CHEMICAL COMPOSITION, METABOLISABLE ENERGY, ORGANIC MATTER DIGESTIBILITY AND METHANE PRODUCTION OF SOME TANNIN CONTAINING FORAGES

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Abstract: The aim of the current experiment was to evaluate the chemical composition, gas, methane production, metabolisable energy (ME), organic matter digestibility (OMD) of some tannin containing hays. There are significant variations among hays in terms of the chemical composition. Crude protein contents of hays ranged from 14.3 to 23.5% with the highest being for Marrubium supinum hay and lowest for Anthyllis cincinata hay. Neutral detergent fiber contents of hays ranged from 40.6 to 57.7% with the highest being for Polygonum aviculare hay and lowest for Scorpinus muricatus hay. Acid detergent fiber contents of hays ranged from 22.5 to 32.9% with the highest being for Lotus corniculatus hay and lowest for Scorpinus muricatus hay. Condensed tannin contents of hays ranged from 0.7 to 7.3% with the highest being for Polygonum aviculare hay and lowest for Marrubium supinum hay. Gas production of tannin containing hays ranged from 77.5 and 105.5 ml/0.5 g DM with the highest being for Anthyllis cincinata and Scorpinus muricatus, and lowest for Marrubium supinum. Metabolisable energy content of legume hays varied between 7.6 and 9.1 MJ/kg DM with the highest being for Scorpinus muricatus hay and lowest for Bituminaria bituminosa hay. The tannin containing hays investigated in the current experiment will provide not only protein but also fiber for ruminant animals. In addition they had low anti-methanogenic potential. The current experiment will provide information for the nutritionist to prepare well balanced diets for ruminants animals. However further in vivo experiments are required to determine the feed intake and anti-methanogenic potential of hays.

Keywords: Forage, Chemical composition, Tannin, Digestibility, Metabolisable energy, Methane emission

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1. Introduction

Forage will provide not only nutrients but also fiber for ruminant animal to meet their requirement. There are some forages in pasture which contains considerable amount of condensed tannin which may have potential on mitigation of enteric methane production when they are consumed by ruminant animals. Although there are a lot of studies involved in chemical composition of forages there is a lack of information about condensed tannin and anti-methanogenic potential of forages. In vitro gas production technique is widely used to evaluate forages in terms of potential nutritive value, metabolisable energy and organic matter digestibility for ruminant animals (Kamalak et al., 2004; Kamalak et al., 2005; Ozturk et al., 2006; Kamalak et al., 2010; Kamalak and Canbolat, 2010; Kamalak et al., 2011; Ozkan et al., 2017; Atalay et al., 2018; Boga et al., 2020; Kamalak et al., 2021). It is well known that some anti-nutritive factors such as tannin and saponin decrease the enteric methane production from ruminant animals. Therefore the aim of the current experiment was to evaluate the chemical composition, ME, OMD, gas and anti-methanogenic potential of tannin containing forages using in vitro gas production technique.

2. Material and Methods

2.1. Tannin Containing Hays

Hays obtained from 3 replicate plots established in the experiment field at flowering stage from 7 different plant species namely, Anthyllis cincinata, Cichorium intybus, Scorpinus muricatus, Lotus corniculatus, Bituminaria bituminosa, Polygonum aviculare, Marrubium supinum in 2019 in Turkey were dried in 65 °C until a constant weight. Hay samples were then milled to pass a 1 mm sieve for chemical analysis and in vitro gas production assay.

2.2. Chemical Analysis of Hays

Dry matter (DM), crude ash (CA), crude protein (CP) and ether extract (EE) contents of hay samples were analyzed according to AOAC (2005). Neutral detergent fiber (NDF) and ADF contents of hay samples using the method described by Van Soest and Wine (1967) and Van Soest

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Crude ash contents of hays ranged from 6.8 to 17.3% with the highest being for *Cichorium intybus* hay and lowest for *Bituminaria bituminosa* hay. Crude protein contents of hays ranged from 14.3 to 23.5% with the highest being for *Marrubium supinum* hay and lowest for *Anthyllis circinata* hay. CP contents of forages used ruminant diets should be higher than 8% of DM to meet maintenance requirement (Norton, 1994). In addition, CP contents of forages used ruminant diets should not be less than 10% to avoid low dry matter intake (Ranjhnan, 2001). As can be seen from Table 1 hays investigated in the current study had a CP contents that higher than those requested for maintenance and proper food intake, which can be used as a protein supplement for poor quality forages to improve productivity of ruminant animals.

Ether extract contents of hays ranged from 3.5 to 4.9% with the highest being for *Polygonum aviculare* and *Marrubium supinum* hays, and lowest for *Anthyllis circinata* and *Cichorium intybus* hays. Neutral detergent fiber contents of hays ranged from 40.6 to 57.7% with the highest being for *Polygonum aviculare* hay and lowest for *Scorpinus muricatus* hay. Acid detergent fiber contents of hays ranged from 22.5 to 32.9% with the highest being for *Lotus corniculatus* hay and lowest for *Scorpinus muricatus* hay. Condensed tannin contents of hays ranged from 0.7 to 7.3% with the highest being for *Polygonum aviculare* hay. Except for *Polygonum aviculare*, the CT contents of forages investigated is not likely detrimental on the digestibility and animal performance.

Yusuf and Muritala (2013) suggested that wide variation in chemical composition can be expected among forages even if they were grown in the same environmental conditions.
conditions and harvested at the similar maturity due to
the inherent characteristics of forages associated
with ability to extract and accumulate nutrients from soil
and fix nitrogen from atmosphere. Some of differences
among forages in terms of chemical composition may be
associated with differences in leaf:stem ratio, which may
result in differences in chemical composition, especially
in NDF and CP contents of forages.

As can be seen Table 1, forages with high cell contents
investigated in the current experiment will provide not
only CP but also fiber for ruminant animals. NRC (1989)
recommends that dairy cow ration should contain of 25%
NDF of DM with 75% of the NDF from forages whereas
feed intake of dairy cattle decreased with increasing NDF
content of diets ranging from 22.5 to 45.8% (Arelovich et
al., 2008).

The gas production, methane production, metabolisable
energy and organic matter digestibility of tannin
containing hays were given in Table 2. Species had a
significant effect on the gas production, methane
production, ME and OMD of tannin containing hays.
Gas production of tannin containing hays ranged from 77.5
and 105.5 ml/0.5 g DM with the highest being for
Anthyllis circinata and Scorpinus muricatus, and lowest
for Marrubium supinum. The differences among hays in
terms of gas production might be associated to
compositional differences of hays, especially cell contents
and CT contents. The extent of total gas production
depends on the available carbohydrate for fermentation
of rumen micro-organism (Blümmel and Orskov, 1993).

However, the presence of secondary metabolites such as
tannin and saponin in hay may affect the extent of gas
produced during fermentation (Kondo et al., 2014;
Jayanegara et al., 2014).

Generally, the percentage methane of usual feeds such as
hay, concentrate or mixture of hay and concentrate range
from 16 to 20%. Feedstufs can be classified in terms of
anti-methanogenic potential using percentage of
methane production after 24 h anaerobic fermentation
(Lopez et al., 2010) According to this classification, most
of hay samples had a low anti-methanogenic potential
since the percentage of methane fell into the range of
>11% and ≤14%. Metabolisable energy content of
legume hays varied between 7.6 and 9.1 MJ/kg DM with the
highest being for Scorpinus muricatus hay and lowest
for Cichorium intybus, Bituminaria bituminosa and
Marrubium supinum hays. Organic matter digestibility of
legume hays varied between 58.2 and 72.4% with the
highest being for Scorpinus muricatus hay and lowest for
Bituminaria bituminosa hay.

Table 2. The gas production, methane production, metabolisable energy and organic matter digestibility of tannin
containing hays

<table>
<thead>
<tr>
<th>Hays</th>
<th>Gas</th>
<th>CH₄ (%)</th>
<th>CH₄ (ml)</th>
<th>ME</th>
<th>OMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthyllis circinata</td>
<td>105.5a</td>
<td>14.9b</td>
<td>12.7c</td>
<td>8.7ab</td>
<td>66.6c</td>
</tr>
<tr>
<td>Cichorium intybus</td>
<td>80.75d</td>
<td>12.7c</td>
<td>14.1b</td>
<td>7.6c</td>
<td>65.5bc</td>
</tr>
<tr>
<td>Scorpinus muricatus</td>
<td>105.2a</td>
<td>14.1bc</td>
<td>12.0c</td>
<td>9.1a</td>
<td>72.4a</td>
</tr>
<tr>
<td>Lotus corniculatus</td>
<td>100.7ab</td>
<td>16.8a</td>
<td>14.9b</td>
<td>8.8b</td>
<td>66.5bc</td>
</tr>
<tr>
<td>Bituminaria bituminosa</td>
<td>86.2d</td>
<td>14.2bc</td>
<td>14.8b</td>
<td>7.8c</td>
<td>58.2d</td>
</tr>
<tr>
<td>Polygonum aviculare</td>
<td>92.2bc</td>
<td>13.4bc</td>
<td>13.0c</td>
<td>8.5b</td>
<td>68.2b</td>
</tr>
<tr>
<td>Marrubium supinum</td>
<td>77.5bc</td>
<td>14.0bc</td>
<td>16.2a</td>
<td>7.8c</td>
<td>64.1c</td>
</tr>
<tr>
<td>SEM</td>
<td>0.328</td>
<td>0.337</td>
<td>0.501</td>
<td>0.179</td>
<td>1.115</td>
</tr>
<tr>
<td>P</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
</tbody>
</table>

aColumn means with common superscripts do not differ (P>0.05), SEM=Standard error mean, GP=gas production (ml), CH₄= methane
production, ME=metabolisable energy (MJ/kg DM), OMD=organic matter digestibility(%) .

4. Conclusion

There are significant variation among hay samples in
terms of chemical composition and potential nutritive
value. The tannin containing hays investigated in the
current experiment will provide not only protein but also
fiber for ruminant animals. In addition they had low anti-
methanogenic potential. The current experiment will
provide information for the nutritionist to prepare well
balanced diets for ruminants animals. However further in
vivo experiments are required to determine the feed
intake and anti-methanogenic potential of hays.

Author Contributions

All authors have equal contribution and the authors
reviewed and approved the manuscript.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Approval

Ethical approval is not required, because this article does
not contain any studies with human or animal subjects.

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