Evaluation of Sunflower Silage in Different Developmental Stages

1E. Mafakher, 1M. Meskarbashee, 1P. Hassibi and 2M.R. Mashayekhi
1Department of Agronomy, Faculty of Agriculture, Shahid Chamran University, Ahvaz, Iran
2Scientific Board of Agriculture and Natural Resources Research Center, Khuzestan Province, Iran

Abstract: This experiment was conducted in a complete randomized block design with three treatments and four replications. Dry and fresh forage yields, starch and head contribution of plant increased with maturity. The values of ash, crude protein, pH, in vitro dry matter digestibility and leaf contribution of plant were higher (p<0.01) in late of budding stage. The best harvest time for ensiling was late of blooming stage and before seed formation under spring condition.

Keywords: Chemical composition, developmental stages, in vitro digestibility, sunflower silage

INTRODUCTION

Sunflower stand out as alternative for forage production and conservation as silage because its drought tolerance, high dry matter yield, resistance to cold and heat, adaptability to different edaphoclimatic conditions and its relative independence of latitude, altitude and photoperiod (Goncalves et al., 1999). Sunflower, in comparison to corn, provides high dry matter yield and has better resistance to both drought and cold (Goncalves et al., 1999). Also, its protein and inorganic nutrients is more than corn (McGuffey and Sehingoethe, 1980). Therefore, application of sunflower forage in corn basis ration seems to be useful for improving livestock nutrients in ration. Palatability, nutrient composition and digestibility of ensiled plant materials is affected by maturity of crop when ensiled, water content of crop and proportion of ears or heads to stalks (Bal et al., 1997). To obtain a good quality and high nutritive values silage, the material should be cut at the right point of maturity (Edwards et al., 1978).

Determined chemical composition and nutritive value of sunflower, cv. Arramiree, at 12 stages of growth. Maximum yield of dry matter occurred at the dough seed stage and the optimum time of cutting for yield of nutrients obtained at the milky ripe stage. Goncalves et al. (1999) reported that the best harvest time of sunflower for ensiling varied according to genotype was 37 days after flowering for DK 180 and M734, more than 51 days for V2000 and about 30 days for Rambosol-91 varieties. Demirel et al. (2006b) observed that dry grass yield and table ration of sunflower green herbage increased from blooming stage to dough stage. Dry matter, organic matter and crude fat content were higher in sunflower silage that harvested at milk-dough seed stage. The highest lactic and propionic acid and the lowest butyric acid and pH values were observed in blooming stage silage. Tan and Tumer

Corresponding Author: Elahe Mafakher, Department of Agronomy, Faculty of Agriculture, University of Shahid Chamran, Ahvaz, Iran
(1996) ensiled sunflower at several stages of maturity and concluded that the final flowering stage was the best stage for silage making.

Studies are limited on the whole plant of sunflower harvested at varying stages of maturity for use as silage in Iran. The objective of this research was determine of dry matter yield, chemical composition and digestibility of sunflower harvested at three developmental stages.

MATERIALS AND METHODS

Sunflower crop (Helianthus annus L.) was planted in different planting date included Feb 26th, March 12th and March 26th, 2008 at Shahid Chamran University of Ahvaz (Iran). Sunflower cultivar was Euroflor that used at 130000 plants ha⁻¹ in a complete randomized block design with four replications. Whole plants were hand harvested on May 22th in late of budding stage (R₁), late of flowering stage (R₅) and milk-dough seed stage (R₇-R₉) from 10 cm above soil level. All samples were harvested from the center of rows and then immediately weighed. Forage samples used for dry matter yield were forced air oven dried at 70°C. Also at same time (May 22th) plant materials at each stages chapped, wilting and ensiled as rapidly as possible in 2 L plastic jars. Then, plant materials was packed and compressed by hand. Sealed experimental silages were incubated at room temperature (20 to 23°C) for 45 days. After this time experimental silos were opened. Samples were dried at 70°C and data reported an oven-dry basis. Fifty grams of each samples was diluted 1:2 with distilled water, blended for 1 min and filtered through Whatman 54 paper and then measuring with a portable pH meter. Dry Matter (DM), Crude Protein (CP), Crude Fiber (CF) and Ash following the method of AOAC (1990) Water Soluble Sugar (WSS) and starch was determined according to Schlegl (1986). In vitro Dry Matter Digestibility (IVDMD) and in vitro Organic Matter Digestibility (IVOMD) was determined by the method of Tilley and Terry (1963). Data were analyzed by Statistical Analysis System (SAS Inst., 2003) to determine significant effects (p<0.01).

RESULTS AND DISCUSSION

The highest forage yield and head ration were obtained at R6-R7 stage and these values increased with maturity. This results were also reported by Demirel et al. (2006b) and Edwards et al. (1978). The highest leaf ration and height were obtained at R3 stage. Height of plant decreased by maturity. arise from the head ration increase with maturity (Table 1). Which is in contrast with result published by Demirel et al. (2006b). This difference may be according to genotype varied. Mean dry matter contents increased with maturity but developmental stages had not significant differences (Table 2). In general, an increase in dry matter and organic matter contents is expected with maturity (Demirel et al., 2006b). Crude protein was greater for R3 stage compared to other stages and had not significant differences among R5 and R6-R7 (Table 2). Many experiments reported similar results that crude protein content declined with increasing maturity (Islam et al., 2004; Harper et al., 1981). This decline was related to decrease in leaf/steam proportion in plant with maturity (Fig. 1, Table 1). Water soluble sugars of R5 stage was higher than other stages (Table 2).

Chemical composition of treatment silages are presented in Table 3. Dry matter of R5 stage silage was higher than of R3 and R6-R7 stages. The concentrations of crude protein and ash were significantly higher in R3 stage silage compared to other treatments and declined with increasing of maturity. This decline was related to the decline in the proportion
Table 1: Height of plant, forage yield and weight, moisture and proportion of shoot dry-matter in sunflower at different developmental stages

<table>
<thead>
<tr>
<th>Developmental stages</th>
<th>Height (cm)</th>
<th>Fresh forage yield (t ha⁻¹)</th>
<th>Dry forage yield (t ha⁻¹)</th>
<th>Composition (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Stem</td>
</tr>
<tr>
<td>R3</td>
<td>152.24a</td>
<td>100.45b</td>
<td>11.43b</td>
<td>48.387a</td>
</tr>
<tr>
<td>R5</td>
<td>137.41ab</td>
<td>147.58ab</td>
<td>18.37ab</td>
<td>48.852a</td>
</tr>
<tr>
<td>R6-R7</td>
<td>129.41b</td>
<td>187.42a</td>
<td>25.47a</td>
<td>44.930a</td>
</tr>
<tr>
<td>CV (%)</td>
<td>5.32</td>
<td>13.20</td>
<td>15.10</td>
<td>4.63</td>
</tr>
</tbody>
</table>

Mean values in the same column followed by the same letter(s) are not significantly different at p<0.01 by ANOVA and Duncan multiple range tests

Table 2: Dry Matter (DM), Crude Protein (CP) and Water Soluble Sugar (WSS) in sunflower at different development stages

<table>
<thead>
<tr>
<th>Development stages</th>
<th>DM (%)</th>
<th>CP (%)</th>
<th>WSS (mg g⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R3</td>
<td>11.35a</td>
<td>16.30a</td>
<td>95.34b</td>
</tr>
<tr>
<td>R5</td>
<td>12.51a</td>
<td>13.38b</td>
<td>116.50a</td>
</tr>
<tr>
<td>R6-R7</td>
<td>13.70b</td>
<td>12.46b</td>
<td>74.50c</td>
</tr>
<tr>
<td>CV (%)</td>
<td>4.81</td>
<td>3.28</td>
<td>4.38</td>
</tr>
</tbody>
</table>

Mean values in the same column followed by the same letter(s) are not significantly different at p<0.01 by ANOVA and Duncan multiple range tests

Fig. 1: Dry matter of leaf to steam. Proportion in plant at different development stages. I, standard error of a mean

of leaf in whole plant (Table 1). There were not significantly different among silages crude fiber, although in R5 stage was greater than R6-R7 stages. It was reported that decreases in NDF content with maturation arise from the fact that seed ration increases and seed has lower cell wall components (Demirel et al., 2006b). Silage pH value was lower for R6-R7 stages and declined with increasing maturity. This result may be due to increase of concentration of water soluble sugars, Lactate and extensive fermentation with increasing maturity (Bal et al., 1997).

The effect of maturity on digestibility is shown in Table 3. In vitro organic matter digestibility was similar in treatments. In vitro Dry matter digestibility was similar in R3 and R5 stages silages and was lower in R6-R7 stage silage. The lower dry matter digestibility of R6-R7 stage may be due to the higher ether extract with seed formation (Valdez et al., 1988). On the other hand, starch and cell wall of feedstuffs have a great impact on digestibility (Demirel et al., 2006a). Therefore, this result is due to the higher content of starch (Fig. 2).
Table 3: Chemical composition, dry and organic matter digestibility (% DM) and pH of sunflower silage at different development stages

<table>
<thead>
<tr>
<th>Development stages</th>
<th>pH</th>
<th>DM</th>
<th>Ash</th>
<th>CP</th>
<th>CF</th>
<th>IVDMC</th>
<th>IVOMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>R3</td>
<td>5.67a</td>
<td>27.91b</td>
<td>21.37a</td>
<td>15.12a</td>
<td>32.25a</td>
<td>69.93a</td>
<td>63.35a</td>
</tr>
<tr>
<td>R5</td>
<td>4.59b</td>
<td>32.97a</td>
<td>17.37b</td>
<td>13.06b</td>
<td>35.50a</td>
<td>69.18a</td>
<td>64.81a</td>
</tr>
<tr>
<td>R6-R7</td>
<td>4.30c</td>
<td>24.19c</td>
<td>16.50b</td>
<td>12.87b</td>
<td>32.75a</td>
<td>65.87b</td>
<td>62.72a</td>
</tr>
<tr>
<td>CV(%)</td>
<td>0.70</td>
<td>2.12</td>
<td>2.70</td>
<td>1.61</td>
<td>6.18</td>
<td>1.24</td>
<td>2.14</td>
</tr>
</tbody>
</table>

Mean values in the same column followed by the same letter(s) are not significantly different at p<0.01 by ANOVA and Duncan multiple range tests.

Fig. 2: Starch content of whole sunflower plant at different development stages. I, standard error of a mean.

In conclusion, acceptable quantity and quality forage can be made from whole plant sunflower at R6-R7 stage. But because of decrease in dry matter digestibility, nutritive value and also stem bending and mechanize harvesting difficult, in this stage, R5 stage was optimum maturity stage for harvesting sunflower to use as silage, however, produced lower dry matter yield.

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REFERENCES


