The present study augmented the nutritional status of *Melia azedarach,* *Albizia procera,* *Mangifera indica* and *Leucaena leucocephala* tree leaves for ruminants. The analysis of leaves revealed that dry matter (DM) contents varied from 230 g/kg in *M. azedarach* to 470 g/kg in *A. procera.* Crude protein (200 g/kg DM) and hemicellulose (171 g/kg DM) were highest, while, acid detergent lignin (50 g/kg DM) and ash (70 g/kg DM) contents were lowest in *L. leucocephala.* Highest neutral detergent fiber (NDF; 490 g/kg DM) and acid detergent fiber (330 g/kg DM) were observed for *A. procera.* Metabolizable energy was highest for *M. azedarach* (9.07 MJ/kg), whereas, lowest for *L. leucocephala* (5.77 MJ/kg). The Ca, P and Na were highest in *A. procera,* K in *M. azedarach,* and Mg in *L. leucocephala.* The Ca:P ratio was much wider among these tree leaves. Highest in sacco DM (78.4%) as well as NDF (62.1%) digestibility and shorter DM lag time (0.66h) were observed for *M. azedarach.* Higher rate of DM and NDF disappearance was observed for *M. indica* and *L. leucocephala,* respectively. Highest extent of DM (80.2%) and NDF digestion (68%) were evident for *M. azedarach,* whereas, shorter NDF lag time was noticed for *M. azedarach* and *L. leucocephala.* Based on chemical composition and in sacco digestion kinetics, selected tree species proved to be potential supplement for ruminants and ranked as *M. azedarach* followed by *A. procera,* *L. leucocephala* and *M. indica.* Wide Ca to P ratio suggests supplementation of cereal byproducts having high level of P with these tree leaves when fed to ruminants.

**Key words:** Tree leaves, chemical composition, secondary metabolites, digestion kinetics.

**INTRODUCTION**

Adequate supply of nutrients from any feed resource depends upon the quantity as well as quality of feed which in turn affects productivity of ruminants. As conventional feed resources are scarce the availability of protein and energy to fulfill the requirements of ruminants, so other possible avenue is to find out non-conventional feed resources which do not compete with human feed (Raghuvansi et al., 2007).

Fodder tree leaves present an alternative feed source for ruminants (Bakshi and Wadhwa, 2007) and can help to minimize the wide gap between demand and supply of nutrients. Supplementation of tree leaves have positive impact on ruminal microbial growth and digestion, resulting in improved animal growth and enhanced productivity in ruminants (Bonsi et al., 1995, Tessema and Baars, 2004). It has been observed that fodder trees under investigation are commonly available in the field and they are relish to small ruminant browsers especially goats.

Digestion kinetics of feeds not only helps to understand the availability of nutrients but also helps to develop a strategy to avoid uncoupling of nutrients at ruminal level resulting to optimize the ruminal fermentation and ultimately the animal productivity (Sarwar and Chaudhry, 2000). Therefore, judicious use of available nutrients from existing feed resources can
increase the nutrient availability for the ruminant production. In view of little information on the nutritive value of fodder tree leaves especially digestion kinetics and metabolizable energy (ME), therefore, the present study was planned to figure out the nutritional value of fodder tree leaves i.e., chemical composition, macro mineral profile, secondary metabolites and digestion kinetics. Secondary metabolites which directly affect digestion mechanism which in turn affect availability of nutrient recovery at cellular and tissue level.

MATERIALS AND METHODS

Harvesting and preparation of tree leaves

Four indigenous fodder trees, five for each species, Leaves of *Melia azedarach*, *Albizia procera*, *Mangifera indica* and *Leucaena leucocephala* (Table 1) were collected from district Faisalabad in Punjab province, Pakistan during April, 2008. Each tree was sampled from five sites (east, west, north, south and canopy), labbed. The collected leaves were dried in forced air oven at 55°C, ground to pass a 2 mm sieve in Willey mill and saved in polythene bags by making composite sample from each tree.

Chemical analysis

Dry matter (DM) content was determined by drying the sample at 105°C in forced air oven till the constant weight. Ash content were measured after igniting sample in a muffle furnace at 550°C for 4 h. Crude protein (CP) was determined by Kjeldahl method (AOAC, 1995). Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined by methods of Van Soest et al. (1991) without the use of alpha amylase but with use of sodium sulfite. After wet digestion (nitric acid and perchloric acid), the P concentration was determined by the spectrophotometer (U 1100, Hitachi), the flame photometer (Jenway PFP7) was used to estimate Na and K concentrations. The Ca and Mg concentrations were determined colorimetric method. All chemical analyses were repeated three times. Digestible energy (DE) was calculated by determining the gross energy (Harris 1970) of tree leaves and residues of leaves at 48 hour (h) of incubation of in sacco trial. This estimation of DE was further used for the calculating ME contents by using following equation (NRC, 2001). $ME = 1.01 \times DE - 0.45$.

Total phenolics were determined by using Folins-Ciocalteu reagent method described by Ainsworth and Gillespie (2007). All the samples were extracted in methanol. In 100mL of each sample 200uL of F-C reagent was added and sample were vortexed thoroughly. 800uL of 700 mM Na$_2$CO$_3$ were added into each sample and incubated at room temperature for 2 h. Then 200uL sample was transferred to a clear 96-well plate and absorbance of each well was measured at 765nm. Amount of total phenolics were calculated using a calibration curve ($R^2$: 99.27) for Gallic acid. The results were expressed as Gallic acid equivalent per dry matter (Ainsworth and Gillespie, 2007). Tannins were determined by vanillin hydrochloride method. One gram of the ground plant material was extracted in 50 mL of methanol, mixed occasionally and after 24 h centrifuge at 12000xg and the supernatant was collected. In one mL of supernatant 5mL vilillin hydrochloride reagent was added, mixed and incubated at room temperature.

The absorbance was noted at 500 nm on microquant spectrophotometer (BioTech, USA). The calibration curve catechin was use as standard for the calculation of tannins (Thimmaiah, 2004). Saponin was estimated by the method reported by Saddiqui and Ali (1997). For the determination of alkaloids, 5g of powdered plant material was taken. Its paste with 5% sodium carbonate solution was prepared, transferred into a flask and 75mL of chloroform was added. The material was refluxed for 15 minutes, then cooled and filtered. Filtrate was transferred to a separator; 40mL of 5% sodium carbonate solution was added, and agitated gently for 7 minutes. Chloroform layer was taken off and reduced to the volume of about 10mL by distillation. 40mL of 1% sulphuric acid was added, and extracted with two 20mL volume of chloroform. Aqueous phase was separated using separating funnel. It was made alkaline with ammonium hydroxide, and extracted with 10mL portions of chloroform. Chloroform layers were combined, and washed with 5mL of water. The total volume of fraction obtained was reduced to 5mL by distillation. Chloroform was transferred to a crystallizing dish and remove remainder of chloroform through evaporation in a vacuum hood. 2mL of absolute alcohol was added to residue and evaporated to dryness at 100°C and solid residue obtained was crude alkaloid.

<table>
<thead>
<tr>
<th>Local name</th>
<th>Botanical name</th>
<th>Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bakain</td>
<td><em>Melia azedarach</em></td>
<td>Meliaceae</td>
</tr>
<tr>
<td>Sirin</td>
<td><em>Albizia procera</em></td>
<td>Mimosaceae</td>
</tr>
<tr>
<td>Mango</td>
<td><em>Mangifera indica</em></td>
<td>Anacardiaceae</td>
</tr>
<tr>
<td>Ipil ipil</td>
<td><em>Leucaena leucocephala</em></td>
<td>Mimosaceae</td>
</tr>
</tbody>
</table>

Table 1: Local and botanical name of trees.
Table 2: Chemical composition of fodder tree leaves (g/kg DM).

<table>
<thead>
<tr>
<th>Items</th>
<th>M. azedarach</th>
<th>A. procera</th>
<th>M. indica</th>
<th>L. leucoephala</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
<td>230</td>
<td>470</td>
<td>452</td>
<td>301</td>
<td>15.2</td>
</tr>
<tr>
<td>Organic matter</td>
<td>921</td>
<td>920</td>
<td>870</td>
<td>930</td>
<td>18</td>
</tr>
<tr>
<td>Crude protein</td>
<td>162</td>
<td>151</td>
<td>90</td>
<td>200</td>
<td>11</td>
</tr>
<tr>
<td>NDF</td>
<td>330</td>
<td>490</td>
<td>433</td>
<td>361</td>
<td>14.7</td>
</tr>
<tr>
<td>ADF</td>
<td>240</td>
<td>330</td>
<td>271</td>
<td>190</td>
<td>12.4</td>
</tr>
<tr>
<td>Hemicellulose</td>
<td>90</td>
<td>160</td>
<td>162</td>
<td>171</td>
<td>7.8</td>
</tr>
<tr>
<td>ADL</td>
<td>60</td>
<td>90</td>
<td>80</td>
<td>50</td>
<td>4.2</td>
</tr>
<tr>
<td>Ash</td>
<td>79</td>
<td>80</td>
<td>130</td>
<td>70</td>
<td>3.7</td>
</tr>
<tr>
<td>ME, MJ/kg</td>
<td>9.07</td>
<td>7.57</td>
<td>6.35</td>
<td>5.77</td>
<td>0.54</td>
</tr>
</tbody>
</table>

SE, NDF, ADF, ADL and ME stand for standard error, neutral detergent fiber, acid detergent fiber, acid detergent lignin and metabolizable energy.

\[
Yield \text{ of Alkaloids (\%)} = \frac{\text{Weight of Alkaloids obtained}}{\text{Total Weight of Sample}} \times 100
\]

In sacco trial

An in sacco trial was conducted to examine the digestion kinetics of leaves of selected tree species. Nylon bags measuring 10×23cm with an average pore size of 50µm were used to determine digestibility, rate of disappearance, lag time and extent of digestion of DM and NDF. A mature ruminally cannulated buffalo bull (350±10kg) was used to study in sacco digestion kinetics of tree leaves. The bull was fed a blend of berseem fodder (*Trifolium Alexandrinum*) and concentrate along with leaves of these trees to meet the nutritional requirements for 35 days. Initial 10 days were adjustment phase whereas following 25 days were for data collection. For each time point, there were 3 bags. Ground samples were weighed (5g on DM basis) into nylon bags. The bags were manually pushed deep into the liquid phase of the ventral sac of rumen and incubated for 0, 3, 6, 12, 24, 36, 48 and 72h. The bags were placed in the rumen in a reverse sequence. All bags were removed at the same time to reduce variation associated with the washing procedure. After removal from the rumen, the bags were washed in running tap water until the rinse was clear. These bags were dried in forced air oven at 60°C for 48h. The bags were weighed and the residues were transferred into bottles and stored for analysis. Digestibility was calculated at 48h of incubation. Rate of disappearance was determined by subtracting the indigestible residue i.e. the 72h residue from the amount in the bag at each point and then regressing the natural log (ln) of that value against time (Sultan et al., 2004). Extent of digestion was determined at 72h of incubation. Lag time was determined by the procedure of Sarwar et al. (1998). The equation for lag time calculation is as follows.

\[
\text{Lag time (h)} = (\ln 100) - \text{Intercept} / \text{Rat of digestion}
\]

\[
Y = \mu + \text{season} + \text{location} + \text{Error}
\]

\[
\mu \text{ is overall mean}
\]

\[
\text{Season= spring and autumn}
\]

\[
\text{Location=1-5}
\]

Statistical analysis

The data collected to find the digestion kinetics parameter like (digestibility, lag time, rate of digestion and extent of digestibility) were analyzed using analysis of variance in a completely randomized design and means were compared by least significant difference test (SPSS, 1999).

RESULTS

Chemical composition

The DM concentration (g/kg) varied from 230 for *M. azedarach* to 470 for *A. procera* (Table 2). *L. leucoephala* contained highest CP (200 g/kg DM) while lowest CP observed for *M. indica* (90 g/kg DM). The NDF contents (g/kg DM) of *A. procera* were higher (490) and lowest in *M. azedarach* (330). The ADF contents (g/kg DM) of *A. procera* were higher (330) and lowest in *L. leucoephala* (190). Highest ADL (90g/kg DM) was observed for *A. procera* and lowest in *L. leucoephala* (50). Highest hemicellulose (170g/kg DM) was observed for *L. leucoephala* and lowest for *M. azedarach* (90g/kg DM). Highest ash (130 g/kg DM) was observed for *M. indica* while lowest for *M. azedarach* and *A. procera* (70 g/kg DM). The ME contents were 9.07, 7.57, 6.35 and 5.77 MJ/kg for *M. azedarach, A. procera, M. indica* and *L. leucoephala*, respectively determined at 48 h of incubation.

Mineral composition

As shown in Table 3, Ca concentration (g/kg DM) varied from 16 for *L. leucoephala* to 44 for *A. procera*. The P concentration (g/kg DM) ranged from 0.6 for *L. leucoephala* to 4.5 for *A. procera*. The Ca to P ratio was
Table 3: Mineral composition of fodder tree leaves (g/kg DM).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>M. azedarach</th>
<th>A. procera</th>
<th>M. indica</th>
<th>L. leucoephala</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca</td>
<td>32</td>
<td>44</td>
<td>38</td>
<td>16</td>
<td>2.9</td>
</tr>
<tr>
<td>P</td>
<td>1</td>
<td>4.5</td>
<td>2.7</td>
<td>0.6</td>
<td>0.11</td>
</tr>
<tr>
<td>Mg</td>
<td>1.2</td>
<td>9.6</td>
<td>8.4</td>
<td>16.8</td>
<td>0.14</td>
</tr>
<tr>
<td>Na</td>
<td>4</td>
<td>5.5</td>
<td>6.8</td>
<td>5.3</td>
<td>0.12</td>
</tr>
<tr>
<td>K</td>
<td>20</td>
<td>10.8</td>
<td>10.9</td>
<td>19</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Se stands for standard error.

Table 4: Antinutritional factors in tree leaves (g/kg DM).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>M. azedarach</th>
<th>A. procera</th>
<th>M. indica</th>
<th>L. leucoephala</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total phenolics</td>
<td>29.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>48.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>53.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>19.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.3</td>
</tr>
<tr>
<td>Tannins</td>
<td>6.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>33.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>21.3&lt;sup&gt;c&lt;/sup&gt;</td>
<td>11.8&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.1</td>
</tr>
<tr>
<td>Alkaloids</td>
<td>1.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>ND</td>
<td>2.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>ND</td>
<td>0.4</td>
</tr>
<tr>
<td>Saponin</td>
<td>ND</td>
<td>ND</td>
<td>4.8</td>
<td>ND</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Se stands for standard error.

Table 5: In sacco dry matter digestion kinetics of fodder tree leaves.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>M. azedarach</th>
<th>A. procera</th>
<th>M. indica</th>
<th>L. leucoephala</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digestibility</td>
<td>78.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>57.8&lt;sup&gt;c&lt;/sup&gt;</td>
<td>55.8&lt;sup&gt;c&lt;/sup&gt;</td>
<td>56.4&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>2.9</td>
</tr>
<tr>
<td>Lag time (h)</td>
<td>0.66&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.94&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.69&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.73&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.03</td>
</tr>
<tr>
<td>Rate&lt;sup&gt;1&lt;/sup&gt;</td>
<td>5.71&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.86&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.97&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.77&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.12</td>
</tr>
<tr>
<td>Extent</td>
<td>80.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>77.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>57.2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>58.2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Means within column with same superscripts are not statistically different (p<0.05).
Dry matter digestibility (%) was determined at 48 h of incubation.
Extent of digestion (%) was determined at 72 h of incubation.
<sup>1</sup>Rate of disappearance, %/h.

32.0, 9.78, 14.07 and 26.67 for *M. azedarach*, *A. procera*, *M. indica* and *L. leucoephala*, respectively. The Mg concentration (g/kg DM) varied from 1.2 for *M. azedarach* to 16.8 for *L. leucoephala*. The Na concentration ranged from 4 (M. azedarach) to 6.8g/kg DM (M. indica). The K concentration (g/kg DM) was found highest for *M. azedarach* (20) and lowest for A. procera (10.8).

**Secondary metabolites**

Total phenolics were higher (p<0.05) in *A. procera* and *M. indica* than *M. azedarach* and *L. leucoephala* (Table 4). Concentration of tannins was different across all tree leaves. Alkaloids concentration in *M. indica* was higher (p<0.05) than *M. azedarach*. Saponins were observed only in *M. indica*.

**In sacco dry matter and neutral detergent fiber digestion kinetics**

The DM degradability of *M. azedarach* was higher (p<0.05) than other tree leaves (Table 5). The DM lag time was shorter for *M. azedarach* and greater for *A. procera*. Rate of DM disappearance was highest for *M. indica* and lowest for *A. procera*. Extent of DM digestion at 72 h of incubation was highest for *M. azedarach* and lowest for *M. indica*. The NDF degradability was highest for *M. azedarach* while lowest for *L. leucoephala* (Table 6). The NDF lag time was shorter for *M. azedarach* and greater for *A. procera*. Rate of NDF disappearance was highest for *L. leucoephala* and lowest for *A. procera*. Extent of NDF digestion at 72 h of incubation was highest for *M. azedarach* and lowest for *L. leucoephala*.

**DISCUSSION**

The chemical analysis values observed in this study were in line with other researchers (Kundu et al. 1988; Chander Datt et al. 2007; Chander et al. 2008). Crude protein concentration was higher than most of cultivated fodders. Dietary level of CP less than 10% adversely affect rumen fermentation (Alam and Dijanigra 1994), however, in this study, CP level in selected tree species was higher than 15% except *M. indica* (9%). Similarly, Venura et al. (2004) reported that fodder tree leaves
contain higher level of CP. Differences in CP contents between leaves of different trees might be due to differences in protein accumulation in them during growth. High ADF content of A. procera and M. indica was due to their high ADL contents. Mandal (1997) reported that the hemicellulose content of the tree leaves varied from 100 to 150g/kg DM. High ash of M. indica indicates rich source of minerals. Likewise, Mandal (1997) reported that ash contents of most of the tree leaves varied from 60-150g/kg DM. High value of ME availability for M. azedarach might due to its high DM digestibility and better quality of NDF. Variation in chemical composition of tree leaves might be due to different geographical distribution of plant species, climate and maturity. In line with the previous studies, the chemical composition of the leaves of plant species analyzed here provides a good source to be used as the nutrient source for ruminant.

The Ca contents were higher than the dietary requirements of dairy cattle (4.3-6.0g/kg DM of diet) recommended by NRC (2001). Ruminants can tolerate Ca up to 20g/kg DM of diet (NRC 1985). Concentration of Ca >10 g/kg of diet DM have been associated with lower DM intake. The excess Ca can interfere with trace mineral absorption (especially Zn) and lower performance of animal (NRC 2001). The observed values of P for M. azedarach (1 g/kg DM) and L. leucocephala (0.6g/kg DM) were found lower than minimum requirements of P (2g/kg DM) reported by McDowell et al. (1984). Likewise, Saha and Gupta (1987) reported that tree leaves are rich in Ca and poor in P. The Ca to P ratio was much wider as compared to those recommended for ruminants (McDowell, 1997) and it should be adjusted to normal one (2:1 to 4:1) by supplementation with P for their proper utilization in the animal system (McDowell 1992) when tree leaves are considerable part of ruminant ration. Ruminant can tolerate Ca:P ratio as wide as 7:1 (NRC, 1985) and higher Ca:P ratio reduces absorption of P (NRC, 2001). The Mg contents observed in present study can fulfill requirement (1.2-1.8g/kg of diet DM) of small ruminants (NRC, 1985). Maximum tolerable level of K is 30g/kg of diet DM (NRC 1980) and increasing dietary level of K from 7 to 30g/kg of diet DM linearly decreased the energy and weight gain in lambs (NRC, 1985).

The Ca, P and K values determined in present study were somewhat higher than reported by Vercoe (1987). The chemical compositions of tree leaves vary with different localities (Mandal, 1997).

Higher mineral contents of the plants species in this study as compared to previous reports further provokes their use a good alternative for animal feed. Tree leaves were found to have in sacco DM digestibility values above 55 % indicating their potential for use in ruminant ration. Higher DM digestibility observed for M. azedarach might be due its lower NDF content as well as high NDF digestibility. The extent to which the cell wall of different plant tissues is colonized and digested by bacteria differs greatly (Mandal 1997). Lower NDF digestibility for L. leucocephala might be due to its lower quality. Greater NDF lag time for A. procera might be due to nature of cell wall. The differences in rate of different fodder tree leaves may be due to chemical or physical nature of the fiber. Lignin causes depression in digestibility by physical encrustation and chemical bonding with structural carbohydrates while polyphenols or tannins inhibit the activity of rumen microbial enzymes thus lowering down the fermentative rate which in turn causes a decline in digestibility and ME contents of feeds (Makkar et al. 1988; Martin et al. 1998). Higher DM degradability of M. azedarach might be due to its lower level of phenolics and tannins than other tree leaves. Cattle can be safely fed L. Leucocephala leaves up to a level of 30% DM basis (Chander et al. 2008).

Secondary metabolites such as alkaloids, saponins and tannins can reduce the nutrient availability and subsequently animal productivity (Thomson et al., 1987; Makkar and Goodchild, 1996). Tannin values (6.3–33.7 g/kg DM) observed in this study were in the range (6–74g/kg DM) as reported by Rubanza et al. (2003), however, TP values (19.3–52.2 g/kg DM) noted in present study were lower than values (65–237g/kg DM) reported by the same authors. Stage of plant growth (Salem, 2005) and site of sampling (Makkar and Becker, 1998) can affect the level of secondary metabolites.

Tannins bind to proteins in the mouth reducing the palatability of the feed and subsequently decrease feed

---

Table 6: *In sacco* neutral detergent fiber digestion kinetics of fodder tree leaves.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>M. azedarach</th>
<th>A. procera</th>
<th>M. indica</th>
<th>L. leucocephala</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digestibility</td>
<td>62.1 a</td>
<td>44.1 b</td>
<td>40.0 c</td>
<td>35.1 d</td>
<td>2.97</td>
</tr>
<tr>
<td>Lag time (h)</td>
<td>0.76 c</td>
<td>0.97 a</td>
<td>0.88 b</td>
<td>0.77 c</td>
<td>0.03</td>
</tr>
<tr>
<td>Rate 1</td>
<td>5.86 b</td>
<td>5.03 a</td>
<td>5.06 b</td>
<td>5.97 d</td>
<td>0.13</td>
</tr>
<tr>
<td>Extent</td>
<td>68.0 a</td>
<td>73.6 a</td>
<td>49.8 c</td>
<td>36.4 a</td>
<td>4.5</td>
</tr>
</tbody>
</table>

SE stands for standard error
Means within column with same superscripts are not statistically different (p<0.05).
Dry matter digestibility (%) was determined at 48 h of incubation.
Extent of digestion (%) was determined at 72 h of incubation.
1Rate of disappearance, %/h.
intake. Tannins have astringent effects on the epithelium of oral cavity and foregut leading to lower DM intake (Silanikove et al. 2001). Tannins have ability to bind and inhibit the digestive enzyme activities (Kumar and Singh, 1984) and affect the microbial and enzyme activities (Makkar et al., 1989). Tannins are present in fibrous fraction in tree leaves and binding of proteins to cell wall seem to be a factor in decreasing digestibility (Reed et al., 1990). However, tannins have also beneficial effects on animal performance depending on their structure and concentrations. Lower concentrations of tannins can improve nutrition for ruminants by reducing protein degradation in the rumen and increasing the flow of amino acids to the intestine (Mc Nabb et al., 1996). Moreover, tannins have adverse impact on internal parasites (Waghorn, 1996). In this study, tannin level was below 4% of DM of fodder tree leaves. Concentration of tannins less than 4% in the ration is beneficial by promoting bypass protein and bloat suppression in ruminant animals (Aganga and Tshwenyane 2003) whereas, tannin concentration higher than 5% adversely affect feed intake and digestibility (Perevolotsky et al. 1993; Silanikove et al. 1996).

Saponins were only observed in M. indica. Saponins are bitter in taste and have foaming properties (Aganga and Tshwenyane, 2003). The adverse effect of bitterness can be overcome by repeated washing with water which makes the feed palatable (Joshi et al., 1989). Alkaloids are also bitter in taste. Aganga and Tshwenyane (2003) reported that alkaloids cause locomotor ataxia of the hind quarters and haemorrhagic diarrhea in sheep.

CONCLUSION

Tree leaves having high CP, shorter lag time and faster digestion rate be considered as potent feed for ruminants. As the Ca to P ratio is wide, therefore, in order to get optimal production it is suggested to supplement the byproducts with high P contents combined with these tree leaves when fed to ruminants. On the basis of higher availability of ME, CP and digestibility of leaves, trees are ranked as M. azedarach > A. procera > L. leucocephala > M. indica. Further research is needed to evaluate leaves of these plant species for any anti-nutritional factor.

REFERENCES

Reed, J.D., Solier, H. and Woodward, A. (1990). Fodder tree and straw diets for sheep: intake, growth, digestibility and the effect of