Determination of Relative Feed Value of Some Legume Hays Harvested at Flowering Stage

Ayfer Bozkurt Kiraz
Department of Animal Science, Cukurova University, Adana, Turkey

ABSTRACT
The aim of this study was to determine the Relative Feed Value (RFV) and Metabolisable Energy (ME) content of some legume hays harvested at flowering stage. Chemical composition including Crude Protein (CP), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), Ether Extract (EE), ash, Dry Matter Digestibility (DMD), Relative Feed Value (RFV) and Metabolisable Energy (ME) were calculated. The CP content of hays ranged from 9.69 to 22.13%. The NDF and ADF contents ranged from 38.48 to 41.06% and 29.95 to 35.75%, respectively. The NDF content of Trifolium repens was significantly higher than those for Vicia sativa and Trifolium incarnatum. The ADF content of Vicia sativa was significantly (p<0.001) lower than that for Trifolium incarnatum, Medicago lupulina and Lathyrus sativus. The DMD of legume hays ranged from 60.54 to 65.56%. The DMD of Vicia sativa was significantly higher than that for Trifolium incarnatum. The DMI was ranged from 2.92 to 3.11% of body weight. The DMI of Trifolium incarnatum was significantly higher than those for the other legume hays. The RFV of legume hays ranged from 138.81 to 155.07. The RFV of Vicia sativa was significantly higher than those for Trifolium repens, Medicago lupulina and Lathyrus sativus. The ME contents of legume hays ranged from 2.346 to 2.522 Mcal kg⁻¹. The ME contents of Vicia sativa was significantly higher than that for Trifolium incarnatum. As a conclusion species had a significant (p<0.001) effect on the chemical composition, DMD, DMI, RFV and ME of legume hays.

Key words: Relative feed value, dry matter intake, digestibility, legume, hay, forage

INTRODUCTION
It is well known that forages have an important role in ruminant nutrition in terms of providing energy, protein and minerals as well as fibre for chewing and rumination. (Ahmad et al., 2000; Ranjbar, 2007; Kamalak and Canbolat, 2010). Although, the relationship used to develop prediction equations for animal performance from intake and digestibility are often less accurate than desired the digestibility and intake of forages has been used to form indices of forage quality (Coleman and Moore, 2003). In Mediterranean areas pastures represent the most important legume forage resource such as Trifolium repens, Vicia sativa, Medicago sativa, Trifolium incarnatum, Medicago lupulina and Lathyrus sativus. Nutritive value of forages depends on their dry matter digestibility and voluntary dry matter intake. The RFV is a widely accepted forage quality index in the marketing of hays in the United States of America. It was developed by the Hay Marketing Task Force of American Forage and Grassland Council (Rohweder et al., 1978). The RFV combines the estimates for forage digestibility and intake into a single number. The RFV is estimated from ADF and NDF content of forages (Caddel, 2005). Hay producers and purchasers also use RFV in price discovery, especially in hay auctions (Undersander, 2001).
Heydari et al. (2006) conducted the experiment to evaluate three wetland plant species including *Paspalum distichum, Sparganium erectum* and *Aeloropus litoralis* as a forage using the chemical composition, estimated relative feed value and dry matter digestibility and concluded that nutritive value of depends on the nutrients concentration, availability of these nutrients to animal, the effect of feed composition on the voluntary intake of the feed.

Hackmann et al. (2008) evaluated the relative feed value of grass and legume forages and suggested that relative feed value was significantly correlated with potentially digestible dry matter and crude protein for early cut alfalfa, potentially digestible dry matter for late cut alfalfa and potentially digestible dry matter and NDF and hemicellulose for grass-legume.

Canbolat and Karaman (2009) also conducted the experiment to evaluate the nutritive value of legume hays including *Medicago sativa, Medicago polymorha, Medicago orbicularis, Melilotus indicus, Melilotus officinalis, Melilotus albus Medicus, Onobrychis sativa, Vicia villosa* and *Lotus corniculatus* using the chemical composition, in vitro gas production, organic matter digestibility, estimated relative feed value and concluded that there were significant differences among the legume hays with a different chemical composition in terms of nutritive value.

Although, RFV as forage quality has been determined for some plant species from different parts of world (Heydari et al., 2006; Hackmann et al., 2008; Canbolat and Karaman, 2009) the information about RFV for plants such as *Trifolium repens, Vicia sativa, Medicago sativa, Trifolium incarnatium, Medicago lupulina* and *Lathyrus sativa* was insufficient in Turkey. Therefore, the aim of this study was to determine the relative feed value of some legume hays harvested at flowering stage.

**MATERIALS AND METHODS**

**Hay samples:** In the current study, *Trifolium repens, Vicia sativa, Medicago sativa, Trifolium incarnatium, Medicago lupulina* and *Lathyrus sativa* were hand harvested from plots established in the experiment units of pasture at flowering stage in Kahramanmaras, Turkey in late May, 2010. The hay samples were shade-dried and milled to pass through a 1 mm sieve for subsequent analysis.

**Chemical analysis:** Dry matter content was determined by drying the samples at 105°C overnight and the ash by igniting the samples in a muffle furnace at 525°C for 8 h. Nitrogen (N) content was measured by the Kjeldahl method. The CP was calculated as N X 6.25. Ether extract was determined by the method of AOAC (1990). NDF and ADF contents were determined using ANKOM Fibre Analyzer (Van Soest et al., 1991). All chemical analyses were carried out in duplicate.

**Relative feed value:** Relative feed value of hays is calculated from the estimates of dry matter digestibility (DDM) and Dry Matter Intake (DMI). Relative Feed Value (RFV) was developed by the Hay Marketing Task force of American Forage and Grassland Council (Rohweder et al., 1978). Quality standards of legume hays are represented in Table 1.
Table 1: Legume, grass and legume-grass mixture quality standards

<table>
<thead>
<tr>
<th>Quality standard</th>
<th>CP</th>
<th>ADP % of DM</th>
<th>NDF% of DM</th>
<th>RFV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime</td>
<td>&gt;19</td>
<td>&lt;31</td>
<td>&lt;40</td>
<td>&gt;151</td>
</tr>
<tr>
<td>1</td>
<td>17-19</td>
<td>31-40</td>
<td>40-46</td>
<td>151-125</td>
</tr>
<tr>
<td>2</td>
<td>14-16</td>
<td>36-40</td>
<td>47-53</td>
<td>124-103</td>
</tr>
<tr>
<td>3</td>
<td>11-13</td>
<td>41-42</td>
<td>54-60</td>
<td>102-87</td>
</tr>
<tr>
<td>4</td>
<td>8-10</td>
<td>43-45</td>
<td>61-65</td>
<td>86-75</td>
</tr>
<tr>
<td>5</td>
<td>&lt;8</td>
<td>&gt;45</td>
<td>&gt;65</td>
<td>&lt;75</td>
</tr>
</tbody>
</table>

*Standard assigned by Hay Market Task Force of American Forage and Grassland Council; **Relative Feed Value (RFV)** Reference hay of 100 RFV contains 41% ADF and 59% NDF

\[
\text{DM} \% = 88.9 \times (0.779 \times \text{ADF})
\]
\[
\text{DMI} \% \text{ of BW} = 120\% \text{NDF}
\]
\[
\text{RFV} = (\% \text{DDM} \times \% \text{DMI}) / 0.29
\]
\[
\text{DMD} = \text{Dry matter digestibility}
\]
\[
\text{ADF} = \text{Acid detergent fibre (\% of DM)}
\]
\[
\text{NDF} = \text{Neutral detergent fibre (\%)}
\]
\[
\text{DMI} = \text{Dry matter intake (\% of BW)}
\]
\[
\text{RFV} = \text{Relative feed value}
\]

The DMD values were used to estimate digestible energy (DE) using the regression equation reported by Fonnesbeck et al. (1984): 
\[
\text{DE} (\text{Mcal kg}^{-1}) = 0.27 \times \text{DMD} (\%)
\]
Then DE values were converted to metabolisable energy (ME) using the formula reported by Khalil et al. (1986):

\[
\text{ME} (\text{Mcal kg}^{-1}) = 0.821 \times \text{DE}
\]

Data on chemical composition, RFV, DMD and ME contents of legume hays were subjected to one way of ANOVA using GLM of SPSS for Windows (2002). Significance between individual means was identified using the Duncan test. Mean differences were considered significant at \(p<0.05\). Standard errors of means were calculated from the residual mean square in the analysis of variance.

RESULTS AND DISCUSSION

The effect of species on the chemical composition of legume hays is given in Table 2, the species had a significant \((p<0.001)\) effect on the chemical composition of hays. The CP content of hays ranged from 9.69 to 22.13\%. The CP of *Lathyrus sativus* was significantly \((p<0.001)\) higher than those for other hay samples. The NDF and ADF content ranged from 38.48 to 41.06\% and 29.95 to 35.75\%, respectively. The NDF content of *Trifolium repens* was significantly higher than those for *Vicia sativa* and *Trifolium incarnatum*. The ADF content of *Vicia sativa* was significantly \((p<0.001)\) lower than that for *Trifolium incarnatum*, *Medicago lupulina* and *Lathyrus sativus*. The EE content of *Trifolium repens* was significantly \((p<0.001)\) higher than those for the other hays. The ash content of *Trifolium incarnatum* was significantly \((p<0.001)\) higher than those for the other hays. The CP, ash and ADF contents of *Trifolium repens* are consistent with findings of Karabulut et al. (2007) although the NDF content of *Trifolium repens* obtained in the current study was a little bit higher than that indicated by Karabulut et al. (2007) who found that the NDF content of *Trifolium repens* was 37.1\%.

The NDF, ADF and CP contents of *Medicago sativa* were comparable with findings of Canbolat et al. (2006). On the other hand, NDF, ADF and CP contents of *Medicago sativa* hay was
considerably lower than those obtained by Yavuz (2005). The difference between these studies is possibly due to difference in harvesting stage of *Medicago sativa* hay. Canbolat et al. (2005) showed that NDF and ADF contents of *Medicago sativa* hay were increased with increasing maturity whereas CP content was decreased with increasing maturity.

The CP content of *Vicia sativa* was considerably lower than that reported by Tuna et al. (2004) who found that CP content of *Vicia sativa* was 14.24%. On the other hand, the CP content of *Lathyrus sativus* was considerably higher than that reported by Tuna et al. (2004) who found that CP content of *Lathyrus sativus* was 16.35%. The NDF content of *Vicia sativa* was considerably lower than that reported by Tuna et al. (2004) who found that NDF content of *Vicia sativa* was 44.38% whereas the ADF content of *Vicia sativa* was considerably higher than that reported by Tuna et al. (2004) who found that ADF content of *Vicia sativa* was 27.69%. The difference between these studies is possibly due to difference in growing sites, climatic conditions and fertilization. On the other hand, NDF and ADF contents of *Lathyrus sativus* were comparable with those reported by Tuna et al. (2004) who found that NDF and ADF contents of *Lathyrus sativus* was 40.76 and 34.06%, respectively.

The effect of species on DMD, DMI and RFV of legume hays is given in Table 3, as can be seen from Table 3 the species had a significant (p<0.001) effect on DMD, DMI and RFV of legume hays. The DMD of legume hays ranged from 60.54 to 65.56%. The DMD of *Vicia sativa* was significantly (p<0.001) higher than that for *Trifolium incarnatum*. The DMI of legume hays was ranged from 2.92 to 3.11% of body weight. The DMI of *Trifolium incarnatum* was significantly (p<0.001) higher than those for the other legume hays. The RFV of legume hays ranged from 138.81 to 155.07. The RFV of *Vicia sativa* was significantly (p<0.001) higher than those for *Trifolium repens*, *Medicago lupulina* and *Lathyrus sativus*.

The ME value of legumes ranged from 2.346 to 2.522 Mcal kg\(^{-1}\). The ME value of *Vicia sativa* was significantly higher than that of *Trifolium incarnatum*.

The DMD, DMI and RFV of *Medicago sativa* obtained in the current study were consistent with finding of Canbolat et al. (2006). On the other hand, the DMD, DMI and RFV of *Medicago sativa* obtained in the current study were considerably higher than those obtained by Yavuz (2005) who found that DMD, DMI and RFV of *Medicago sativa* were 59.7%, 2.56 and 118.8, respectively. The difference between these studies is possibly due to difference in harvesting stage of *Medicago sativa* hay. Canbolat et al. (2006) showed that DMD, DMI and RFV of *Medicago sativa* hay were decreased with increasing maturity.

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**Table 2: The chemical composition of legume hays harvested at flowering stage**

<table>
<thead>
<tr>
<th>Constituents</th>
<th><em>Trifolium repens</em></th>
<th><em>Vicia sativa</em></th>
<th><em>Medicago sativa</em></th>
<th><em>Trifolium incarnatum</em></th>
<th><em>Medicago lupulina</em></th>
<th><em>Lathyrus sativus</em></th>
<th>SEM</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM</td>
<td>98.01</td>
<td>96.88</td>
<td>99.15</td>
<td>98.75</td>
<td>98.60</td>
<td>98.31</td>
<td>0.041</td>
<td>***</td>
</tr>
<tr>
<td>CP</td>
<td>15.08</td>
<td>9.69</td>
<td>20.20</td>
<td>16.74</td>
<td>21.09</td>
<td>22.13</td>
<td>1.294</td>
<td>***</td>
</tr>
<tr>
<td>NDF</td>
<td>41.06</td>
<td>39.34</td>
<td>40.15</td>
<td>38.48</td>
<td>40.92</td>
<td>40.92</td>
<td>0.450</td>
<td>***</td>
</tr>
<tr>
<td>ADF</td>
<td>33.15</td>
<td>29.93</td>
<td>33.76</td>
<td>36.40</td>
<td>34.76</td>
<td>35.74</td>
<td>1.889</td>
<td>***</td>
</tr>
<tr>
<td>EE</td>
<td>3.29</td>
<td>2.49</td>
<td>2.58</td>
<td>1.96</td>
<td>2.51</td>
<td>2.50</td>
<td>0.144</td>
<td>***</td>
</tr>
<tr>
<td>Ash</td>
<td>9.77</td>
<td>8.69</td>
<td>8.58</td>
<td>10.09</td>
<td>9.76</td>
<td>8.16</td>
<td>0.000</td>
<td>***</td>
</tr>
</tbody>
</table>

Row means with common superscripts do not differ (p>0.05); SEM: Standard error mean; Sig: Significance level. ***p<0.001. DM: Dry matter %, CP: Crude Protein, NDF: Neutral Detergent Fiber %, ADF: Acid Detergent Fiber %, EE: Ether Extract %
Table 3: The dry matter digestibility, dry matter intake and relative feed value of legume hays harvested at flowering stage

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Trifolium repens</th>
<th>Vicia sativa</th>
<th>Medicago sativa</th>
<th>Trifolium incarnatum</th>
<th>Medicago lupulina</th>
<th>Lathyrus sativus</th>
<th>SEM</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMI</td>
<td>63.07&lt;sup&gt;a&lt;/sup&gt;</td>
<td>65.56&lt;sup&gt;b&lt;/sup&gt;</td>
<td>62.69&lt;sup&gt;b&lt;/sup&gt;</td>
<td>60.54&lt;sup&gt;c&lt;/sup&gt;</td>
<td>61.82&lt;sup&gt;b&lt;/sup&gt;</td>
<td>61.06b&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.470</td>
<td>***</td>
</tr>
<tr>
<td>DMI</td>
<td>2.92&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>3.05&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>2.99&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.11&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.93c&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.93c&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.094</td>
<td>***</td>
</tr>
<tr>
<td>RFV</td>
<td>142.96&lt;sup&gt;a&lt;/sup&gt;</td>
<td>155.07&lt;sup&gt;b&lt;/sup&gt;</td>
<td>145.04&lt;sup&gt;a&lt;/sup&gt;</td>
<td>146.36&lt;sup&gt;a&lt;/sup&gt;</td>
<td>149.59b&lt;sup&gt;b&lt;/sup&gt;</td>
<td>138.81b&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.119</td>
<td>***</td>
</tr>
<tr>
<td>ME</td>
<td>2.435&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.522&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.418&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.346&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.391&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.364&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.516</td>
<td>NS</td>
</tr>
</tbody>
</table>

Row means with common superscripts do not differ (p>0.05); SEM: Standard error mean; Sig.: significance level, ***p<0.001. DMD: Dry matter digestibility%, DMI: Dry matter intake, % of Body weight, RFV: Relative feed value. ME: Metabolisable energy (Mcal kg<sup>-1</sup>)

The ME content of *Medicago sativa* was considerably higher than that reported by Arzani *et al.* (2006) who found that ME content of *Medicago sativa* was 2.33 Mcal kg<sup>-1</sup>. The high ME of *Medicago sativa* in the current experiment may be high DMD of *Medicago sativa*.

**CONCLUSION**

As a conclusion species had a significant effect on the chemical composition, dry matter digestibility, dry matter intake, relative feed value and metabolisable energy content of legume hays.

**REFERENCES**


