Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.7, No.19, 2017

Evaluation of the Nutritional Composition of Selected Indigenous Fodder Trees and Shrubs in Daro Labu District, Eastern Ethiopia

Muleta Debela[1] Getachew Animut[2] Mitiku Eshetu[3]
1.Mechara Agricultural Research Center (McARC), P. O. B 19, Mechara, Ethiopia
2.Agricultural Transformation Agency (ATA), P. O. B 708, Addis Ababa, Ethiopia
3.Haramaya University, School of Animal and Range Sciences, P. O. B 138, Dire Dawa, Ethiopia

Abstract
Low availability of quality fodder particularly in the dry season is a major factor constraining livestock production in Ethiopia. Therefore, a study was conducted in Daro Labu District of West Hararghe Zone, Eastern Ethiopia to evaluate the nutritional composition of selected indigenous fodder trees and shrubs as a feed resources. Three Rural Kebeles (villages) were purposively selected in the highland, midland, and lowland in the district. Chemical analysis of leaves of selected fodder trees and shrub samples, namely, Acacia brevispica L., Combretum molle, Erythrina abyssinic (Lam), and Cordia africana (Lam) were analyzed for their chemical composition. The results of chemical analysis of feed samples of the selected fodder trees and shrubs revealed that the dry matter of Combretum molle was found to be significantly higher ($P<0.01$) than that of Accia brevispica. The ash content of the selected fodder trees and shrubs ranged 7.3-16.6%. The ash content of Cordia africana was significantly higher ($P<0.01$) than that of Combretum molle. The crude protein contents of Acacia brevispica L., Combretum molle, Erythrina abyssinic (Lam) and Cordia africana (Lam) were 17.51, 15.84, 14.04 and 8.89%, respectively. The neutral detergent fiber was greater (59.14%) in Cordia africana and lower (47.49%) in Acacia brevispica. The relative feed value of Acacia brevispica, Combretum molle, Erythrina abyssinica and Cordia africana were 136.3, 121.26, 112.9 and 74.8, respectively. The crude protein (CP) content and relative feeding value (RFV) of Acacia brevispica was significantly higher ($P< 0.05$) than the crude protein contents and relative feeding values of the other fodder tree/shrub species. This closely followed by the crude protein and feeding value of the leaves of Erythrina abyssinica. Generally, Acacia brevispica and Erythrina abyssinica had higher potential as animal feed in terms of crude protein contents and relative feeding value. In conclusion based on these results, Acacia brevispica and Erythrina abyssinica species could be recommended as potential animal feed resources in the study area.
Keywords: Chemical analysis, feed resources, fodder trees and shrubs

1. Introduction

The major limiting factor for livestock production is feed in terms of both quantity and quality. To curb the problem of feed shortage, use of indigenous multipurpose fodder trees could be regarded as good option. Indigenous multipurpose fodder trees are potentially good protein supplements for ruminants, particularly during the critical periods of the year when the quantity and quality of herbage is limited (Takele *et al*., 2014). Fodder trees and shrubs play a vital role in improving livestock productivity in the arid and semi-arid zones of tropical Africa. They supply goats and camels with the bulk of their nutrient requirements and complement the diet of cattle and sheep with protein, vitamins and minerals (Dicko and Sikena, 1992).

Indigenous browse shrub and tree foliages represent locally available crude protein and mineral supplements for ruminant livestock in the tropics and these plants remain green during the dry season and provide vegetation with better nutritive value than other annual grass and herbaceous species (Aregawi *et al.,* 2008). They have also potential to prevent desertification, mitigate the effects of drought, and enhance the restoration of the vegetation and recuperation of rangelands (Robles *et al*., 2008).

Utilization of browse fodder tree supplements in ruminant feeding in the tropics is limited by lack of information on their nutritive potential (Rubanza *et al.,* 2006). Several studies on multi-purpose fodder trees (MPFTs) have been conducted in different parts of Ethiopia. However, most of them deal with introduced or exotic tree fodder species and very scanty information is available on the chemical composition of indigenous multi-purpose fodder trees (Takele *et al*., 2014). Despite the wider use of indigenous browse species, little research has been done with regard to the extent of their utilization and their potential nutritive value (Dicko and Sikena, 1992). Many wild browse and bush species are undervalued mainly because of insufficient knowledge about their potential feeding value (Boufennara *et al*., 2012). Likewise, local knowledge on fodder tree and shrub species was not investigated in Daro Labu district. Therefore, this study was conducted with the objectives of evaluating the nutritional composition of selected indigenous fodder trees and shrubs as a feed resource in Daro Labu district.

2 .Materials and Methods

2.1. Description of the Study Area

The study was conducted in Daro Labu district, West Hararghe Zone of Oromia Regional State, Ethiopia. The capital town of the District, Mechara, which is located at a distance of about 434 km southeast of Addis Ababa. It is bordered by in the south by the Hawi Gudina District, in the west by Arsi Zone, in the northwest by Guba Koricha District, in the north by the Habro district, and in the east by Boke District. The study area is located at $8^0$10' N latitude, $40^0$30' E longitude and the altitude ranging between 1300 to 2450 meters above sea level. The district encompasses three distinct agro-ecologies, of which 12% of its area lies in the highland, 44% in the midland, and 44% in the lowland agro-ecological zones. The rainfall pattern is bimodal, the small rains fall starting from March/April to May and the main rainy season extends from June to September/October with an average annual rainfall of 963 mm and average annual minimum and maximum temperatures of 14^0C and 26^0C, respectively. The area constitutes different farming systems (mixed farming and agro pastoral and pastoral) and is predominantly known for cash crop production particularly coffee (*Coffea arabica* L.) and *Khat* (*Catha edulis* Forsk.) (Dereje *et al*., 2013).

2.2. Sampling Design and Data Collection

The study covered three agro-ecological sites, namely highland, midland and lowland were selected from rural Kebeles (villages) of Daro Labu district. Secondary data relevant to the study were collected from various sources (Agricultural Research Center, Agricultural Office of the District, and other sources).

2.3. Collection and Preparation of the Leaf Samples of Fodder Tree and Shrubs

Four Indigenous Fodder Trees and Shrubs (IFTS) species were selected for the study base. Leaf samples of the plants were plucked from the fodder trees and shrubs by hand. The leaf samples were collected from three agro-ecologies (highland, midland, and lowland). A total of 36 leaf samples[four fodder tree and shrub species, three leaves sample collected from bottom, middle and top of each IFTS and three agro-ecologies] were collected from the selected fodder tree and shrub species. One kg of green leaf samples were taken to Haramaya University's Animal Nutrition Laboratory for chemical analysis.

2.4 Chemical Analysis

The selected indigenous fodder trees and shrub samples were dried in a forced air oven at 65^OC for 72 hours for DM determination. The AOAC (1990) procedure of proximate composition was used for the determination of dry matter (DM), ash and crude protein (CP). The actual DM content was determined by oven drying at 105^OC for 24 hours. The ash component was determined by igniting the dried sample in a muffle furnace at 600^OC overnight. The residue left after burning in the furnace was recorded as ash. The nitrogen content was determined using the micro-Kjeldahl technique. The CP was calculated by multiplying the tissue nitrogen concentration in the dry matter of the leaves by 6.25. Acid detergent fiber (ADF), acid detergent lignin (ADL) and neutral detergent fiber (NDF) were determined by the methods of Van Soest and Robertson (1985). Hemicellulose was calculated by subtracting the ADF from the NDF contents while cellulose was determined by subtracting the ADL from the ADF content. Relative feed value (RFV) has no unit, but it is a way to compare the potential of two or more forages for energy intake. Feed with values greater than 100 is of higher quality. It is calculated from dry matter intake (DMI) and digestible dry matter (DDM) values of the forage as RFV = (%DDM * %DMI)/1.29; where, %DMI = 120/%NDF (as a percent of body weight) and %DDM = 88.9 - (0.779* %ADF).

2.5 Statistical Analysis

The collected chemical composition data was analyzed using analysis of variance (ANOVA) by the general linear model procedure of SAS (version 9.1) software. Mean separation was done whenever treatments showed significant differences using the least significant difference (LSD) test.

The model used was:

$Y_{ij} = \mu + \alpha_i + e_{ij}$

Where: Y_{ij} = response variable; μ = the overall mean; α_i = the effect of fodder tree and shrubs species; e_{ij} = the random error

3. Results and Discussion

3.1 Chemical Composition of Fodder Trees and Shrubs Leaves

The chemical composition leaves of fodder trees and shrubs are presented in Table 1. The ash content of the selected fodder trees and shrubs ranged from 7.3 to 16.6%, being the highest for *Cordia Africana* but the lowest for *Combretum molle*. This variation may be due to environmental factors and varietal difference of the plants. Generally, the high ash content of such fodder trees and shrubs is indicative for such feed resources to be rich in

minerals and may satisfy mineral requirement of the animals.

The crude protein content of *Acacia brevispica* was the highest (P<0.05) whereas the lowest was for *Combretum molle* with the following ranking order: *Acacia brevispica* > *Erythrina abyssinica* > *Cordia Africana* > *Combretum molle.* The crude protein content of *Acacia brevispica* was in agreement with the report of Rahim *et al.* (2013) who found shrub leaves to contain of 16.6% crude protein. Likewise the crude protein content of *Erythrina abyssinica* and *Cordia africana* was similar to the report of Simbaya (2002) who noted fodder trees to have crude protein contents of about 14.29%.

Table 1. Mean proximate chemical composition and cell wall constituents of selected fodder trees and shrub leaves in the study area

	Chemical composition on %DM basis								
FTS species	DM	%Ash	%CP	%NDF	%ADF	%ADL	Hcel	Cel	RFV
Acacia brevispica	93.28^{c}	8.74^{c}	17.51^{a}	47.49^{c}	24.87^{d}	19^{b}	22.62^{a}	5.8^{b}	136.3^{a}
Cordia africana	94.18^{b}	16.6^{a}	14.05^{c}	59.14^{a}	53.28^{a}	34.6^{a}	5.86^{d}	18.7^{a}	74.8^{d}
Combretum molle	95.91^{a}	7.31^{d}	8.89^{d}	48.47^{bc}	33.35^{c}	23.4^{b}	15.12^{b}	10^{b}	121.3^{b}
Erythrina abyssinica	94.64^{b}	13.7^{b}	15.84^{b}	50.17^{b}	37.44^{b}	20.3^{b}	12.74^{c}	17.1^{a}	112.9^{c}
Mean	94.50	11.59	14.07	51.32	37.23	24.33	14.09	12.90	111.32
LSD (5 %)	0.45	1.02	1.567	2.108	2.26	6.55	2.26	6.13	5.78
P-value	**	**	**	**	**	**	**	**	**
CV (%)	0.50	9	11.4	4.2	6.2	27.5	16.4	48.5	5.3

Note: Means followed by different superscripts within a column are significantly different at P ≤ 0.05 level of significance; **=significant at P<0.01; DM= dry matter; CP=crude; NDF=neutral detergent fiber; ADF= acid detergent fiber; ADL= acid detergent lignin; Hcel= hemicelluloses; Cel=cellulose and RFV= relative feed value

The neutral detergent fiber (NDF) contents of *Cordia africana* was significantly (P <0.01) highest. The result of this study (table 1) shows that the NDF contents of fodder trees and shrub was higher than that reported by Azim *et al.* (2011) for fodder tree leaves. This may be due to the season of sample leaf collection, stage of maturity of the plant, and environmental factors. According to Singh and Oosting (1992), the NDF content of roughage feeds with less than 45% was grouped as a high quality feed, while feed with NDF content of 45-65% was categorized as medium quality feed. Therefore, all experimental fodder trees and shrubs had less than 65% of NDF content and can be categorized as medium quality feed. According to Van Soest (1967), NDF content above 55% was reported to limit DM intake, indicating that the NDF content of the *Cordia africana (59.14%)* in this study could affect feed intake of animals, which may limit productivity.

The ADF content of the fodder tree and shrub species was significantly different (P<0.05), and was in the order of *Cordia africana* > *Erythrina abyssinica* > *Combretum molle* > *Acacia brevispica.* Cellulose and hemicellulose contents were also significantly different among plant species. Regarding the relative fee value (RFV), *Acacia brevispica* had significantly higher (P<0.01) RFV than *Combretum molle, Erythrina abyssinica* and *Cordia africana.*

4. Conclusions and Recommendation

This study has demonstrated that *Cordia africana, Combretum molle,* and *Erythrina abyssinica*, which are grown by farmers as hedge of homesteads, were found to have high potential as nutritious animal feed. These fodder trees and shrubs are also known for their versatility, serving as shade for livestock and coffee, as well as as fuel and natural fences. Nutritionally, *Acacia brevispica* and *Erythrina abyssinica* had higher potential as animal feed in relation to both high relative feed value and crude protein contents compared to the other fodder trees and shrub species. Based on this result, *Acacia brevispica* and *Erythrina abyssinica* species could be recommended for expansion as high potential animal feed resources in the study area. Promoting the development of fodder trees and shrubs through agro-forestry plantations in a good strategy to enhance availability and quality of feed resources in the area throughout the year.

Acknowledgement

The author would like to acknowledge Dr. Getachew Animut and Dr. Mitiku Eshetu for their professional guidance and constructive comments on the research work. The author also acknowledge to Mechara Agricultural Research Center (McARC) and Oromia Agricultural Research Institute (OARI) for the allocating budget with the agreement of Haramaya University "CASCAPE" project for granting the financial support for the research work. The author would like to thank all the staff members of Mechara Agricultural Research Center in general, particularly Coffee Research Team and the researchers Mr. Fekede Gemechu, Mr. Birmaduma Gadisa, Mr. Desalegn Mamo, Mr. Tadese Malka, Mr. Sudi Dawud and the driver Mr. Nibirete Abite for their kindly support during feed samples data collection for the study. In addition, the author would like to thank to Haramaya University of Animal Nutrition Laboratory employees for sharing valuable experience, ideas and comments during the practical work done in the laboratory.

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