EVALUATING THE NUTRITIVE VALUE AND DIGESTIBILITY OF LOWLAND ACACIA SPECIES AS RUMINANT FEED IN TIGRAY, NORTHERN ETHIOPIA

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Kibrom Gebremeskel, Kinfe Mezgebe, Adugna Gesesse (2019); Evaluating the nutritive value and digestibility of lowland acacia species as ruminant feed in Tigray, northern Ethiopia. Journal of the Drylands, 9(SP1): 896-902

A study was conducted in Hawzen (Koraro) to evaluate the nutritive potential, digestibility and tannin content of Acacia tree species. Leaf samples were collected during wet season. Conventional chemical analysis procedures in vitro organic matter digestibility were used to determine the nutritional content of the Acacia species. A wide variability in chemical composition, digestibility and tannin content was recorded. Crude protein content ranged from 11.64 % to 21.38 %. The content of neutral detergent fiber, acid detergent fiber and acid detergent lignin ranged from 26.46 % to 47.59 %, 21.63% to 43.26% and 2.53 % to 6.06 % respectively and was significantly (p<0.001) different among the species. In vitro organic matter digestibility was highest (70.88 %) in Acacia col while the lowest (62.59%) in Acacia glaucocaesia. The values reported for tannin content were ranged from 7.90 g/Kg in Acacia pychantha to 42.25 g/Kg in Acacia saligna local. The ranking order of the acacia species on the basis of their crude protein content was A. saligna local (Tigray) > A. glaucocaesia > A. tumida > A. pychantha > A. victoriae > A. col. The results have shown that the CP content of Acacia species was sufficiently high to warrant consideration of their use as protein supplement to low quality diets. The potential nutritive value of the Acacia species was comparable to other browse and that the species had high digestibility. However, more work especially on animal responses, is needed to affirm the nutritional characteristics reported in this study.

Keywords: Acacia, Feed source, Foliage, In vitro organic matter digestibility, Tannin

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Received: April 18, 2019 Accepted: May 31, 2019

INTRODUCTION

Nutrition is one of the major constraints to animal production in the tropics, particularly the lack of protein during the dry season (Minson 1990). The major use of foliage of browse species is as a source of protein. This quality of browse species is most useful during the dry season when most of the range grasses and other herbaceous species dry off (Muluket et al...
The ability of most browses to remain green in the dry season is attributed to their deep roots that enable them to extract water and nutrients from deep in the soil profile. Moreover, leguminous browse species fix atmospheric nitrogen, and this increases soil fertility that can be utilized by the subsequent crops grown in the area (Atta-Krah 1990). Browse fodder trees and shrubs, which can fit with the existing farming system and are well adapted with the environment and with the economic realities of farmers. The main features of such plants as a feed resource are their high crude protein content. Previous studies have shown that a range of 9.7% to 24.5% CP was recorded for the browse species in different regions of Ethiopia (Mohammed 2009, Samson 2010, Zewdie 2010).

Acacia species can be used to combat desertification, mitigate the effects of droughts, allow soil fixation and enhance the restoration of the vegetation and the rehabilitation of rangelands. Browsing tree foliage plays an important role in ruminant feeding systems in many tropical environments around the world (Mahipala et al 2009). *Acacia saligna* is one of the introduced browse tree species, which is widely grown and evergreen in different agro-ecological zones of Tigray (Shumuye and Yayneshet 2011). *A. saligna* has reasonably large amount of crude protein (Kibrom et al 2019) which has the potential to supplement the mainly poor quality fibrous feeds widely used by smallholder farmers. Studies have indicated that seed pods of some Acacia species such as *A. tortilis* and *A. albida* as well as leaves of *A. brevispica* when offered as supplements to poor-quality roughages, give live weight gains comparable with those of livestock fed oilseed cakes and *Medicago sativa* (Tanner et al 1999). Currently, there are lowland Acacia species planted for the purpose of adaptation and evaluation. But their nutritive value and digestibility are not yet studied. Therefore, the objective of this study was to determine chemical composition, *in vitro* organic matter digestibility (IVOMD) and tannin content of the Acacia species foliage used to feed ruminants.

**MATERIALS AND METHODS**

**Description of the study area**

The study was conducted in Hawzen district of Tigray Regional State in Northern Ethiopia (Koraro Rural Kebele). The altitude of the study area lies as low as 1500 m.a.s.l (meter above sea level). With an average annual rainfall amount of 500 mm, the village frequently experiences shortage of rain, and frequently suffers from late onset or early withdrawal of rainfall or both. The area is virtually split into two major soil textural classes: sandy (49%) and sandy-silt/loam (51%), which are both classified as Arenosols according to the FAO classification. The soils are severely degraded from erosion with no topsoil remaining in most of the area. Lowland Acacia species had been grown in a replicates trial since planting in 2012.

**Foliage sample collection and preparation**

The foliage samples of the five lowland *Acacia* species were collected for chemical composition analysis and *in vitro* Organic Matter Digestibility (IVOMD). Samples were collected by hand picking from randomly selected, nine individual Acacia trees of each species. The samples were taken at three heights (top, middle and bottom of the tree) during wet season (Late August). From each Acacia species, leaves were collected; thoroughly mixed, and three composite samples were taken for laboratory analysis. From one composite sample for each species, one sub samples were taken for laboratory analysis. The samples were air dried in a well-ventilated room until transported to laboratory and further dried in an oven at 65°C for 72 hours. Each of the samples were ground in a Willey mill to pass through a 1 mm sieve (for chemical analysis) The samples were then placed in plastic bags, sealed and kept for further analysis.

**Chemical composition analysis**

Triplicate samples of each *Acacia* species was taken for chemical composition analysis. Dry matter content of the different samples (foliage) was determined by oven drying the samples at 105°C for 24 hours. Total Nitrogen (N) was determined by the Kjeldahl method (AOAC 1990). Crude protein (CP) was calculated as N x 6.25. Ash was determined by complete burning of the feed samples in a muffle furnace at 500°C overnight according to the procedure of AOAC (1990). The structural plant constituents: Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Acid Detergent Lignin (ADL) were analyzed using the detergent extraction method (Van Soest et al 1991). The fat content was estimated according to the procedure of AOAC (1990). Condensed tannin content was determined according to (Burns, 1971).

**In vitro organic matter digestibility**

In *vitro* Organic Matter digestibility (IVOMD) of foliage samples was determined by the method of Tilley and Terry (1963) as modified by Van Soest and Robertson (1985). About 0.5 g of the samples was incubated in 125 ml Erlenmeyer flasks containing rumen fluid-medium mixture for 48 hours in a water bath maintained at 39°C. After the first 48 hrs of incubation, 35 ml of pepsin solution was added to the flasks and again incubated for another...
48 hrs in a 39°C water bath. Shaking flasks was done at 2, 4, and 6 hrs after pepsin addition. Moreover, metabolisable energy contents of the feeds were estimated from in vitro organic matter digestibility using the equation of (McDonald et al 2002). ME (MJ/kg) = 0.016 DOMD (g/Kg DM), Where: DOMD = Digestible Organic Matter in the Dry matter.

**Statistical analysis**
Results of the chemical composition, tannin and in vitro organic matter digestibility (IVOMD) were subjected to the one way analysis of variance (ANOVA) using a general linear model (GLM) of SAS 9.3 (SAS Institute 2002). Tukey test at P<0.05 was used to compare the treatment means.

**RESULTS**

**Chemical composition of Acacia species**
The CP, NDF, ADF, ADL, Ash and tannin contents were significantly (p<0.001) varied. Higher value of CP was observed for *Acacia Saligna Local (Tigray)* (21.38%) followed by *Acaci Tumida* (16.45%) and *Acacia Glaucocaesia* (16.39 %) while lowest in *Acacia Coli* (11.64 %). The highest fat content was recorded for *Acacia pychantha* (8.63 %) and the lowest was recorded for *Acacia Saligna Local* (Tigray) (2.73) and *Acacia Glaucocaesia* (42.25g/Kg) and the lowest value was in *Acacia Pychantha* (7.90 g/Kg) (Table 1).

**Table 1**: Chemical composition and tannin content of the lowland Acacia species leaf

<table>
<thead>
<tr>
<th>Acacia species</th>
<th>DM (%)</th>
<th>g/Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CP</td>
<td>Fat</td>
</tr>
<tr>
<td><em>Acacia Coli</em></td>
<td>91.82</td>
<td>11.64&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td><em>Acacia Victoriae</em></td>
<td>91.64</td>
<td>13.74&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td><em>Acacia Pychantha</em></td>
<td>93.64</td>
<td>14.22&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td><em>Acacia Tumida</em></td>
<td>93.57</td>
<td>16.45&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td><em>Acacia Saligna Local</em></td>
<td>91.91</td>
<td>21.38&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td><em>Acacia Glaucocaesia</em></td>
<td>90.41</td>
<td>16.39&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

| SEM                     | 0.34   | 0.14     | 0.23     | 0.13    | 0.11   |
| p                       | 0.0001 | 0.002    | 0.0001   | 0.0001  | 0.0001 |

<sup>a-f</sup> Mean values with different superscripts in a column are different at p<0.05; DM = Dry Matter; OM = Organic Matter; CP = Crude protein; SEM = Standard error of the mean.

Fiber content and In vitro Organic Matter Digestibility (IVOMD) of the *Acacia* species are presented in Table 2. The NDF content varied from 26.46% to 47.59 %. Maximum NDF value was recorded for *Acacia Tumida* (47.59%) whereas minimum value was recorded for *Acacia Glaucocaesia* (26.46 %). ADF also ranged between 21.63% and 43.26%. The highest content of ADF was measured for *Acacia Tumida* (43.26%) while the least ADF content was recorded for *Acacia Glaucocaesia* (21.63%). The least ADL content was recorded in *Acacia Coli* (2.53%) whereas a maximum value was determined in *Acacia Tumida* (6.06%). IVOMD value of the *Acacia* species, varied from 62.59% in *Acacia Glaucocaesia* to 70.88% in *Acacia Coli*. The maximum EME value was found for *Acacia Coli* (11.34%), while the minimum was for *Acacia Glaucocaesia* (10.01%).
DISCUSSION
Chemical composition of Acacia species

The values of crude protein (CP) content of Acacia species in the present study fall within the range reported by previous studies (Abdulrazak et al 2000, Robyn A et al 2002, Alam et al 2006) who reported that CP value of Acacia species range from 13.07% to 25.62%. With the exception of Acacia colli, the rest are in the range with those reports (Range: 13.74% to 21.38%). Values of CP content of lowland Acacia species in the present study are less than within the current studies by Kibrom et al (2019) who reported that midland Acacia species provenances ranged from 16.4% to 28.3%. The CP content in all of the Acacia species in the current study were well above the minimum CP level of 80 g/kg DM for ruminant diets (Minsom 1990). This justifies the use of all the lowland Acacia species as supplements to the low quality crop by products consumed by ruminant. The CP concentration above the threshold CP content (11-12%) is required for moderate level of ruminant production (ARC 1980) and a minimum of 15% CP is required for lactation and growth (Norton 1982).

NDF content was greater than the previous reports of Boufennara et al (2013) and Gebekeyew K et al (2015) who reported that NDF value of Acacia species to range from 18.6% to 24.5%. This could be attributed to differences in species, agro-ecology, stage of maturity at harvest and harvesting season. NDF content above 55% was reported by Van Soest (1994) to limit appetite and digestibility. Singh and Oosting (1992) also categorized roughages with NDF content of 45-65% as a medium quality feed, while feeds with NDF below 45% as high quality feeds. However, it is interesting to note that there is no Acacia species of the present study that is up to that threshold level. Tree forages with a low NDF concentration (20-35%) are usually of great digestibility (Bakshi and Wadhwa 2004).

ADF content had highly significant differences among the Acacia species. In the present finding, the ADF content was in range with the previous reports of Boufennara et al (2013) who reported that ADF value of Acacia species to range from 9.2% to 26.7%. Except Acacia Coli, ADF value was higher than the previous reports. This could be a result of a presence of wide variations in the macroclimate of the study area, species and possibly differences in the stage of maturity of the Acacia tree. ADF content may have lower digestibility since digestibility of feeds and ADF content are negatively correlated (McDonald et al 2002). According to Kellem and Church (1998) roughages with less than 40% ADF are categorized as high quality and those above 40% as low quality. Lowland Acacia species sampled from the study area had ADF value below 40% except Acacia tumida (43.26%).

The ADL content of Acacia species included in this study is less than within the 4.67% to 15.9% of indigenous browse species ranges reported by others (Boufennara et al 2012, Ogumbosoye and Babayami 2010). Values ranging from 7.23% to 20.28% were also reported by others (Njidda et al 2013, Kassahun et al 2016). This variation could be due to differences in species, stage of maturity and seasons of harvest. Lignin is completely indigestible and it forms lignin cellulose/ hemicelluloses complexes (Kellem and Church 1998) making the cell wall content unavailable to microbial enzymes (McDonald et al 1995). Nevertheless, the maximum level of lignin content of all browse species investigated was 10% which is likely to limit DM intake (Reed et al 1986).

In vitro Organic Matter Digestibility (IVOMD) of Acacia species reported in this study was higher than the 56% to 66% reported earlier for tropical browse species (Sanon 2007, Zewdie 2010).

Table 2: Fiber fractions and In vitro Organic Matter Digestibility (IVOMD) of the lowland Acacia species leaf

<table>
<thead>
<tr>
<th>Acacia species</th>
<th>NDF (%)</th>
<th>ADF (%)</th>
<th>ADL (%)</th>
<th>IVOMD (%)</th>
<th>EME (MJ/Kg DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acacia Coli</td>
<td>32.64a</td>
<td>23.74a</td>
<td>2.53d</td>
<td>70.88a</td>
<td>11.34a</td>
</tr>
<tr>
<td>Acacia Victoriae</td>
<td>36.35a</td>
<td>31.22a</td>
<td>5.14a</td>
<td>64.70a</td>
<td>10.35a</td>
</tr>
<tr>
<td>Acacia Pycantha</td>
<td>41.55b</td>
<td>29.88d</td>
<td>3.43b</td>
<td>65.78cd</td>
<td>10.52d</td>
</tr>
<tr>
<td>Acacia Tumida</td>
<td>47.59a</td>
<td>43.26a</td>
<td>6.06b</td>
<td>67.80b</td>
<td>10.84d</td>
</tr>
<tr>
<td>Acacia Saligna local</td>
<td>38.15c</td>
<td>36.15b</td>
<td>5.37b</td>
<td>66.65c</td>
<td>10.63bc</td>
</tr>
<tr>
<td>(Tigray)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acacia Glaucoacaesia</td>
<td>26.461</td>
<td>21.631</td>
<td>3.181</td>
<td>62.59f</td>
<td>10.01f</td>
</tr>
<tr>
<td>SEM</td>
<td>0.06</td>
<td>0.16</td>
<td>0.09</td>
<td>0.36</td>
<td>0.055</td>
</tr>
<tr>
<td>p</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.003</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Note: *Mean values with different superscripts in a column are different at p<0.05; DM = Dry Matter; NDF = Neutral detergent fiber; ADF = Acid detergent fiber; ADL=Acid detergent lignin; IVOMD=Invitro Organic Matter Digestibility; ME=Estimated Metabolisable Energy; SEM =Standard error of the mean.
Minson (1990) indicated that organic matter digestibility varies with the proportion of cell contents and cell wall constituents. The cell contents are digestible, while cell wall digestion depends on the degree of lignifications, the activity of rumen microbes, and the time the forage is retained in the rumen. The higher digestibility values could be partially attributed to the higher CP content of the feeds while the lower digestibility records might be associated with higher proportion of NDF, ADF, and lignin (Moore and Jung 2001, Tessese 2008).

Tannin contents of the leaves of Acacia species were significantly (P<0.001) varied. According to Kumar and Vaithiyathan (1990) and Ologhobo et al (1989), tannins’ levels in excess of 50 g/kg dry matter can lead to low palatability, reduce digestibility, lower intake, inhibit digestive enzymes and be toxic to rumen micro-organisms. From 2-4 % tannins in the diet protects protein from rumen degradation and increases the absorption of essential amino acids (Terrill et al 1992, Barry and McNabb 1999). Accordingly, Tannin contents of the Acacia species leaf were lower than this range. The Acacia species shows high protein content and its foliage is highly digestible probably due to its low tannin content.

CONCLUSIONS
In conclusion, it is generally believed that the lowland Acacia species in this study were superior in terms of nutritive value, In vitro Organic Matter Digestibility and tannin content. The nutritional composition of these lowland Acacia species showed that they can be utilized as sole feed or supplements to balance low quality forages for ruminants due to the high CP level, digestibility and low anti-nutrient composition. It is recommended to conduct animal feeding and digestibility trials by supplementing with the promising Acacia species to animals fed on poor quality roughages, and appropriate entry point of the promising Acacia species should be identified with respect to the prevailing socioeconomic and environmental realities of the area.

ACKNOWLEDGMENTS
We would like to give their deep appreciation to NOW-WOTRO for provision of primary funding for this research. We are also grateful to Tigray Agricultural Research Institute (TARI) and World Vision Australia (WVA) for their financial support. We would like to express our deepest respect, most sincere thanks and heart-felt appreciation to Peter Cunningham (Consultant, Australia) and Professor Frans (Wageningen University, Netherlands) for their unreserved support, valuable comments and suggestions from the very beginning of research idea until the successful completion of the thesis write-up.

REFERENCES


Agricultural Research Council (1990): (Great Britain) and Commonwealth Agricultural Bureaux. The nutrient requirements of ruminant livestock: technical review (No. 2). CAB Intl.


Tanner JC, Reed JD and Owen E (1990): The nutritive value of fruits (pods and seeds) from Acacia species compared with extracted nough (Guizonia abysinica) meal as supplement to maize stover for Ethiopian highland sheep. Journal of Animal Science 51: 127-133.

