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EFFECT OF MOLASSES AND CORN AS SILAGE ADDITIVES ON THE CHARACTERISTICS OF MOTT DWARF ELEPHANT GRASS SILAGE AT DIFFERENT FERMENTATION PERIODS

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ABSTRACT

The aim of the present study was to determine the best stage of cut and to enhance the quality of mott grass silage by the addition of additives. For this purpose, mott grass was obtained at 45 and 60 days of its re-growth, chopped with an average particle length of ½ inches and filled in plastic boxes by mixing two additives (molasses and corn), @ 0, 1, 3 and 5% of the forage dry matter (DM), with three replicates each. In this way, 72 silos for each stage of cut were prepared and kept at room temperature. Three silos of each treatment were opened at each fermentation period (30, 35 and 40 days) for determination of pH and lactic acid contents. The results indicated that mott grass cut at 45 days of its regrowth was the best to harvest maximum nutrients. The addition of molasses @ 3% was found to be the best at 35 days fermentation period. The pH decreased and lactic acid increased with level of additives and fermentation periods. Dry matter and crude protein contents increased to some extent. However, silage without additives showed the highest pH and low lactic acid, indicating the poor quality silage. Similarly, a loss in DM and crude protein was observed in mott grass ensiled without additives. It was concluded that the use of additives such as molasses @ 3% fodder DM is imperative to make quality mott grass silage.

Key words: Mott dwarf elephant grass, molasses, corn, silage, fermentation period, pH, lactic acid**.**

INTRODUCTION

Growing human population urges the immense need to exploit the existing livestock resources to meet the animal protein requirements. It is impossible unless optimal fodder and forage production is ensured. In Pakistan, low quality fodders coupled with the reduction in the fodder area are the main constraints, which adversely affect the animal production. In future, it is expected that ruminants will be more dependant on forages because readily expanding human population will have direct competition with livestock for edible grains. In Pakistan, 22.96 million hectares are under crop production, out of which only 3.35 million hectares are devoted for fodder crops, which produce 58 million tons of fodder and this area is decreasing @ 2% after each decade (Gill, 1998).

The quantity of fodder produced is 54-60% less than actual need of livestock (Chaudhary *et al*., 1991). There are two fodder scarcity periods (November-January and May–July), having a negative impact on livestock productivity. One way to improve the current situation is the introduction of high yielding fodder varieties and adopting the technology through which fodder can be preserved for scarcity periods. At the same time, to harvest maximum nutrients beneficial for livestock feeding, fodder cut at proper stage is very imperative as crude protein contents decreased and fiber contents increased with the fodder maturity (Lee *et al*., 1991).

Mott grass is one of the high yielding fodder varieties available in Pakistan. It is high quality forage that maintains its quality over long re-growth intervals. This fodder has the potential to provide fodder in one slump period (May-July) when other traditional fodders are inadequate. If mott grass is preserved as silage during this period and fed during second slump period (November-January), quality fodder supply can be ensured.

Silage is a method of forage preservation through stabilizing fermentation process by decreasing the pH within minimum fermentation period. In silage, lack of oxygen and the accumulation of lactic acid inhibit its microbial metabolism and preserves nutrients (Ranjit and Kung, 2000). Successful silage fermentation depends on achieving both anaerobic conditions and a low pH. The low pH is usually accomplished through the fermentation of sugars in the crop to lactic acid by lactic acid bacteria, which decreases plant enzyme activity and prevents the proliferation of detrimental anaerobic microorganisms, especially clostridia and enterobacteria (Yang *et al.,* 2004). The mott grass has low concentrations of fermentable carbohydrates and the addition of additives can improve the quality of its silage (Iqbal *et al*., 2005). Molasses enrich the fresh material with carbohydrates and fills the gaseous pores, thereby reducing the influx of oxygen in the silage. Using molasses or corn as additive can increase the amount of fermentation end products due to fermentation of the available sugars (Yakota *et al*., 1992). The present study was conducted with an aim to finalize the proper stage of cut for feeding and to establish the best additive, level of additive and fermentation period for mott grass silage making.

MATERIALS AND METHODS

Mott grass sampling

Mott grass was obtained at 45 and 60 days of its re-growth from the field adjacent to Livestock Experiment Station, University of Agriculture, Faisalabad, Pakistan. It was chopped, dried at 60°C and ground through a willey mill to 2 mm size. The dry matter (DM), nitrogen content and ash of the mott grass were determined using methods described by AOAC (1990). The neutral detergent fiber (NDF), acid detergent fiber (ADF), hemicellulose, cellulose and acid detergent lignin (ADL) were determined using methods described by Van-Soest *et al.* (1991).

Laboratory scale silage

The mott grass was chopped with an average particle length of ½ inches and thoroughly filled in plastic boxes by mixing two additives (molasses and corn) @ 0, 1, 3 and 5% of the forage DM, with three replicates. In this way, 72 silos for each stage of cut were prepared and kept at room temperature. Three silos of each treatment were opened at each fermentation period (30, 35 and 40 days) for each stage of cut for determination of pH and lactic acid contents (Bakers and Summerson, 1961). These samples were also analyzed for DM, nitrogen and ash by using the methods as mentioned above.

Statistical analysis

The data on each parameter were analyzed following completely randomized design with four factors and three replicates. The means were compared using Least Significance Difference test (Steel and Torrie, 1980). A COSTAT computer package (CoHort Software, Berkeley CA, USA) was used for analysis of data for all parameters.

RESULTS AND DISCUSSION

Chemical composition of mott grass

Mott grass cut at 45 days stage of maturity had significantly higher crude protein (CP), ash and hemicellulose but lower DM, NDF, ADF, ADL and cellulose contents compared to 60 days stage of cut (Table 1). The increase in DM with maturation of mott grass may be attributed to increased cell wall contents and decreased moisture contents. The reduction in CP contents with maturation may be due to decrease in leaf to stem ratio as well as accelerated rate of accumulation of structural material. The probable reason of increase in fiber fractions may be an increase in cell wall contents and DM. With the maturity of plant, cell wall becomes thickened and concentration of fiber fractions increase because the carbon skeleton of other cell contents is converted into the fiber fraction and lignin content increases as well. The results of the present study are consistent with previous studies (Dabo *et al.*, 1988; Lee *et al.*, 1991; Ruiz *et al.*, 1992) that DM, NDF, ADF, ADL and cellulose contents increased with the increase in stage of maturity, while CP contents decreased.

Table 1: Chemical composition (%) of mott grass at 45 and 60 days of maturity

Parameters	Stage of maturity (days)	
	45	**60**
Dry matter	$15.45^b \pm 0.12$	$18.23^a \pm 0.16$
Crude protein	$13.90^a \pm 0.17$	$11.75^b \pm 0.19$
Ash	$12.40^a \pm 0.11$	$11.12^b \pm 0.10$
Neutral detergent fiber	$69.72^b \pm 0.18$	$74.92^a \pm 0.20$
Acid detergent fiber	$40.52^b \pm 0.08$	$46.08^a \pm 0.09$
Acid detergent lignin	$5.90^b \pm 0.19$	$6.50^a \pm 0.20$
Cellulose	$38.62^b \pm 0.13$	$41.12^a \pm 0.10$
Hemicellulose	$29.22^a \pm 0.21$	$28.84^b \pm 0.24$

Values with different superscripts within a row differ significantly from each other (P<0.05).

Silage characteristics

The changes in pH of mott grass silage due to additives and fermentation periods are shown in Table 2. Maximum pH was found in control and it increased with increase in fermentation period. However, a decrease in pH due to level of additives and fermentation period was observed. In case of molasses addition, pH was significantly (P<0.05) low compared to corn additive (Table 3). There was non-significant difference in pH at 3 and 5% levels. However, a minimum value was found at 35 days fermentation period that differed significantly (P<0.05) with 30 days fermentation period but the difference in pH at 35 and 40 days was non-significant (Table 3). On the other hand, minimum lactic acid values were found at 0% additive level at all fermentation periods and both stages of cut (Table 4). However, lactic acid increased due to level of additives and fermentation periods. Statistically, there was non-significant difference in lactic acid production at both stages of cut; 35, 40 days fermentation periods and 3 and 5% additive levels. But the lactic acid production at all three levels (1, 3 and 5%) were higher (P<0.05) compared to 0% level of additive (Table 3). It was also observed that color and flavor of silage was desirable due to additives but it was not good in case of control. Almost similar trend was found in pH and lactic acid production in mott grass silage at 60 days harvest stage.

In brief, 3% molasses level and 35 days fermentation period were found sufficient to produce the quality silage as pH was minimum and lactic cid was maximum under these conditions. High pH and low lactic acid in mott grass silage without any additive may be attributed to low concentration of fermentable carbohydrates in the mott grass. Bolsen *et al.* (1996) also reported that the fermentation process was highly influenced by the availability of fermentable carbohydrates and pre-dominant bacteria during ensiling process. The addition of additive decreased pH and increased lactic acid, due to increased availability of carbohydrates. The sugars provided substrate for lactic acid bacteria that increased accumulation of lactic acid, resulting in low pH. In the present study, minimum pH and maximum lactic acid contents were found in the silage ensiled for 35 days, probably because of increased population density of epiphytic lactic acid which increased the accumulation of lactic acid with increasing fermentation time and subsequently reduced pH. According to McDonald *et al*. (1991) and Yang *et al*. (2004), attainment of low pH is one of the important determinants for final silage fermentation quality.

Chemical composition of mott grass silage

The DM recovery was higher due to additives compared to control (Table 5). Statistical analysis indicated significantly (P<0.05) more DM due to molasses compared to corn (Table 3). Similarly, 3 and 5% levels of additive recovered significantly (P<0.05) more DM compared to other levels. More DM recovery with molasses may be due to the addition of water soluble carbohydrates that improves the fermentation characteristics. Once the silage gains the stability then there is no more fermentation and at very low pH the microbes become the part of medium and reduction in DM is prohibited. Weinberg and Muck (1996) and Sharp *et al.* (1994) have indicated that increased DM recovery may have been due to homolactic fermentation, which decreased fermentation losses. Lactic acid production reduces the carbon loss which results in more DM recovery.

There was improvement in CP contents due to additives when compared with control (Table 6). Statistical analysis of the data indicated significantly (P<0.05) more CP at 45 days than 60 days cut (Table 3). A minor increase in CP due to corn was found but statistically it did not differ from molasses. Maximum CP was found at 3% additive level that differed significantly from other levels. The possible reason of increase in CP during ensiling may be the fact that proteolytic activity during fermentation produces NH_3 but due to efficient fermentation and early stability of silage, this proteolysis activity is inhibited and the produced NH_3 helps in getting the aerobic stability because of its fungicidal properties (Kung *et al*., 2000). The other possible reason of increase in CP contents due to additives may be protein sparing activity, as by day 7, pH has been reduced sufficiently to inactivate the plant proteolytic enzymes. These enzymes are acid labile with optimum pH ranges from 5 to 6 and their activity is decreased as pH approaches 5 but completely stopped at pH 4.5 to 3.8 (Sharp *et al*., 1994). Leibensperger and Pitt (1988) pointed out that a rapid decrease in pH inhibits clostridial fermentation and hydrolysis of plant proteins by plant enzymes. Moreover, due to efficient fermentation, preservation and stability of silage, different types of bacteria present in the medium have no chance to perform their activity and they become the part of medium (silage). These bacteria are protein in nature and contain more than 75% true protein (Yang *et al*., 2004).

A minor increase in ash contents was observed due to additives compared to control (Table 7). Statistical analysis indicated significantly (P<0.05) more ash contents at 45 days stage compared to 60 days cut. In case of molasses, ash contents were significantly (P<0.05) higher compared to corn. There was non-significant difference in ash at 35 and 40 days fermentation period. However, each level of additive significantly (P<0.05) improved ash contents (Table 3). Various previous studies (Garcia *et al*., 1989; Mustafa *et al*., 2000) supported these findings and reported that ash contents increased to some extent during ensiling at different fermentation periods. This increase may be attributed to increase in DM during ensiling and reduction in control may be due to DM loss.

It was concluded that mott grass cut at 45 days of its regrowth is the best to harvest maximum nutrients beneficial for more production. To produce the quality mott grass silage, use of molasses @ 3% fodder dry matter and 35 days fermentation period are imperative.

Table 2: pH of mott grass silage as affected by level of additives and fermentation periods

Additives	Levels (%)	45 days stage of cut			60 days stage of cut		
		Fermentation periods (days)			Fermentation periods (days)		
		30	35	40	30	35	40
Molasses	0	4.65±0.015	4.80±0.018	4.90±0.018	4.66±0.021	4.81±0.006	4.91±0.015
	1	4.20±0.018	4.14±0.023	4.08±0.015	4.21±0.019	4.17±0.015	4.19±0.006
	3	4.10±0.018	3.98±0.012	3.98±0.015	4.11±0.024	3.99±0.006	3.99±0.006
	5	4.08±0.015	4.01±0.015	4.01±0.012	4.09±0.030	4.02±0.015	3.81±0.207
Corn	0	4.69±0.052	4.85±0.026	4.90±0.006	4.71±0.030	4.84±0.031	4.80±0.015
	1	4.36±0.021	4.24±0.030	4.19±0.015	4.35±0.020	4.26±0.023	4.19±0.015
	3	4.21±0.024	4.17±0.015	4.08±0.009	4.22±0.028	4.17±0.021	4.08±0.015
	5	4.19±0.021	4.14±0.018	4.11±0.019	4.20±0.006	4.15±0.026	4.12±0.006

Table 3: Mean comparison of mott grass silage composition

Factors	Mean values (± SE) for				
	pH	Lactic acid	DM	CP	Ash
Stage of cut					
45 days	4.30± 0.016[a]	3.86 ± 0.012[a]	16.17 ± 0.017[b]	13.73 ± 0.026[a]	12.18 ± 0.015[a]
60 days	4.34 ± 0.018[a]	3.86 ± 0.014[a]	18.20 ± 0.021[a]	12.59 ± 0.023[b]	11.25 ± 0.019[b]
Additives					
Molasses	4.28 ± 0.029[b]	3.88 ± 0.010[a]	17.79 ± 0.026[a]	13.15 ± 0.012[a]	11.86 ± 0.022[a]
Corn	4.36 ± 0.027[a]	3.84 ± 0.013[b]	16.59 ± 0.026[b]	13.17 ± 0.015[a]	11.57 ± 0.035[b]
Level of additives (%)					
0	4.83 ± 0.019[a]	3.64 ± 0.012[c]	15.96 ± 0.032[c]	12.04 ± 0.070[c]	11.47 ± 0.001[d]
1	4.29 ± 0.015[b]	3.87 ± 0.020[b]	17.08 ± 0.026[b]	13.41 ± 0.029[b]	11.74 ± 0.006[b]
3	4.09 ± 0.019[c]	3.97 ± 0.015[a]	18.28 ± 0.026[a]	13.63 ± 0.029[a]	11.72 ± 0.023[c]
5	4.07 ± 0.021[c]	3.97 ± 0.018[a]	18.20 ± 0.026[a]	13.60 ± 0.029[a]	11.93 ± 0.021[a]
Fermentation periods (days)					
30	4.35 ± 0.020[a]	3.83 ± 0.012[b]	16.95 ± 0.023[c]	13.12 ± 0.021[b]	11.69 ± 0.035[b]
35	4.29 ± 0.018[b]	3.87 ± 0.009[a]	17.32 ± 0.025[a]	13.17 ± 0.006[a]	11.72 ± 0.013[a]
40	4.31 ± 0.014[b]	3.89 ± 0.010[a]	17.29 ± 0.025[b]	13.19 ± 0.006[a]	11.74 ± 0.023[a]

Values with different superscripts within a row for each factor differ significantly ($P<0.05$).

Table 4: Lactic acid of mott grass silage as affected by level of additives and fermentation periods

Additives	Levels (%)	45 days stage of cut			60 days stage of cut		
		Fermentation periods (days)			Fermentation periods (days)		
		30	35	40	30	35	40
Molasses	0	3.70±0.019	3.62±0.012	3.59±0.015	3.72±0.015	3.60±0.012	3.55±0.026
	1	3.86±0.021	3.94±0.018	3.95±0.019	3.83±0.018	3.95±0.015	3.94±0.021
	3	3.91±0.018	4.08±0.009	4.10±0.012	3.89±0.015	4.10±0.021	4.08±0.029
	5	3.87±0.023	3.98±0.015	4.08±0.007	3.92±0.022	3.97±0.018	4.09±0.015
Corn	0	3.75±0.018	3.69±0.009	3.53±0.012	3.76±0.021	3.71±0.007	3.54±0.015
	1	3.79±0.012	3.83±0.020	3.89±0.015	3.80±0.012	3.84±0.021	3.90±0.012
	3	3.85±0.019	3.90±0.013	3.98±0.015	3.86±0.023	3.91±0.012	3.99±0.021
	5	3.91±0.010	3.94±0.012	4.01±0.015	3.92±0.026	3.95±0.015	4.02±0.032

Table 5: DM of mott grass silage as affected by level of additives and fermentation period

Additives	Levels (%)	45 days stage of cut			60 days stage of cut		
		Fermentation periods (days)			Fermentation periods (days)		
		30	35	40	30	35	40
Molasses	0	15.45±0.026	15.10±0.023	14.80±0.012	17.90±0.026	17.35±0.026	16.20±0.023
	1	15.60±0.026	15.75±0.026	16.71±0.025	18.30±0.026	18.72±0.012	19.10±0.023
	3	16.90±0.026	18.95±0.026	18.93±0.026	18.95±0.021	21.99±0.021	21.93±0.026
	5	17.35±0.026	16.80±0.026	17.67±0.018	19.04±0.015	18.25±0.026	19.23±0.020
Corn	0	15.25±0.026	15.02±0.032	14.90±0.026	16.98±0.018	16.65±0.026	16.00±0.026
	1	15.40±0.026	16.35±0.026	15.85±0.026	17.15±0.026	17.90±0.026	18.20±0.023
	3	15.95±0.026	16.65±0.026	16.00±0.026	17.28±0.018	17.95±0.026	17.95±0.006
	5	15.98±0.012	15.80±0.026	15.12±0.015	17.75±0.026	18.02±0.032	18.07±0.038

Table 6: CP of mott grass silage as affected by level of additives and fermentation period

Additives	Levels (%)	45 days stage of cut			60 days stage of cut		
		Fermentation periods (days)			Fermentation periods (days)		
		30	35	40	30	35	40
Molasses	0	12.95±0.026	12.55±0.026	12.00±0.026	11.90±0.006	11.75±0.026	11.20±0.023
	1	13.93±0.026	14.00±0.026	14.10±0.022	12.52±0.015	12.85±0.026	12.80±0.022
	3	14.10±0.023	14.18±0.018	14.15±0.026	12.70±0.006	12.95±0.026	14.00±0.021
	5	14.16±0.021	14.13±0.026	13.95±0.026	12.85±0.026	12.86±0.015	12.93±0.026
Corn	0	12.98±0.018	12.50±0.071	12.06±0.015	11.93±0.026	11.70±0.023	11.00±0.022
	1	13.95±0.029	14.10±0.029	14.25±0.029	12.60±0.022	12.92±0.015	12.98±0.018
	3	14.15±0.012	14.17±0.019	14.30±0.006	12.85±0.026	12.90±0.006	13.15±0.012
	5	14.65±0.012	14.25±0.029	14.00±0.026	12.75±0.012	12.95±0.026	13.10±0.022

Table 7: Ash of mott grass silage as affected by level of additives and fermentation period

Additives	Levels (%)	45 days stage of cut			60 days stage of cut		
		Fermentation periods (days)			Fermentation periods (days)		
		30	35	40	30	35	40
Molasses	0	12.24±0.015	12.20±0.023	12.18±0.022	11.10±0.006	11.08±0.006	10.94±0.015
	1	12.28±0.015	12.35±0.009	12.33±0.015	11.26±0.021	11.38±0.026	11.40±0.006
	3	12.27±0.035	12.30±0.006	12.29±0.027	11.27±0.035	11.28±0.023	11.34±0.013
	5	11.98±0.022	12.44±0.015	12.46±0.021	12.07±0.017	12.10±0.023	12.20±0.020
Corn	0	11.90±0.006	11.83±0.015	11.70±0.00	11.00±0.006	10.85±0.015	10.65±0.006
	1	12.08±0.020	12.18±0.022	12.40±0.006	11.10±0.023	11.07±0.030	11.15±0.006
	3	12.16±0.021	12.20±0.023	12.28±0.023	11.07±0.009	11.10±0.023	11.15±0.006
	5	12.10±0.006	12.08±0.020	12.16±0.021	11.18±0.023	11.19±0.012	11.28±0.023

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