Evaluation of Fermentation Qualities and Digestibilities of Silages Made from Sorghum and Sunflower Alone and the Mixtures of Sorghum-Sunflower

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Abstract: The objectives of this study were to evaluate fermentation qualities and digestibilities of silages prepared from sorghum (S) and sunflower (SF) alone and the mixtures of sorghum and sunflower at differing rates 75% sorghum+25% sunflower (75S25SF), 50% sorghum+50% sunflower (50S50SF) and 25% sorghum+75 sunflower (25S75SF) ensiled in 120 L plastic barrel for 90 days. pH values of sorghum and the mixtures were significantly lower than that of sunflower silage (p<0.05). Concentrations of lactic, acetic, propionic and butyric acids were significantly greater in sunflower silage compared with sorghum silage (p<0.05). Silage acid concentration tended to decrease with increasing levels of sorghum in the mixtures. While concentrations of DM, OM and NDF were lower, concentrations of CP and EE were higher in sunflower than sorghum silage (p<0.05). Sunflower had greater DM, CP and EE but lower ADF and NDF digestibilities compared with sorghum silage (p<0.05). As percentage of sunflower increased, DM, CP and EE digestibilities increased but ADF and NDF digestibilities decreased in the mixtures. It has been concluded that better quality silages could be obtained by mixing sorghum and sunflower at 50% ratio.

Key words: Sorghum, sunflower, silage quality, digestibility

INTRODUCTION

Conserving feedstuffs as silage with a minimal nutrient loss is as important as their production (Çerçi et al., 1997). The concentrations of dry matter, soluble sugar, protein and thus, fermentability of silage material are very critical for obtaining high quality silage (Filya, 2000). Even though sorghum silage is reach enough in carbohydrate for silage fermentation (Undersander et al., 1990), digestibility of sorghum silage is low due to tannin content and structure of endosperm (Hart, 1990). On the other hand, sunflower silage has low dry matter and high cell wall contents, which negatively affects silage quality but has high concentrations of crude protein and ether extract (Gregoire, 1999).

The objectives of this study were to ensile the different mixture of sorghum and sunflower to minimize ensiling risk in addition to supplement deficient nutrient by mixing them and to evaluate silage quality and digestibility of silage.

MATERIALS AND METHODS

Sunflower (SF) and sorghum (S) harvested with a silo track at dough stage of maturity were used as silage material. The mixtures of sunflower and sorghum at differing rates of 75% sorghum+25% sunflower (75S25SF), 50% sorghum+50% sunflower (50S50SF) and 25% sorghum+75% sunflower (25S75SF) were prepared on fresh material basis. A total of 25, 5 replicate for 5 treatments, silages were prepared in 120 L plastic barrels. Silages were packed with foot stamping and then, barrels were capped tightly with lids. After that, barrels were flipped over and buried approximately 25 cm in depth into soil to eliminate air leakage. After 90 days of incubation, silages were opened and sub-sampled for physical and chemical analysis. Physical properties such as color, smell, structure, total point quality classification of silages were determined with DLO silage evaluation guide (Alçıçek and Özkân, 1997). Feigl point was calculated as described by Kılıç (1996). After hydration of silage samples as described by Hart and Horn (1987), pH was determined with a digital pH meter. The filtrate were filtrated through Whatman 54 filter paper, centrifuged and stored at 20°C for organic acid analysis. Lactic acid and volatile fermentation products were determined by high performance liquid chromatography (Muck and Dickerson, 1988).

All of silage samples were analyzed for Dry Matter (DM), Crude Protein (CP), Ether Extract (EE) and ash.

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(Bulguru and Ergül, 1978), Acid Detergent Fiber (ADF) and neutral detergent fiber (NDF; Van Soest and Robertson, 1979). Only crude protein content of silages was determined using wet samples. Metabolism trail was designed as completely randomized design and each treatment was randomly fed to 5 rams (Düzgüneş et al., 1978). Metabolism trail (feeding of animals, determination of feed intake, collection of faeces and analysis) was conducted as described by Bulguru and Ergül (1978) using 6, 2 year old Morkaraman rams.

All data were subjected to analysis of variance using General Linear Model procedure of SAS (2005). Mean treatment differences were determined by Duncan’s multiple range test with a level of statistical differences of 5% (Düzgüneş et al., 1978).

RESULTS AND DISCUSSION

The concentrations of DM, OM and NDF were significantly lower in SF silage compared with those of S silage (p<0.05). Dry matter, OM and NDF contents linearly increased as the percentage of sorghum increased in silage prepared with a mixture of sunflower and sorghum (p<0.05). While ADF contents of SF and S silages were similar, it was significantly greater in the mixtures compared with sunflower and sorghum (p<0.05). Both CP and EE concentrations of SF silage were significantly higher than those of S and CP and EE concentrations increased in the mixtures with increasing levels of sunflower (p<0.05; Table 1). Similar to our study, it was reported that sunflower contained 7.1-10.7% EE and 10-12% CP on DM basis (Undersander et al., 1990; Gregoire, 1999). The differences in nutrient contents of silages have reported to be due to differences in plant species and levels of plant species in the mixtures (Baxter et al., 1984; Anil et al., 2000; Immig and Pubst, 2002). It has been noted that the NDF and ADF concentrations decreased due to increasing level of EE in sunflower silage (Gonçalves et al., 1999; Gregoire, 1999; Immig and Pubst, 2002) but increased in sorghum silages as harvest delayed (Nichols et al., 1998).

All of the silages were excellent in terms of physical quality criteria such as color, smell and structure. The highest fleig point was obtained in S silage and there were significant differences among groups (p<0.05). SF and 25S75SF were good and sorghum alone and the other mixtures were excellent in quality based on fleig point (Table 1). It has been reported that silages with low DM content might have low fleig point and excellent silage can be obtained by increasing carbohydrate content of silage material (İptaş and Aveoğlu, 1997). In addition, Kılıç (1986) reported a positive relationship between fleig point and silage quality.

Silage pHs significantly differed among groups (p<0.05). While SF silage had the highest pH value (4.35), S silage had the lowest pH value (3.88). Silage pH values decreased parallel to the decreases of sorghum levels in the mixtures. The concentrations of lactic, acetic, propionic and butyric acids were significantly different between SF and S silages (p<0.05). The highest lactic acid level were observed in SF silage, lactic acid level decreases parallel to the increases of sorghum levels in the mixtures (p<0.05). Acetic acid content of SF silage was significantly higher compared with other groups, except 75S25SF group (p<0.05). Silage propionic acid concentrations were negatively correlated with sorghum in mixtures (p<0.05). While 25S75 SF and 75S25SF groups had the lowest butyric acid levels, SF and 50S50SF groups had the highest butyric acid levels (p<0.05; Table 2).

It has been reported that addition of silage materials with high CP and low fermentable carbohydrate contents into mixtures (Çerçi et al., 1997; Türemiş et al., 1997a, b; Demirel et al., 2001a, b, 2003) as well as low DM content of silage material (Kılıç, 1986; İptaş and Aveoğlu, 1997) can increase silage pH. Silage quality is highly related to DM content of silage material ensiled. Many studies (Tan

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**Table 1: Mean chemical compositions (DM %), physical characteristics and quality classification of different silages**

<table>
<thead>
<tr>
<th></th>
<th>SF</th>
<th>S</th>
<th>25S75SF</th>
<th>50S50SF</th>
<th>75S25SF</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
<td>21.1%</td>
<td>23.5%</td>
<td>23.6%</td>
<td>22.8%</td>
<td>23.7%</td>
<td>0.18</td>
</tr>
<tr>
<td>Organic matter</td>
<td>88.54</td>
<td>91.48</td>
<td>89.46</td>
<td>90.44</td>
<td>90.59</td>
<td>0.15</td>
</tr>
<tr>
<td>Crude protein1</td>
<td>1.74ab</td>
<td>1.48ab</td>
<td>1.75ab</td>
<td>1.82a</td>
<td>1.68ab</td>
<td>0.03</td>
</tr>
<tr>
<td>Crude fat</td>
<td>11.57a</td>
<td>2.09</td>
<td>10.55</td>
<td>9.86c</td>
<td>5.86d</td>
<td>0.13</td>
</tr>
<tr>
<td>ADF</td>
<td>37.56</td>
<td>42.30</td>
<td>47.36a</td>
<td>45.36a</td>
<td>47.70a</td>
<td>0.45</td>
</tr>
<tr>
<td>NDF</td>
<td>40.79b</td>
<td>62.11a</td>
<td>47.98c</td>
<td>54.56b</td>
<td>56.85b</td>
<td>0.39</td>
</tr>
<tr>
<td>Smell</td>
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<td>14</td>
<td>11</td>
<td>12</td>
<td>14</td>
<td>14</td>
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<td>4</td>
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<tr>
<td>Color</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total point</td>
<td>16</td>
<td>19</td>
<td>16</td>
<td>17</td>
<td>20</td>
<td>20</td>
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<tr>
<td>Quality classify</td>
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<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>0.07</td>
</tr>
<tr>
<td>Fleig point</td>
<td>72.17d</td>
<td>96.92a</td>
<td>79.88c</td>
<td>85.31bc</td>
<td>88.33b</td>
<td></td>
</tr>
<tr>
<td>Quality classify</td>
<td>Good</td>
<td>Excellent</td>
<td>Good</td>
<td>Excellent</td>
<td>Excellent</td>
<td></td>
</tr>
</tbody>
</table>

1 Fresh material: Values with different superscripts in the same line differ significantly (p<0.05)
Table 2: Mean fermentation qualities (%DM) and digestibility of different silages, (%)

<table>
<thead>
<tr>
<th>Silages</th>
<th>SF</th>
<th>S</th>
<th>25S75SF</th>
<th>50S50SF</th>
<th>75S25SF</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>4.35a</td>
<td>3.88c</td>
<td>4.23b</td>
<td>4.11c</td>
<td>4.01d</td>
<td>0.012</td>
</tr>
<tr>
<td>Lactic acid</td>
<td>8.75a</td>
<td>6.20c</td>
<td>7.03b</td>
<td>6.31c</td>
<td>7.50b</td>
<td>0.324</td>
</tr>
<tr>
<td>Acetic acid</td>
<td>1.89a</td>
<td>1.18b</td>
<td>0.68c</td>
<td>0.84b</td>
<td>1.92a</td>
<td>0.121</td>
</tr>
<tr>
<td>Propionic acid</td>
<td>1.88a</td>
<td>0.75c</td>
<td>1.89a</td>
<td>1.75a</td>
<td>1.13b</td>
<td>0.124</td>
</tr>
<tr>
<td>Butyric acid</td>
<td>0.61a</td>
<td>0.42b</td>
<td>0.19c</td>
<td>0.65a</td>
<td>0.39b</td>
<td>0.009</td>
</tr>
<tr>
<td>DM digestibility</td>
<td>59.34a</td>
<td>53.83bc</td>
<td>57.18ab</td>
<td>55.47b</td>
<td>50.53c</td>
<td>0.58</td>
</tr>
<tr>
<td>OM digestibility</td>
<td>59.38a</td>
<td>57.90ab</td>
<td>59.05a</td>
<td>57.93ab</td>
<td>53.89b</td>
<td>0.63</td>
</tr>
<tr>
<td>CP digestibility</td>
<td>55.27a</td>
<td>35.57c</td>
<td>47.01b</td>
<td>49.48b</td>
<td>38.55c</td>
<td>0.64</td>
</tr>
<tr>
<td>CP digestibility</td>
<td>92.62a</td>
<td>76.18c</td>
<td>92.75a</td>
<td>91.88a</td>
<td>87.69b</td>
<td>0.28</td>
</tr>
<tr>
<td>ADF</td>
<td>59.19c</td>
<td>54.20a</td>
<td>54.04ab</td>
<td>52.51ab</td>
<td>55.04a</td>
<td>0.66</td>
</tr>
<tr>
<td>NDF</td>
<td>48.67b</td>
<td>53.15a</td>
<td>47.66b</td>
<td>48.45b</td>
<td>46.21b</td>
<td>0.71</td>
</tr>
</tbody>
</table>

Values with different superscripts in the same line differ significantly (p<0.05).

Tümer, 1996; Gregoire, 1999; Immig and Pust, 2002) have been conducted to increase DM content of silage because low DM content of silage material causes fermentation losses and high pH values. It has been reported that there is a positive correlation between fermentation quality and organic acid levels taken place in silages and especially, acetic, propionic and butyric acids inhibit aerobic yeast and mould growth in silages (Moon, 1983).

It has been noted that silage fermentation quality did not negatively affect with increasing levels of CP in silages (Hart, 1990; Ahmad et al., 1995; Demirel et al., 2001a, b). Silage acetic acid contents did not differ (Çerçi et al., 1997 Türemiş et al., 1997a, b; Bolsen et al., 1991) but propionic and butyric acid concentrations increased with increasing levels of CP in silages (Türemiş et al., 1997b; Demirel et al., 2001a). It has been stated that addition of 25% legumes into silage mixtures had positive effect but not at or over 50% on laetic acid production (Demirel et al., 2001a, b). While addition of 25% legumes into rapidly fermentable silage material did not affect silage lactic, acetic, propionic and butyric acid levels, addition of 50% legume reduced laetic acid but increased the levels of other organic acids (Demirel et al., 2003). Thus, readily fermentable carbohydrate as well as CP contents of silage materials reported to be imported for laetic acid production (Kılıç, 1986; Çerçi et al., 1997; Filya, 2000).

Whereas digestibilities of DM, CP and EE were higher digestibilities of ADF and NDF were lower in SF silages compared with S silages (p<0.05) but OM digestibility were similar between SF and S silages. Dry matter, OM and ADF digestibilities did not significantly differ between S and mix silages. Crude protein, except 75S25SF silage and EE digestibilities of S silage were less than those of all mixtures (p<0.05). On the other hand, S silage had greater NDF digestibility compared with all of mixtures (p<0.05). Digestibilities of EE and CP increased with increasing levels of sunflower in the mixtures.

Acknowledgments

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References


