Evaluation of Palatability and Nutrient Composition of Terminalia Brownii (Fresen) Leaves Grown in Farm Land in Southern Ethiopia

Bayisa Bekele  
*Department of Forestry, College of Agricultural sciences, Arba Minch University, Arba Minch P.O. Box 21, Ethiopia*, bayyubekele02@gmail.com

Mohinder Singh Hooda  
*Department of Forestry, College of Agricultural sciences, Arba Minch University, Arba Minch P.O. Box 21, Ethiopia*, Mshooda51@gmail.com

Asmelash Tesfaye  
*Department of Forestry, College of Agricultural sciences, Arba Minch University, Arba Minch P.O. Box 21, Ethiopia*, asmet1979@gmail.com

Follow this and additional works at: [https://corescholar.libraries.wright.edu/jbm](https://corescholar.libraries.wright.edu/jbm)  
*Part of the Forest Management Commons, and the Other Forestry and Forest Sciences Commons*

**Recommended Citation**  
ISSN: 2309-3854 online  
(Received: Jan 24, 2024; Accepted: May 4, 2024; Published: Jun 30, 2024)

This Article is brought to you for free and open access by CORE Scholar. It has been accepted for inclusion in Journal of Bioresource Management by an authorized editor of CORE Scholar. For more information, please contact library-corescholar@wright.edu.
Evaluation of Palatability and Nutrient Composition of Terminalia Brownii (Fresen) Leaves Grown in Farm Land in Southern Ethiopia

Cover Page Footnote
With profound gratitude I consider myself highly privileged to have professor M. S. HOODA, my major advisor College of Agricultural Sciences, Arba Minch University. My heartfelt thanks are due to his valuable guidance, constant encouragement, devoted interest, everlasting patience and for his close counseling and critical evaluation at every step of this thesis work. I emphatically extend my heartiest thanks to Mr. Asmelash Tesfaye my co-advisor, for his valuable and critical support at every steps of this research works and finalization of this thesis. My depest thanks also goes to Mr. Korra Gara (local elder) who helped me during the data collection period and also Mr. Tesfaye Teka Department of Animal sciences, college of Agricultural Sciences, Arba Minch University for his unlimited helps in facilitating all the laboratory works from the begning to the final of my laboratory works. I also gratefully thanks the Arba Minch University for giving me a chance of graduate study and all other kinds of helps during my study and Holeta Agricultural Research Center biology laboratory technicians for offering me all possible helps in all aspects of the laboratory work. Particularly I have the heartfelt thanks to department head of Forestry Mr. Daba Misgana for his special faciliatation of all facilities and smooth relations. I extend my sincere thanks to all my staff members and my class mates for rendering their help during the period of this thesis study. My sincere thanks are also to Ethiopian ministry of sciences and higher education for financing my study at Arba Minch University. Finaly I owe this pride place and can never forget to express my respect and gratitude to my beloved parents my mother Tedalu Adugna, my elder brother Tolcha Bekele and all my brothers and sister for their constant faith, selfless persuasian, sacrifice, heartfelt blessings and constant inspiration for my life.

© Copyrights of all the papers published in Journal of Bioresource Management are with its publisher, Center for Bioresource Research (CBR) Islamabad, Pakistan. Users have the right to read, download, copy, distribute, print, search, or link to the full texts of articles in the Journal. We operate under International Version 4 (CC BY 4.0) of Creative Commons Attribution License which allows the reproduction of articles free of charge with the appropriate citation of the information.

This article is available in Journal of Bioresource Management: https://corescholar.libraries.wright.edu/jbm/vol11/iss2/5
EVALUATION OF PALATABILITY AND NUTRIENT COMPOSITION OF *TERMINALIA BROWNII* (FRESEN) LEAVES GROWN IN FARM LAND IN SOUTHERN ETHIOPIA

BAYISA BEKELE¹, MOHINDER SINGH HOODA¹, AND ASMELASH TESFAYE¹

¹Department of Forestry, College of Agricultural sciences, Arba Minch University, Arba Minch P.O. Box 21, Ethiopia

Corresponding author’s email: bayyubekele02@gmail.com

ABSTRACT

Fodder trees and shrubs are important diet and they can provide huge amount of nutrient for grazing animals specifically in areas where less amount of forage is found. The current study was conducted during the year of 2020-2021 at Southern Ethiopia with the objectives of evaluating the palatability and nutrient composition of *Terminalia brownii* leaves grown in farmland. Survey was conducted in the study area with a 5 % of the total HHs through selecting randomly from the kebeles resident list. Five samples from each management practice i.e. lopping, pollarding and pruning were taken and analyzed in the laboratory for nutrient composition. The results revealed that among different management practices the palatability of *T. brownii* was ranked in the order of pruning > pollarding >lopping. The nutrient composition varied significantly (P < 0.05) among three tree management practices i.e. lopping, pollarding and pruning which includes 5.40 %, 4.60 % and 5.50 % of crude protein (CP), 8.59 %, 10.65 % and 12.23 % of Ash, 74.90 %, 59.53 % and 79.30 % of acid detergent fiber (ADF) respectively. The study confirmed that pruning was the best *T. brownii* tree management practice for the farmers to feed their goats and cattle. On the basis of current study it is recommended that farmers should use leaves of the fresh growth stage for their ruminant and farmers required to be trained in adoption of package and practices of the species in their farm land.

Keywords: *T. brownii*, tree management, palatability, nutritive value, konso.

INTRODUCTION

In major resource poor farmers, people participate in livestock rearing as it is their occupation and sources of income specifically in Africa (Randolph et al., 2007; Herrero et al., 2013; Kristjanson et al., 2014). For the sake of efficient utilization of available resources, the sustainable productions of livestock are always involved. Fodder trees are mainly used for livestock management, and savannah areas are account about 10 to 15 % of fodder trees used for the purpose of livestock feed specially during the dry seasons (Franzel et al., 2014; Ouachinou et al., 2018). The reason for this is the less rainfall in area and the lower biomass production, but they support over 90 % of livestock. (Osemeobo, 1996). The length of dry season is negatively affecting the quality as well as the quantity of the forage. These are said to be one of the constraints in livestock rearing of some different developing countries (Balehegn et al., 2020). In the dry season of different rural areas, the available grazing is insufficient to meet the nutritional needs of grazing animals (Matlebyane et al., 2010; Ogunbosoye and Babayemi, 2010).

The browse species contain significant amounts of
nutrients that are limited in other feed resources, like grasses, and crop residues especially in the dry seasons. Mui et al. (2005) reported that from different components of ruminant diet, trees and shrubs fodders are critical diets and it can provide huge amount of nutrient for grazing animals specifically in areas where less amount of forage is found.

According to the report by NAERLS (2005), in the dry season of the year, majority of trees and shrubs especially deciduous trees and shrubs shed their leaves, annual grasses are die back and some perennial grasses are dry up; so that the livestock left with little or no feed. Even though the plants’ parts which are produced in this season, such as new flash of leaves, flowers and fruits are rich in proteins, vitamins and other minerals. Livestock found in pastoral and agro-pastoral areas graze on natural pasture and browse species, crop residues and by-products of cash crops for the significant periods of the years. They also migrate with their herders for searching of better forages (Simpkin, 2005).

Majority of farmers in Southern Ethiopia are using trees and shrubs fodder that are consumed by their livestock for the trees’ and shrubs’ nutrients content. *T. brownii* is the one which is used by local farmers as a fodder trees in this area. The farmers are potentially grown and maintained *T. brownii* as fodder trees for their livestock especially, for small ruminants. Since tree is the major source of fodder for livestock in study area, it become imperative to know the palatability and nutrient composition of this much demanded fodder tree. By taking this into consideration, the current study was undertaken during the year of 2020-2021 in the southern Ethiopia with the objectives of evaluating the palatability and nutrient composition of *T. brownii* leaves grown in the farmland.

**MATERIALS AND METHODS**

**Description of the Study Area**

The study was conducted in Konso zone of southern nation’s nationalities and peoples’ regional state (Figure 1). The zone is geographically lies between 5° 0' 0" to 5° 40' 0" N and 37° 0' 0" to 37° 40' 0" E and situated at about 541 Km south of the national capital city, Addis Ababa. For ease of administration Konso zone is divided in to five districts (Woredas) and fourty three Kebeles.

The number of population in Konso zone is estimated to be about 250,389; from these about 129,951 (51.9 %) are female and 120,438 (48.1 %) are male with estimated total of 50,150 households (WoFED, 2013). The zone has about 2022.87-Km² total size of land (WoFED, 2014). Maximum area is under cultivation (39 %) followed by grazing land (26 %), forest, bushes, and shrubs (1 %), cultivable land (12 %) and uncultivable land (22 %). The average annual rainfall of the study area is 550 mm. On the basis of agro-climatic classification the zone is classified into Kola (Lowland) and woyina-dega (Midland) agro-climatic Zones where 70 % of the land falls under former which characterized by warm and semi-climate condition with an altitudinal range between 500 and 1500 masl while 30 % falls under which later has cool sub humid with mid-altitudes of between 1500 and 2100 masl.

Crop production and livestock production (i.e. mixed farming) are the primary household economic activities in the area. Their crop production is mostly based on rain-fed farming system, except in few areas where farmers involved in spate irrigation. Various food crops are grown in this area, such as maize, sorghum, teff, haricot beans, millet, wheat and barley.
Concerning perennial crops, fruit trees, Coffee, Gesho, Khat and Cassava are major cash crops and root tuber respectively in the study area. *Moringa stenopetala* which is known as cabbage tree and part of daily meal for majority of household and also used as cash earning commodity in the local market (WoFED, 2014).

![Map of the study area](image)

**Figure 1** Map of the study area.

Followed to crop production, livestock rearing is considered as major source of income. The major livestocks are cattle, goats and sheep. The methods of livestock management and feed sources are seems different along the elevation differences for instance: in the mid-highlands of the area (woynadega), livestock are mainly herded in the villages predominantly on the graze land which is privately owned lands very close to the house compounds. On the other hand around the lowland areas (kola), majority of livestock are herded in open fields of communal or private grazing lands. The people use different fodder trees including *T. brownii*, *Leucaena leucocephala*, *Ziziphus mauritiana*, *Acacia tortilis*, *Rhus natalensis*, *Combretum aculeatum* and the byproducts of *Cajanus cajan* and *Moringa stenopetala*.

**Sampling and Data Collection Method**

Based on the potential availability and experiences of using *T. brownii* as fodder tree, *Dokatu Kebeles* (i.e. Higher Dokatu and Lower Dokatu) were selected. The total number of household in study area was 1,971. The socio-economic setup and heterogeneity of the study population is tolerable for the subject of interest and hence, 5% of the total households (i.e. 1971*5 % = 98) from the kebeles were considered and the sample households were selected randomly from the kebeles resident list. Survey questionnaires were undertaken with both closed and open
ended types of questions to obtain primary data and covering various issues about the palatability of *T. brownii*. The palatability of the tree leaves was obtained from selected household through interview and validated by local experienced people whom selected by using snow ball method (Sedgwick, 2013). The palatability then classified as, less palatable, moderately palatable and highly palatable (Farrukh and Durrani, 2009). Key informant interview were held with key informants whom selected from herder by using snow ball method to acquire basic information regarding indigenous knowledge on the palatability and for validating the collected data from the household assessment. Social variations such as: gender, level of education, occupation and age were considered during comprising the key informant interview.

**Tree Selection and Sampling Method**

*T. brownii* was selected purposively based on the potential availability, long experience of usage and management practices of the tree. Fresh leaves were collected from a minimum of 5 selected trees for each management practices (i.e. Lopping, Pollarding and Pruning) and labeled respecting to tree managements. The fresh leaves samples were brought to Arba Minch University, College of Agricultural Sciences’ laboratory and washed immediately in order to remove dust and other adhering substances. After washing, all the samples were air dried for 24 hours to reduce chemical and biological changes of the leaf samples. The representative samples were packed in the labeled paper bag and put into oven dry for 24 hours at 105°C for the estimation of dry matter and further studies. The dried samples were ground and finally 300 g of grounded samples were prepared for the laboratory analysis.

**Chemical Analysis**

The AOAC (2005) procedures were used to determine the Dry matter (DM), Ash, Crude protein (CP). The leaf samples were grounded in a Willy mill to pass through 1-mm sieve. Thereafter, samples were identified and labeled in respective of the different tree management practices (viz. pruning, pollarding and lopping). Actual dry matter content of *Terminala brownii* leaves were determined by oven drying the leaves at 105°C for 24 hours and ash content was determined by igniting the dried leave sample in a muffle furnace at 600°C overnight. Thus the residue which is remained after burning in the furnace was recorded as ash. The Nitrogen, potassium, and phosphorus content were determined by using the micro-Kjeldahl technique (AOAC, 2005). The CP was calculated by multiplying the Nitrogen concentration dry matter of the leaves by 6.25. The structural plant constituents such as Acid Detergent Fiber (ADF) and Acid Detergent Lignin (ADL) were analyzed by following the Van Soest and Robertson (1985), and Van Soest et al., (1991) was used to determine the Neutral Detergent Fiber of the leaves. Laboratory works for DM, Ash, Crude protein, ADF and NDF were determined at Arba Minch University Abaya campus chemistry laboratory and for ADL Holota Agricultural research center.

**Statistical Analysis**

Data was analyzed by using analysis of variance employing general leaner model procedures of SAS software (SAS, 2002). The nutrient composition parameters under the three discrete tree management practices were evaluated by one way ANOVA among the tree management practices. The household and key informant interviews on the tree management practices and palatability were described, analyzed and presented through Microsoft Excel work sheet. The
mean separation was tested by using the least significant difference (LSD) at 5% error margin.

\[ X_{ik} = \mu + F_i + e_{ik} \]

Where \( X_{ik} \) = dependent variables, \( \mu \) = general mean, \( F_i \) = the effect of \( i \)th tree management practices and \( e_{ik} \) = residual error.

RESULTS AND DISCUSSION

**Palatability of T. brownii Leaves under Different Tree Management Practices**

The palatability of *T. brownii* leaves was determined through interviewing the selected household from the kebeles. Under the three different tree management practices, the degree of palatability classification of *T. brownii* was shown in Table 1, which is based on the usual use of the trees.

<table>
<thead>
<tr>
<th>Tree management types</th>
<th>Palatability classification</th>
<th>Number of household</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pruning</td>
<td>Highly palatable</td>
<td>53</td>
<td>54.08</td>
</tr>
<tr>
<td>Pollarding</td>
<td>Moderately palatable</td>
<td>33</td>
<td>33.67</td>
</tr>
<tr>
<td>Lopping</td>
<td>Less palatable</td>
<td>12</td>
<td>12.24</td>
</tr>
</tbody>
</table>

As shown in Table 1, about 54.08% of the sample household scored the newly sprout leaves of *T. brownii* under pruning as highly palatable for their livestock, while the new leaves under pollarding and lopping tree management practices were categorized as moderate and less palatable, respectively. This was because of the growth stage of the tree in which there is newly sprouted fresh leaves under pruning rather than under pollarding and lopping. According to the respondents, the refusal and acceptance of *T. brownii* by goats or cattle was depend on the growth stage of the tree, accessibility of feed and hungry of the goats or cattle. If there is no feed access, *T. brownii* is palatable for goats and cattle under all management (*viz.* lignified and newly sprout). This behavior of livestock is in line with the report by Kochare et al. (2018) on other fodder trees reported in the palatability and animal preferences of plants in small and fragmented land holding.
Nutrient Composition of T. brownii Leaves under Different Tree Management Practices

Table 2: Nutrient composition of T. brownii leaves under different tree management in the study area (±SD)

<table>
<thead>
<tr>
<th>Nutrient (% DM) content</th>
<th>Tree management practices</th>
<th>Lopping</th>
<th>Pollarding</th>
<th>Pruning</th>
<th>SED</th>
<th>CV %</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM</td>
<td></td>
<td>36.17b</td>
<td>42.37a</td>
<td>42.35a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CP</td>
<td></td>
<td>5.40±0.30</td>
<td>4.60±0.70</td>
<td>5.50±0.61</td>
<td>0.54</td>
<td>3.6</td>
<td>*</td>
</tr>
<tr>
<td>Ash</td>
<td></td>
<td>8.59±1.85</td>
<td>10.65±0.65</td>
<td>12.23±0.73</td>
<td>0.96</td>
<td>6.9</td>
<td>**</td>
</tr>
<tr>
<td>ADF</td>
<td></td>
<td>74.90±25.08</td>
<td>59.53±19.47</td>
<td>79.30±8.68</td>
<td>18.82</td>
<td>3.7</td>
<td>**</td>
</tr>
<tr>
<td>NDF</td>
<td></td>
<td>67.47±11.90</td>
<td>58.13±3.70</td>
<td>85.93±14.30</td>
<td>10.93</td>
<td>1.0</td>
<td>**</td>
</tr>
<tr>
<td>ADL</td>
<td></td>
<td>8.30±0.34</td>
<td>6.72±1.20</td>
<td>6.89±0.62</td>
<td>0.77</td>
<td>3.2</td>
<td>*</td>
</tr>
<tr>
<td>K</td>
<td></td>
<td>4.45±0.79</td>
<td>4.83±1.40</td>
<td>3.85±0.52</td>
<td>0.50</td>
<td>2.3</td>
<td>*</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>3.78±0.60</td>
<td>4.16±0.28</td>
<td>4.46±0.58</td>
<td>0.57</td>
<td>19.2</td>
<td>*</td>
</tr>
</tbody>
</table>

The “a-c” letters within the row shows the significant difference between treatment means at p≤0.05; ** =significant and * = non-significant; DM, CP, ADF, NDF, ADL, K and P are dry matter, crude protein, acid detergent fiber, neutral detergent fiber, acid detergent lignin, potassium and phosphorus respectively; SED =standard error of difference of mean; CV % = percent of coefficient of variance

The categorizing of palatability into three (viz. highly palatable, moderately palatable, and less palatable) was based on the usual use of T. trees by farmers. As observed and information from the sampled household, the preference of livestock for the trees under all tree management is increasing in the dry season. This is due to the unavailability of the grazing fodder in the dry season. This opinion is compatible with the work of Khan and Hussain (2012) in which they report as palatability depends on plant availability in Tehsil (Pakistan).

It has been identified that T. brownii under pruning tree management practice is producing highly palatable and preferred sprout leaves for livestock. This is because, the pruned trees provide the new sprout which is more preferable to cattle and goats and it is true that livestock prefers fresh foliage than dried and non-succulent forage (Abdullah et al., 2017).

The nutrient composition of T. brownii under the three different tree management practices (viz. pollarding, pruning and lopping), the dry matter (DM) in leaves of T. brownii ranged between 36.17 % and 42.37 %. Crude protein (CP) ranged between 4.60 % and 5.50 %, similarly, ash ranged between 8.59 % and 12.23 %, ADF between 59.53 % and 79.30 %, NDF between 58.13 % and 85.93 %, ADL between 6.72 % and 8.30 %, potassium (K) between 3.85 % and 4.83 %, and phosphorus (P) ranged between 3.78 % and 4.46 % which indicates the significant variation among three tree management practices. The dry matter contents of T. brownii were significantly different (P < 0.05) between the tree management practices (Table 2), while pollarding and pruning tree management practices were at par to each other. However, no significant variations in CP contents were recorded for these tree management practices. The content of Ash is significantly varied (P < 0.05) among the tree managements, it was greater under pruning (12.23 %) and lower under lopping (8.59 %).

The content of ADF and NDF are significantly varied (P < 0.05) among the tree management practices for T. brownii. It was observed that, under pollarding T. tree had lower ADF (59.53 %) and NDF (58.13 %) than under pruning (79.30 % and 85.93 %), respectively. The content of ADL under lopping was greater (8.30 %), while it is statistically similar under pollarding and pruning (6.72 % and 6.89 %), respectively. The macro nutrients content of T. brownii under all the three

© 2024 by Journal of Bioresource Management is licensed under CC BY 4.0
tree management practices were also showed significant variation. The K contents of this tree under lopping and pollarding practices were comparable, while significantly varied with that of pruning. Moreover, the P content under pollarding and pruning were comparable, while it is significantly varied (P < 0.05) with that of lopping.

The present study showed that different tree management practices were differently affecting the nutritive value of the fodder trees. For instance, the actual mass of *T. brownii* under pollarding and pruning was higher than lopping. This indicates the tree management practices have direct and indirect effect on bulk production of leaves and on the nutrient content of fodder trees respectively. The increasing and decreasing of fodder tree dry matter can cause over and under feeding of nutrients. The CP content of *T. brownii* under the three tree management practices had lower than the maximum concentration of CP content which is about 11-12 % required for moderate level of ruminant production (ARC, 1980). Harvesting season may affect the content of crude protein in *T. brownii*. This can be agreeing with the report by Girma et al. (2015) and Gebremedhin et al. (2020). Despite this, pruning is probably good to provide crude protein for the small ruminants compared with the rest of the tree management practices identified during the study period.

The Ash content of *T. brownii* under the three tree management practices was ranged between 8.59 % and 12.23 % which was agreed with the result reported by Debela et al. (2017) work entitled as evaluation of the nutritional composition of selected indigenous fodder trees and shrubs. This means the minerals found in *T. brownii* under pruning tree management was moderately good.

In addition to the effect of tree management on the structural composition of *T. brownii* under the three different tree management practices, *T. brownii* had a NDF ranging from 58.13 % to 85 %. This was numerically greater than the 55 % reported by Van Soest (1965) to limit the appetite and digestibility. But it was within the range of the report of Singh and Oosting (1992) who categorized roughage within the range of 45 % to 65 % as a medium quality feed. It was out of the ranges under pruning (85.93 %). These showed that the NDF content of *T. brownii* under pollarding was categorized under medium livestock appetite limit and it was lower under lopping and pruning.

The higher concentration of NDF results in a lower concentration of neutral detergent soluble which is composed primarily of starches, sugars, fats and crude protein (Abdullah et al., 2017). In this study, NDF under pollarding was numerically lower than other tree management practices and it is within the range of medium quality feed. Even though, it is not mean that pollarding is the best tree management practice to have good forage quality and digestibility. Because it has less content of crude protein compared to other tree management practices.

In the result, the ADL content of *T. brownii* under all the tree management practices was within the range of 6.72 % to 8.30 % which was analogous with Santra et al., (2008), Shankute et al. (2012) and Abdullah et al. (2017). The ADL of *T. brownii* under pruning and pollarding has no physical barrier on the ruminant appetite. The result showed that, the concentration of phosphorus in the leaves of *T. brownii* was lower when it was compared with the critical level (7.7g p/Kg DM) which was suggested by national research council (1985). But it was within the range of the level of most fodder tree and shrub species’ that was reported by Rubanza et al. (2006) and Mtengeti et al. (2006) which are 1-5 g/Kg DM.
CONCLUSION

From current study it is concluded that nutrient composition of *T. brownii* leaves get affected by the type of management system that is followed by the farmers. Pruning was comparatively better than the remaining tree management practices across all the evaluated nutrient composition parameters except with ADF, NDF and K. Pruning also results in better palatability than pollarding and looping system of tree management system.

CONFLICT OF INTEREST

This study was sponsored by Arba Minch University and the authors declare that there is no conflict of interest. This work is our original work.

THE AUTHOR’S CONTRIBUTION

The contribution of the 1st author was working as a principal researcher while the two authors’ (2nd and 3rd) contributions were advising and guiding the 1st author throughout the work.

REFERENCES


