Determination of nutritive value of five species of halophyte plants used by camel in East South Iran

Yousef Elahi*, M.

Dept. of Animal Science & Special Animals Institute, University of Zabol, Zabol, Iran.

*Corresponding author email: (m_yousefelahi@uoz.ac.ir)

ABSTRACT: This study carried out to determine chemical composition and nutritive value of five species of range plants in Sistan including Zygophyllum eurypterum, Artemisia maritime, Aeluropus littoralis, Prosopis farcta and Carthamus lanatus by in vitro gas production technique. Samples were collected by systematic and random sampling procedure in autumn according to standard methods. Chemical composition, cumulative gas production at 2, 4, 6, 12, 24, 48, 72 and 96 h were determined. The results of this experiment showed that, there are significant difference in terms of chemical compositions of these samples (P<0.05). The crude protein, ADF and NDF contents were between 5.20 and 9.60, 47.30 and 50.30% and 53.50 and 66.90% respectively. There was significant difference (P<0.05) between these species in different incubation times. The maximum cumulative gas volume at 96 hours for b fraction were related to Aeluropus littoralis. Also, organic matter digestibility and metabolisable energy in Aeluropus littoralis species were higher than other species. The results of chemical composition and gas production showed that in these plants, Aeluropus littoralis species has the highest nutritive value and also, these species can use as feed for camel.

Keywords: Nutritive value, Digestibility, Sistan, Camel

INTRODUCTION

The first step for determining the nutritive value of feedstuff for camels is to analyse the chemical composition of different species of plants preferred by camels, and then to measure their digestibility and palatability. The chemical composition of many foods has been measured from different ecosystems in the Arab region of Asia and Africa (Wardeh et al., 1990). In Iran, Javan (2001) reported the digestibility of some arid-rangeland plants using bovine rumen liquor. Towhidi (2007) reported the nutritive value of 11 plant species from the province of Yazd and also, Yousef Elahi et al. (2012a, b) reported nutritional quality of some halophytes species from Sistan area, Iran, but in general little information is known about the nutritive value of range herbage consumed by camels in the arid and semi-arid zones of Iran.

The nutrient value of range forage is dependent on botanical composition. Botanical and chemical composition and season of growth affect the digestibility of pasture, and the nature and quantities of the products of digestion. Generally, legumes have higher protein content than grasses and this declines only slowly with maturity (Norton, 1982). Corbett (1987) believed that desirable forage is green, leafy, and leguminous. These are the components of pasture preferred by animals.

Halophytes represent a major part of the natural ranged and particularly the perennials and shrubby ones. These plants can grow in saline to extremely saline habitats and have particular characteristics which enable them to evade and/or tolerance salinity by various eco-physiological mechanisms. The fodder quality of these plants depends on a combination of climatic, soil, and plant factors (El Shaer, 2010). It is worthy to note that halophytes and other salt-tolerant plants can constitute a major part of the feeding program of sheep, goats, and camels in the arid and semi-arid regions (Squires and Ayoub, 1994; El Shaer, 1997). So, the objective of this study was to determine the chemical composition and nutritive value of Zygophyllum eurypterum, Artemisia maritime, Aeluropus littoralis, Prosopis farcta and Carthamus lanatus by using in vitro gas production technique.
MATERIALS AND METHODS

Sampling zone and collection
This experiment was conducted using halophyte plants from the south-eastern part of Iran. The area is located at an altitude of 595 m above sea level. The mean annual rainfall and temperature are 61 mm and 21 °C, respectively. Plant samples were collected in autumn 2012 using stratified random sampling from the rangelands of Sistan region in Iran. Studied species were Zygophyllum eurypterum, Artemisia maritime, Aeluropus littoralis, Prosopis farcta and Carthamus lanatus.

Samples were with 5 replicates. For each replicate 5 individual plants of each species were cut and mixed (25 individual plants for each species). Considering homogeneity samples of each species were collected in the vegetation community that species was dominant. Samples were dried in room temperature in laboratory and were ground to pass through 1.0 mm sieve for subsequent analyses.

Chemical composition

Dry matter was determined by drying the samples at 105°C overnight and ash by igniting the samples in a muffle furnace at 550°C for 8 h. Nitrogen content was measured by the Kjeldahl method (AOAC, 1990). Crude protein was calculated as N × 6.25. Concentrations of neutral detergent fibre (NDF) and acid detergent fibre (ADF) of samples were determined by the method of Van Soest et al. (1991). All chemical analyses were carried out in triplicate.

Gas production

Rumen fluid was obtained from three fistulated native cattle fed twice daily on a diet containing lucern hay (60%) and concentrate (40%). About 200 mg of sample were incubated in vitro with 30 ml of rumen fluid-buffer mixture (ratio of 1:2) in calibrated glass syringes in a water bath kept at 39.0°C in triplicate, following the procedures of Menke and Steingass (1988). Blanks with buffered rumen fluid were also included in the incubations. The syringes were prewarmed at 39.0°C before the injection of 30ml rumen fluid-buffer mixture into each syringe followed by incubation in a water bath at 39°C. Reading of gas production was recorded before incubation zero and 2, 4, 6, 8, 10, 12, 24, 48, 72 and 96 h after incubation. Total gas values were corrected for blank incubation. Cumulative gas production data were fitted to the exponential equation: 

\[ p = b(1-e^{-ct}) \]

(Ørskov and McDonald, 1979): where p is the gas production at time t; b is the potential gas production (ml), c is the gas production rate constant, t incubation time (h).

The metabolisable energy (ME; Mj/kg DM) of samples was calculated using equation of Menke et al. (1979) as follows:

\[ \text{ME (MJ/kg DM)} = 2.20 + 0.136GP + 0.057CP (R^2= 0.94) \] (Menke et al., 1979)

where, GP is 24 h net gas production (ml/200 mg), CP is Crude protein (%), the in vitro organic matter digestibility (IVOMD) of foliages was calculated using equation of Menke et al. (1979) as follows:

\[ \text{IVOMD (%) = 14.88 + 0.889GP + 0.45 CP + 0.0651XA} \]

where, GP is 24 h net gas production (ml/200 mg), CP is Crude protein (%) and XA is ash content (%).

Statistical Analysis

Data on chemical composition, in vitro gas production kinetics, OMD and ME contents of samples were subjected to the random completely design using General Linear Model (GLM) of SAS (2002). Data were analysed as and the statistical model was:

\[ Y_{ijk} = \mu + S_i + \epsilon_{ijk} \]

where, \( Y_{ijk} \) represents the general observation on chemical composition, in vitro gas production kinetics, OMD and ME contents, \( S \) the effect of species on the observed parameters and \( \epsilon_{ijk} \) the standard error term common for all observations. Significant differences between individual means was identified using the Turkey’s Multiple Range 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

Chemical composition
Table 1 show the chemical composition of different plant species. There was a considerable variation between species in terms of chemical composition (p<0.05). The DM content of analysed species varied between 93.90% DM for Carthamus lanatus until 95.40% DM for Aeluropus littoralis (p<0.05). Towhidi et al. (2007) Reported DM content for nine plant species for camel between 936 and 954 g/kg DM. Crude protein contents of plants ranged from 5.20 to 9.60% DM. The crude protein of Prosopis farcta was higher than in the other species (p<0.05). Feeds containing less than 80 g/kg DM crude protein are considered deficient since they cannot provide the minimum
ammonia levels required by rumen micro-organisms to support optimum activity (Norton, 2003). So, Zygophyllum eurypterum, and Carthamus lanatus aren’t useful plants for providing of maintenance requirements of ruminants. Towhidi (2007) reported that the CP contents of 11 different plant species were 55.0 g/kg DM in Atemisia sibirica to 183.0 g/kg DM in Tamarix aphyila. Laudadio et al. (2009) reported a similar range of CP content in present study. The cell wall content (NDF and ADF) which represents the most important fraction of dry matter for all forages, ranged from 53.50 to 66.90 and from 47.30 to 49.57% DM, respectively. The NDF and ADF contents of these species weren’t similar to those reported by Arzani et al. (2006). As shown in Table 1, it clearly deduces the non-existence of a relationship between CP contents of the halophytes plants and its structural carbohydrates content (NDF and ADF). The variations between our species and other species in the chemical composition contents can be attributed to due to any or all of the vegetative stage (Makkar and Singh, 1993), method of storage (Makkar and Singh, 1993), drying conditions (Makkar and Singh, 1991), species (Makkar and Singh, 1993; Makkar et al., 1991) and habital (Goncalves-Alvim et al., 2004).

### Table 1. Chemical composition (g/kg DM) of experimental species

<table>
<thead>
<tr>
<th>Species</th>
<th>DM (94.28b)</th>
<th>OM (92.00b)</th>
<th>Ash (11.70b)</th>
<th>CP (6.30c)</th>
<th>EE (2.53b)</th>
<th>ADF (49.60b)</th>
<th>NDF (54.50d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zygophyllum eurypterum</td>
<td>94.40</td>
<td>88.10</td>
<td>11.90</td>
<td>8.70</td>
<td>2.70</td>
<td>66.90</td>
<td>55.20</td>
</tr>
<tr>
<td>Artemisia maritima</td>
<td>93.94</td>
<td>95.80</td>
<td>4.20</td>
<td>9.60</td>
<td>2.17</td>
<td>47.30</td>
<td>57.20</td>
</tr>
<tr>
<td>Aeluropus littoralis</td>
<td>93.90</td>
<td>91.90</td>
<td>8.10</td>
<td>5.20</td>
<td>2.70</td>
<td>50.30</td>
<td>57.20</td>
</tr>
<tr>
<td>Prosopia farcta</td>
<td>93.94</td>
<td>91.90</td>
<td>8.10</td>
<td>5.20</td>
<td>2.70</td>
<td>50.30</td>
<td>57.20</td>
</tr>
<tr>
<td>Carthamus lanatus</td>
<td>93.90</td>
<td>91.90</td>
<td>8.10</td>
<td>5.20</td>
<td>2.70</td>
<td>50.30</td>
<td>57.20</td>
</tr>
</tbody>
</table>

The means within a row without common letter differ (p<0.05).

Figure 1. Gas production volume (ml/200mg DM) of experimental species in different incubation times. Ze: Zygophyllum eurypterum, Am: Artemisia maritima, Al: Aeluropus littoralis, Pf: Prosopia farcta , Cl: Carthamus lanatus.

### In vitro gas production

Cumulative gas production profiles from the in vitro fermentation of experimental species are shown in Figure 1 and the estimated parameters are given in Table 2. There were significantly differences (p<0.05) in gas production volumes among species at different incubation times (Figure 1). The cumulative volume of gas production increased with increasing time of incubation. Gas produced after 96 h incubation ranged between 28.35 and 49.17 ml/200 mg DM. Wood et al. (1998) reported that there was gas production differences significantly (p<0.05) in samples of different regions. Odeyinka et al. (2003) compared nutritive value of some different plant species by gas test technique. Results showed that the effect of plant species on the gas production is significant. Abdulrazak et al. (2000) reported that there are some variations between gas productions of different species.

Potential gas production (b fraction) was significantly different among species (p<0.05). Aeluropus littoralis has the highest potential gas production and Zygophyllum eurypterum had the lowest potential gas production.

The results from Table 2 show that the predicted ME and OMD profile were widely varied in five plant species. Aeluropus littoralis has a higher ME and OMD contents than other species (p<0.05). The lowest ME and OMD values of Zygophyllum eurypterum can be associated with high ash content and low CP content. Hosseini
Nejad et al. (2012) studied on the five halophytes species and reported that OM digestibility these species were from 66.13 to 76.24 g/kg DM. These results are higher than present study.

CONCLUSION

This study has provided information on the value of a number of plant species adapted to arid environments for use as camel feed. This information may prove useful for herders, farmers and ruminant’s nutritionists in feeding strategies for camels in the dry season. There were no consistent patterns between the chemical compositions with gas production of studied plants. It is suggested to evaluate of antinutrients such as tannins and saponin in these species.

### Table 2. Gas production volume (ml/200 mg DM) in 96 h incubation time and gas production parameters of experimental species

<table>
<thead>
<tr>
<th>Species</th>
<th>Incubation time (h)</th>
<th>Gas production kinetics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zygophyllum eurypterum</td>
<td></td>
<td></td>
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<tr>
<td>Artemisia maritima</td>
<td></td>
<td></td>
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<tr>
<td>Aeluropus littoralis</td>
<td></td>
<td></td>
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<tr>
<td>Prosopis farcta</td>
<td></td>
<td></td>
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<tr>
<td>Carthamus lanatus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>23.90&lt;sup&gt;a&lt;/sup&gt;</td>
<td>34.82&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>37.83&lt;sup&gt;a&lt;/sup&gt;</td>
<td>21.72&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>38.25&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.633</td>
</tr>
<tr>
<td>96</td>
<td>28.35&lt;sup&gt;a&lt;/sup&gt;</td>
<td>42.25&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>53.36&lt;sup&gt;a&lt;/sup&gt;</td>
<td>33.16&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>49.17&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.678</td>
</tr>
</tbody>
</table>

b: the asymptotic gas production (ml/200 mg DM), c: the rate of gas production (/h), OMD: organic matter digestibility (g/kg DM) and, ME: Metabolisable energy (MJ/kg DM). Different superscripts following means within species in the same row indicate differences at p<0.05.

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