion *et al.* (2013). On the other hand, the mean grazing land holding per household observed in the present study (0.1152) was lower than 0.24 ha reported by Fsahatsion *et al.* (2013) for the highlands and midlands of GamogofaZone.The overall average TLU of study woreda (3.23) was lower than the 5.45 TLU reported by Yeshitila (2008) from Alabaworeda, Southern Nations Nationalities and People's Regional State.

The majority of the respondents in the Ganta Afeshum District Eastern zone of Tigray indicated that crop residues from wheat, maize, barley, bean, and peas as well as "atella" are important feed sources, especially during the dry season when the availability of pasture is low (Berihu *et al.*, 2014). According to Abate *et al.* (2010) straw from maize, sorghum, and teff was used mainly during the dry season in southeastern parts of the country.

Higher (317.18) leaf dry matter yield (kg DM/tree) was reported for *Erythrina brucei in* Hadiya & Kembata-Tembaro Zones, southern Ethiopia (Getachew and Wondimu,2022). A dry matter yield of 30.3kg/tree was noted for *Balanites aegyptiaca* in the Afar Rangeland of North Eastern Ethiopia (Merga *et al.*, 2016). The same author noted a leaf biomass yield of 9.5-15.5kg/plant for acacia species. Fodder yield (kg DM/tree) recorded in this study was comparable to higher than reported figures (23.80-31.70 kg DM/tree) for some fodder species (Upreti and Devkota, 2017). Differences in dry matter yield might be due to differences in soil types, physiological stages, season of harvesting, and environmental factors.

The ash contents of tree leaves were within the range of reported figures (52-126) for leaves of some fodder tree species (Rubanza *et al.,* 2003). The Ash contents are lower than 113-151g/kg DM for fodder species reported by Tufarelli *et al.* (2010). The ash contents of Moringa oleifera, Albizia lebbeck, and Gmelina aborea leaves were reported as 78.4, 70, and 55 respectively (Awotoye *et al.,* 2016). CP contents were comparable to the value (155-190 g/kg DM) reported for leaves of fodder tree species (Welay *et al.*, 2018). Belete *et al*. (2012) reported CP values of fodder species ranging from 89.5-209 g/kg DM. The CP content of all fodder tree species studied was above the minimum (70-80g/kg DM feed) level required for ideal ruminal fermentation (Van Soest, 1994). This indicates the selected fodder species analyzed in this study may be well used as a protein supplement to low-quality feeds such as crop residues due to a higher level of crude protein of all the fodder species. The ether extract contents were comparable to higher than the reported figures (9-13g/kg DM) for some fodder species (Tufarelli *et al.*, 2010). NDF contents in the current study were within the range of (154-619g/kg DM) reported by Rubanza *et al* (2006) and Mtui *et al* (2009), lower to comparable with some values (408-650 g/kg DM) reported studies for fodder species (Welay *et al.,* 2018). The ADF and ADL content were comparable with Welay *et al.,* (2018) who reported the ADF and ADL values (g/kg DM) of some fodder species ranged from 248-424 and 69 to 106 respectively. The presence of condensed tannins in browse species is detrimental to the intake and digestibility of these feed resources, especially during the dry season when animals require supplementary feeds (Hassanpour *et al.,* 2011). The findings for oxalate contents are within the range reported for leaves of some browse plants by Fadiyimu *et al.,* (2011). Ghosh *et al*. (2012) also reported Oxalate values of some browse species ranged from 14.9-70.1g/kg DM.

Conclusion

The results of the current study indicate that there are a number of promising fodder species in Mirab Abaya flora, which can be used as a source of feed for livestock. There is a great variation among selected fodder trees in fodder yield (kg DM/tree) that ranged from 24.83kg for *Rhus natalensis* in the lowland to 148 kg for *Erythrinabrucei* in the highland. As it has been observed the twelve fodder species had high crude protein concentrations greater than 8% which is considered adequate as it can provide the minimum nitrogen levels required by ruminants and has low to moderate content of fiber. Therefore, the fodder species in the current study can be used as protein supplements to ruminant livestock fed on low-quality feeds.

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توافر وإنتاج الكتلة الحيوية والقيم الغذائية لأوراق شجرة العلف في منطقة ميراب آبايا في جنوب إثيوبيا

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تاريخ استلام البحث: 2024/1/31 وتاريخ قبوله: 2024/5/29.

ملخص

تم إجراء الدراسة لتقييم مدى توفر المحصول العلفي والقيم التغذوية لأوراق أشجار العلف المختارة. تم استخدام المسوحات الأسرية والقياسات الميدانية والتحليلات المعملية لتوليد البيانات. تم جمع بيانات المسح من 138 مشاركًا تم اختيارهم عشوائيًا باستخدام استبيانه منظمه تم اختبارها مسبقًا. تم تحديد وتصنيف 11 و18 و13 شجرة علفية على التوالي في الارض المرتفعة والارض الوسطية والارض المنخفضة. تم أخذ ما مجموعه 12 نوعًا من أشجار العلف في الاعتبار لتقدير إنتاجية الأوراق والتحليل المختبري. تراوح متوسط إنتاجية الأوراق) كجم (DM لكل شجرة من الأنواع العلفية المختارة من 15.96 لنبات Rhus natalensisفي الأراضي المنخفضة إلى 128.43 لـ Erythrinabrucei في الارض المرتفعة وتباين بشكل كبير (P <0.05) بين الأنواع .كان محتوى البروتين الخام (CP) بال-(جم/كجم DM) هو الأعلى في Erythrinabrucei (198.3) وكان الأقل في Psydrax schimperiana (151). وقد لوحظ أعلى مستخلص إيثر (EE) في Mystroxylon aethiopicum (18.66 جم/كجم DM) وأدنى ما لوحظ في Nuxiacongesta (13.36 جم/كجم DM). كانت الألياف المنظفة المحايدة/ NDF/ هي الأعلى في Arundinaria alpine (602 جم/كجم DM) وأقلها في Psydrax schemperiana (297.4 جم/كجم DM). لم تكن هناك فروق معنوية في محتوى التانين المكثف بين الأشجار العلفية المدروسة. تراوحت قيم الأوكزالات من 18.4 جم/كجم DM في نبات Terminalia brownii إلى 36.5 جم/كجم DM في Balanites aegyptiaca بشكل عام، كانت الاختلافات b في محصول الأوراق والمحتوى التغذوي بين الأنواع العلفية المختلفة معنوية (P<0.05). من نتائج هذه الدراسة، يمكن استنتاج أن أنواع الأشجار العلفية يمكن اعتبارها مصدراً محتملاً للإنتاج الانقى للبروتين الخام لتكملة العلف الخشن ذو الجودة الرديئة لسد الفجوة.

الكلمات الدالة: الوفرة، إنتاجية العلف، التركيب الكيميائي، العوامل المضادة للتغذية

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