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Evaluation of Potential Yield and Chemical Composition of Selected Indigenous Multi-Purpose Fodder Trees in Three Districts of Wolayta Zone, Southern Ethiopia

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Abstract: Ethiopia is believed to have the largest livestock population in Africa and the major limiting factor among others for livestock production is nutrition both in terms of quantity and quality. To curb the problem of feed availability, use of indigenous multipurpose fodder trees would be regarded as good option. In this study, we evaluated the potential yield and chemical composition of selected indigenous multi-purpose fodder trees in three districts of Wolayta zone, Southern Ethiopia. A total of 28 indigenous MPFT species were identified. The five MPFT species from identified indigenous fodder were important and taken in this study for biomass estimation and laboratory analysis were *Erythrina* brucei, *Vernonia* amygalina, Ehertia cymosa, Cordia africana and Dovylas abyssinica. Potential yield of the selected MPFTs ranges from 25 kg for Dovylas abssinica in Humbo district to 959 kg for Erythrina brucei in Sodo Zuria district and vary significantly ($P < 0.05$) among the selected MPFTs and among the districts. The five selected indigenous MPFT species had chemical composition of 11–21% Crude protein, 8-14% ash, 38-56% Neutral detergent fiber, 33-51% Acid detergent fiber and 9-17% lignin, indicating their wide variability among species ($P < 0.05$). It can be concluded that the indigenous MPFT species can be considered to be a potential source of CP to supplement poor quality roughages to fill the gap especially in dry season.

Key words: Chemical Composition · Potential yield · Indigenous · Multipurpose Fodder trees · Feeding system

INTRODUCTION

Ethiopia is believed to have the largest livestock population in Africa [1]. This livestock sector has been contributing a considerable portion to national economy and 26% for agricultural GDP production [2] and still promising to rally round the economic development of the country. The major limiting factor among others for livestock production is nutrition both in terms of quantity and quality. To curb the problem of feed availability, use of indigenous multipurpose fodder trees would be regarded as good option. Indigenous multipurpose fodder trees is a potentially expensive locally produced protein supplement for ruminants, particularly during the critical periods of the year when the quantity and quality of herbage is limited [3]. Multipurpose fodder plant have high crude protein content, ranging from 10 to more than 25% on dry matter basis and may be considered as a more reliable feed resource of high quality to develop sustainable feeding systems and in increasing livestock productivity [4, 5].

Indigenous MPFTs are grown naturally on smallholder farms and are an integral part of the farming system. Most of the indigenous fodder tree species are not primarily grown for fodder but for other purposes [6]. Several studies on multi-purpose fodder trees (MPFTs) have been conducted in different parts of Ethiopia on different aspects [7-11, 5]. However, most deal with introduced or exotic tree fodder species and very meagre information is available about the chemical composition of indigenous MPFTs. The significance of this study gives insight to chemical composition of indigenous MPFTs as animal feed. Moreover, site specific evaluation of these species can contribute to further establishment, adaptation and utilization as fodder. It is, therefore, imperative to evaluate potential yield and chemical composition of the indigenous MPFTs in order to provide best indigenous MPFTs to alleviate feed shortage in the

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Wolayta zone and in areas with similar agro-ecologies. Therefore, the objective of this study was to evaluate the potential yield and chemical composition of the indigenous multipurpose trees for sustainable animal production in the study districts.

MATERIALS AND METHODS

Study Location: The study was conducted in three districts of Wolayta Zone, Southern Nation Nationalities Regional State (Figure 1 and 2). The three districts were selected based on the potential of livestock production and were in different altitudinal ranges. The districts were Soddo Zuria (highland), Damot Woyde (mid altitude) and Humbo district (lowland) and were located at 330 km, 356 km and 347 km South of capital city, Addis Ababa and at altitude between of 1950-2400, 1400-1750 and 750-1100 meters above sea level, respectively. All areas experiences 8 to 10 months of rainfall and bimodal rainfall is common [12]. The main rainy season extends from May to September and the small rainy season is in February to April but the amount is variable in the three districts [13].

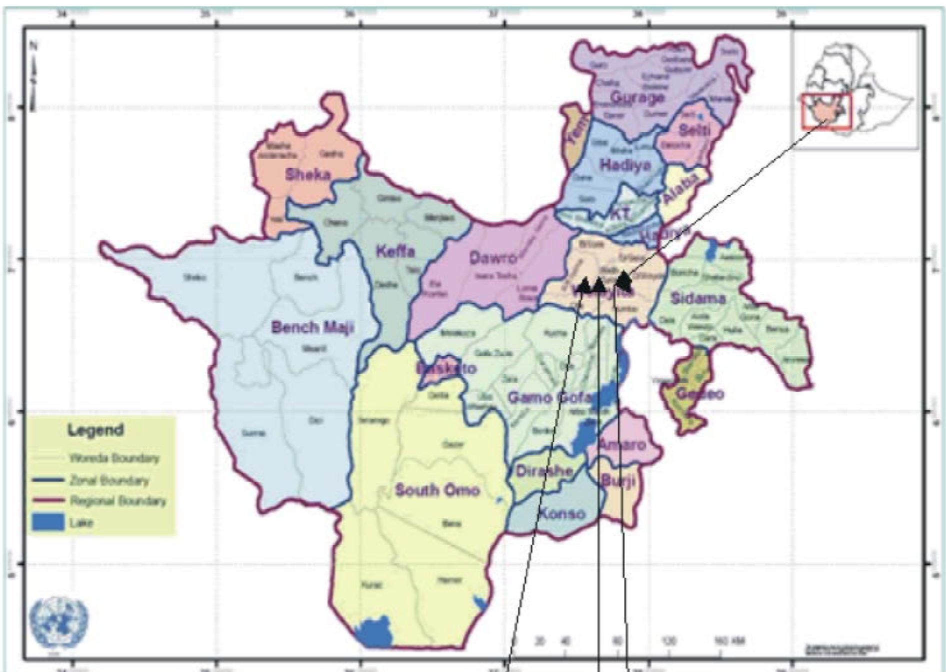

Fig. 1: Map of Southern Nations and Nationalities Regional state (source: UN)

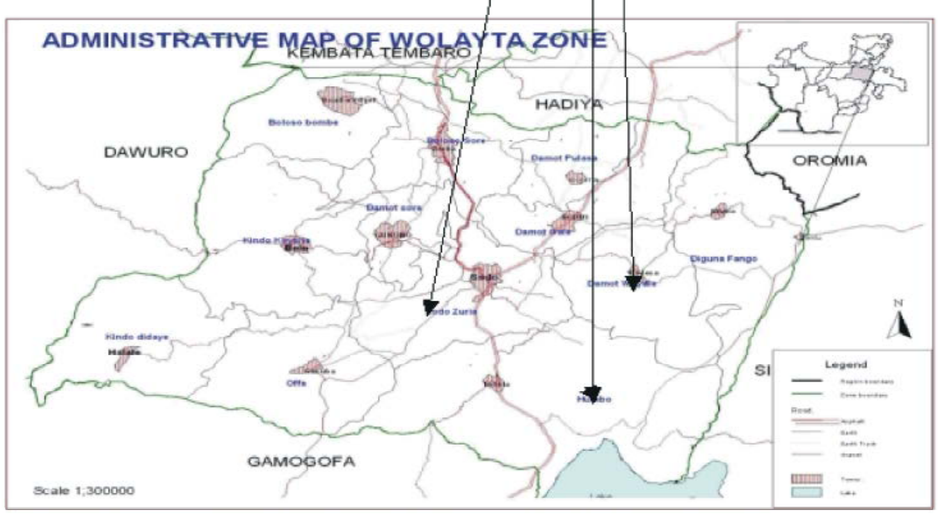

Fig. 2: Map of Wolayta Zone (Source: Zonal finance and economy office)

The Sodo Zuria is located approximately at 6°50'N-7°53'N and 37°36'E-37°53'E, average temperature range 13-26°C, annual maximum and minimum rainfall is 1300 mm and 1150 mm, Damot Woyde is located approximately at 6°43'N-7°33'N and 37°28'E-37°43'E, average temperature range 17-24°C, annual maximum and minimum rainfall is 1100 mm and 900 mm mm and Humbo districts is located approximately at 6°34'N and 37°43'E latitude and longitude, average temperature range 18-30°C, annual maximum and minimum rainfall is 1000 mm and 650 mm. The soil types of the three districts were Vertisoil and nitosoil. [14, 15]. Subsistence production and rain fed agriculture are the main livelihood activities. The main economic sources for the districts are sale from crops, animals, animal products and off-farm activities like working around town, construction labourers, merchants and employed in government and non-governmental organizations.

Sampling and Data Collection: The five MPFTs leaves were selected for potential yield and evaluation through chemical analysis. From each browse tree selected for chemical analysis, a separate sample of leaves from three Peasant Association(PA) of each district was harvested. From each PA, leaf samples were collected from at least ten randomly selected trees and bulked to have one leaf sample for each MPFT species per PA. Thus, there were a total of Fifteen leaf samples of fodder trees for chemical analysis at Holeta Agricultural Research center.

Predicting Potential Yield of Selected Fodder Trees: Potential yield of browses is the foliage available for defoliation [16]. Using measuring tape, the circumference of trunk or stem of each selected MPFT species was measured and recorded. Fifteen circumference measurements for each selected MPFT species in each PA were taken and the diameter was calculated as: D = 0.636C, where D=diameter C= circumference. The equation below was used to estimate the potential yield of the MPFT species by entering the diameter value as: Log W= 2.24Log DT-1.50 where W= leaf yield in kilograms of dry weight and DT= trunk diameter (cm) at 130cm height [17].

Chemical Analysis: Leaf samples were dried in air at the field and then oven dried at 65°C for about 24 hours for dry matter determination. All fodder samples collected for feed evaluation were subjected for the analysis of dry matter (DM), ash and CP [18]. Samples were also analysed for neutral detergent fiber (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) [19].

Statistical Analysis: Data on potential yield and chemical analysis were analyzed using analysis of variance employing the general linear model procedure of SAS software [20]. Mean separation was tested using the least significant difference (LSD). The model for the potential yield and chemical analysis was; Yij = μ+Ai +eij Where, Yij = response variable, μ = overall mean, Ai = fodder tree species effect and eij = random error.

RESULTS

Major Feed Resource Base and Constraints to Animal Production: The respondents showed that the shortage of feed resource has been an immense constraint due to high human population in three districts that convert pasture and grazing land to agricultural field. In the study districts, the respondents indicated that shortage of feed/grazing land and water followed by animal disease were the major constraints to animal production to the three districts and these constraints were similar to the constraints faced by farmers in other parts of similar agro-ecology [12]. The respondents showed that the shortage of feed resource has been an immense constraint due to high human population in three districts that convert pasture and grazing land to agricultural field (Table 1). In the study districts, the respondents indicated that shortage of feed/grazing land and water followed by animal disease were the major constraints to animal production to the three districts and these constraints were similar to the constraints faced by farmers in other parts of similar agro-ecology [12].

As figured out from the interviews made with the farmers, access to veterinary services was limited and disease was put as the primary challenge for small ruminants and donkey production. Low productivity of animals, water and labour shortages were also among the constraints for livestock production mentioned by few of the respondents in the area (Table 2).

Potential Yield of the Selected Indigenous Multipurpose Trees: Foliage biomass yield that can be defoliated for animal feeding differed ($P < 0.05$) among the five selected MPFT species in all the three study districts (Table 3). Biomass yield in all districts were greatest ($P < 0.05$) for *Erythrina brucei* followed by *Cordia africana.* In Sodo Zuria and Humbo districts biomass yield was the lowest ($P < 0.05$) for *Dovylas abssinica,* but the value for *Dovylas abssinica* was similar ($P > 0.05$) with that of *Ehertia cymosa* for Damot Woyde district.

Table 1: Major feed resource available in the study districts during the dry and wet seasons

		% of respondents		
Season	Major feed sources base	Sodo Zuria	Damot Woyde	Humbo
Wet	Grazing natural pasture	87.4	85.6	82.1
	Crop residues	32.7	33.5	29.4
	Parts of root and tuber crops	44.0	48.5	38.7
	Fodder tree foliages	43.5	41.5	35.0
	Agro-industrial by products	25.6	21.0	17.0
Dry	Grazing natural pasture	15.7	12.5	13.5
	Crop residues	73.5	67.5	76.0
	Parts of root and tuber crops	20.2	18.2	14.2
	Fodder tree foliages	65.8	58.6	55.4
	Agro-industrial by products	26.3	22.0	19.4

Table 2: Constraints of animal production in the study districts

	Ranking by respondents*								
	Sodo Zuria			Damot Woyde			Humbo		
Problem	C	Sh and G	D	C	Sh and G	D	C	Sh and G	D
Shortage of Feed	1	2	2	1	2	4	1	2	2
Shortage of grazing land	2	3	4	2	3	2	2	3	1
Health problem (Veter. Service)	3	1	1	3	1	1	3	1	4
Low Productivity	5	6	3	4	4	3	5	4	3
Water Scarcity	4	5	6	4	5	6	4	6	6
Labour scarcity	6	4	5	6	6	5	6	5	5

*C= Cattle, Sh= Sheep, G=Goat, D=Donkey, 1= >85%, 2 = 65-85%, 3 = 55-65%, 4 = 40-55%, 5 =25- 40%, 6 = <25%

Table 3: Leaf biomass yields (kg) of the five selected indigenous multipurpose fodder trees at the 130cm height of the three districts

	Multipurpose tree species per 3 *kebeles*					
District	*E. brucei*	*C. africana*	*V. amygdalina*	*E. cymosa*	*D. abssinica*	SEM
Sodo Zuria	958.76^{a}	925.53^{b}	95.577^{d}	96.539^{c}	39.60^{e}	9.12
Damot Woyde	529.12^{a}	512.59^{b}	97.64^{c}	51.06^{d}	47.09^{d}	5.91
Humbo	68.53^{a}	53.228^{b}	43.947^{c}	36.63^{c}	24.55^{d}	3.31

^{abcde}Means in a row with different superscript are significant at p<0.05; SEM= standard error of the mean

Table 4: Nutrient composition (% for DM and % DM for others) of leaves of five selected indigenous multipurpose tree species of the study districts Fodder tree species

Parameter	*E. brucei*	*V. amygdalina*	*E. cymosa*	*C. africana*	*D. abssinica*	SEM
DM	95.13	94.24	94.253	94.31	95.35	0.43
CP	21.30^{a}	19.25^{a}	15.67^{b}	15.55^{b}	11.34^{c}	0.95
Ash	13.42^{a}	13.31^{a}	13.83^{a}	14.11^{a}	8.39^{b}	0.82
OM	86.57^{b}	86.69^{b}	86.17^{b}	85.89^{b}	91.61^{a}	q0.82
NDF	53.5^{a}	38.33^{b}	42.75^{b}	55.52^{a}	40.67^{b}	2.19
ADF	43.05^{ab}	34.51^{c}	39.95^{bc}	50.65^{a}	33.56^{c}	2.57
Lignin	9.56^{b}	8.47^{b}	10.92^{b}	16.99^{a}	9.104^{b}	1.26

^{abc}Means in a row with different subscripts are significantly different (p<0.05); DM = dry matter; CP = crude protein; OM = organic matter; NDF = neutral detergent fiber; ADF = acid detergent fiber

Biomass yield for *Vernonia amygdalina* was greater than *Ehertia cymosa* ($P < 0.05$) in Sodo Zuria and Damot Woyde districts but values were similar ($P > 0.05$) in Humbo district. Generally biomass yield of the selected MPFTs ranges from 25 kg for *Dovylas abssinica* in Humbo district to 959 kg for *Erythrina brucei* in Sodo Zuria district.

Chemical Composition of Selected Indigenous MPFTs Trees: The chemical composition of the selected indigenous MPFTs in study districts is presented in Table 4. The five selected indigenous MPFT species had chemical composition ranges of 11–21% CP, 8-14% ash, 38-56% NDF, 33-51% ADF and 9-17% lignin, indicating their wide variability in chemical composition. All chemical composition values were varying significantly ($P < 0.05$) among the five species of MPFTs. The CP content was in the order of *Erythrina brucei* > *Vernonia amygdalina* > *Ehertia cymosa* > *Cordia africana* > *Dovylas abssinica.* Ash content was lowest ($P < 0.05$) for *Dovylas abssinica* and values for other species were similar ($P > 0.05$).

The content of NDF and ADF was greater for *Erythrina brucei* and *Cordia africana* than the other three species which were similar among each other. The lignin content was higher for *Cordia africana* than other species having similar lignin with each other [21].

DISCUSSION

Without due consideration the differences among the five selected species, the chemical composition values suggest the potential of the indigenous MPFTs as a possible supplement to roughage based diets like crop residues consistent with that has been noted before [3, 11, 22]. Most can serve as good sources of CP. The relatively low level of NDF in the fodder trees also suggests their potential as a supplement. The CP content of the selected MPFTs was within the range of 10-25% reported by others [23, 4, 11, 22]. The ash content of MPFTs considered in this work was similar with the other findings in tropics [4, 5]. The ash contents of *Vernonia amygdalina, Ehertia cymosa* and *Cordia africana* of this study were comparable to the report in similar agro-ecology in the region [11].

The NDF content of MPFTs in this study was analogous to the finding on similar issues [11]. The current result also agrees with other reports [24, 23, 25] that noted NDF and ADF contents below 30% and 40%, respectively for different MPFTs, which was similar for the values observed for *Ehertia cymosa, Vernonia amygdalina* and *Dovylas abssinica.* Variations in the chemical composition of the fodder trees considered in this study could probably be due to difference in their ability to accumulate proteins at the stage of their sampling, growth potential of the plant and possible differences in the amounts of minerals or nutrient in the soil [3].

The variation among species in biomass yield suggests differences in potential biomass yield that may be associated with differences in growth of the species. It also appears that there is variation in biomass yield among districts within each species, which may be related to spatial differences and associated variation in climatic factors and soil fertility. As such biomass yield of each of the selected MPFTs appeared to decline with a decrease in altitude of the districts. Generally, the result revealed that highest weight yield recorded in *Erythrina brucei* followed by *Cordia africana* in three districts and lowest in *Dovylas abssinica* in three districts. Some possible inconsistencies in chemical composition values reported by other studies could be due to variations in season of samples collected, environmental and climatic influences on foliage growth and altitudinal differences of the sampling site.

CONCLUSION

This study focused that the indigenous MPFT have supplementary feed to livestock production for the poor quality and quantity basal diet during dry season as indigenous MPFTs are believed as nutritious to animal. The five MPFT species identified as important in the study area based on their abundance and utilization as animal feed are *Erythrina brucei*, *Vernonia amygalina*, *Eherthia cymosa*, *Cordia africana* and *Dovylas abyssinica.* These five MPFT species were for their feeding values in the laboratory. The variation among species in biomass yield suggests differences in potential biomass yield that may be associated with differences in growth of the species. It also appears that there is variation in biomass yield among districts within each species, which may be related to spatial differences and associated variation in climatic factors and soil fertility. Thus, the indigenous MPFT species can be considered to be a potential source of CP to supplement poor quality roughages to fill the gap especially in dry season and *Erythrina brucei, Eherthia cymosa* and *Vernonia amygdalina* were better in their chemical compositions like CP. So, farmers should select these valuable indigenous MPFT trees for sustainable animal production at dry seasons.

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