Effect of Additives and Fermentation Periods on Chemical Composition and *In situ* Digestion Kinetics of Mott Grass (*Pennisetum purpureum*) Silage

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ABSTRACT : This study was conducted to see the influence of additives and fermentation periods on Mott grass silage (MGS) characteristics, its chemical composition and to compare the digestion kinetics of Mott grass (MG) and MGS in *Nili* buffaloes. Mott grass chopped with a locally manufactured chopper was ensiled using two additives, cane molasses and crushed corn grains each at 2, 4 and 6% of forage DM for 30 and 40 days in laboratory silos. The pH, lactic acid concentration, dry matter (DM), crude protein and fiber fractions of MGS were not affected by the type or level of additive and fermentation periods. The non-significant pH lactic acid concentration, and chemical composition of MGS indicated that the both molasses and crushed corn were utilized at similar rate for the growth of lactic acid bacteria and production of organic acids. The MG ensiled with molasses at 2% of fodder DM for 30 days was screened out for *in situ* digestion kinetics in *Nili* buffaloes. Ruminal DM and neutral detergent fiber (NDF) degradabilities of MGS were significantly ($p<0.05$) higher than that of MG. The DM and NDF rate of degradation, lag time and extent of degradation was non-significant between MGS and MG. The higher ruminal degradation of DM and NDF of MGS than MG was probably a reflection of fermentation of MG during ensilation that improved its degradability by improving the availability of easily degradable structural polysaccharides to ruminal microbial population. The results in the present study have indicated that MG ensiled with either 2% molasses or 2% crushed corn for 30 days has better nutritive value for buffalo. ***(Asian-Aust. J. Anim. Sci. 2005. Vol 18, No. 6 : 812-815)***

Key Words : *In situ* Digestion Kinetics, Mott Grass, Buffalo, Silage

INTRODUCTION

Regular availability of quality fodder is critical for cost effective ruminant production. However, growing human need for food in south Asia has limited the area under fodder cultivation. The fodder supply is further hampered by the weather extremes where ruminants have been suffering from increasingly lean periods of fodder availability (Sarwar et al., 2002; Sarwar et al., 2003ab). The increasing gap between fodder availability and demand in the region calls for the preservation of fodder crops when abundantly available to regularize fodder supply.

The main aim of ensiling is to preserve fodder under anaerobic condition where anaerobic microbes build up organic acids mainly lactic acid by using fermentable carbohydrates (Bolsen et al., 1996; Yahaya et al., 2004). Factors that affect the rate of lactic acid build up, pH decline and final pH of the silage are fermentable carbohydrate in fodder, its buffering capacity (related to the amount of acid needed to change the pH), dry matter (DM) content, the type and amount of bacteria present on fodder (Higginbotham et al., 1998; Sarwar et al., 2004). The most widely ensiled fodder is maize (Woolford, 1984), however, oat, sorghum, barley and millet grasses could also be ensiled.

Mott grass (MG) has recently been introduced in the region that maintains its quality over long re-growth periods and has potential to produce about 100 ton/hectare. It could be ensiled to improve fodder supply during lean availability of fodder (Akbar and Ullah, 1994; Sarwar et al., 2003b). However, MG has low concentration of soluble carbohydrates (Bolsen et al., 1996) thus its ensilation with fermentable carbohydrates is prerequisite for better fermentation. The scientific evidence regarding the nutritive value and ruminal digestion kinetics of MG and its silage in *Nili* buffaloes is limited.

Therefore, the objective of this study was to examine the influence of additives and fermentation periods on Mott grass silage (MGS) characteristics, its chemical composition and to compare the digestion kinetics of MG and MGS in *Nili* buffaloes.

MATERIALS AND METHODS

Fodder

Mott grass (*Pennisetum purpureum*) cuttings were sown in the fields of the Animal Nutrition Research Center, University of Agriculture, Faisalabad, Pakistan. The samples of MG were taken at different maturities and were analyzed for yield and nutrient concentration. The fodder was chopped in a locally manufactured chopper. Samples were dried at 55°C and ground to particle size of 2 mm through a Wiley mill. These samples were analyzed for DM,

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Table 1. Chemical composition of Mott grass on dry matter basis

Parameters	Composition (%)
Dry matter	17.0
Crude protein	11.9
Neutral detergent fiber	76.8
Acid detergent fiber	47.0
Acid detergent fiber	4.32
Hemicellulose	29.8
Cellulose	42.7
Ash	11.9

nitrogen (N) content, total ash using methods described by AOAC, (1990), neutral detergent fiber (NDF), acid detergent fiber (ADF), hemicellulose, cellulose and acid detergent lignin (ADL) by the methods of Van Soest et al. (1991).

Preparation of laboratory silos

Mott grass chopped with a locally manufactured chopper was ensiled using two additives, cane molasses and crushed corn grains each at 2, 4 and 6% of forage DM for 30 and 40 days in laboratory silos. After opening the laboratory silos, pH and lactic acid contents were determined immediately (Baker and Summerson, 1961). The silage samples were analyzed for DM, N, true protein (TP), total ash using methods described by AOAC (1990), NDF, ADF, hemicellulose, cellulose and ADL by methods of Van Soest et al. (1991).

***In situ* trial**

One ruminally cannulated *Nili* buffalo bull was used to study the ruminal digestion kinetics of MG and MGS. The buffalo bull was housed on a concrete floor in a pen. Ten days were given as adaptation period to the diet at the start of experiment followed by 4 days of incubation period for the *in situ* nylon bags. The ruminally cannulated buffalo bull was fed the same diet as was being incubated in its rumen to avoid the effects of diet on the ruminal fermentation (Clark and David, 1990). The MG and MGS were ground to 2 mm and screened through a Wiley mill. Nylon bags measuring 10×23 cm, with an average pore size of 50 μm, were used. Each bag contained a 10 g sample of MG or MGS (DM basis). The bags were closed and tied with nylon fishing line and were exposed to ruminal fermentation for 1, 2, 4, 6, 10, 16, 24, 36, 48 and 96 h. Two bags were incubated for each time point to determine DM and NDF digestion. All bags were soaked in distilled water (39°C) for 15 minutes just before placing them into the rumen (Sarwar et al., 1999). After removal from the rumen, these bags were washed in running tap water until the rinse was clear. The bags were then dried in a forced air oven at 55°C. After equilibration, the bags were weighed back and residues were transferred to 100 ml beakers for NDF analysis. Digestion coefficient of DM and NDF were calculated at 48 h of incubation. Rate of disappearance, lag time and extent of digestion of DM and NDF of Mott grass and its silage were determined by the methods described by Sarwar et al. (1991).

Statistical analysis

The data thus generated during laboratory trial were subjected to analysis of variance technique according to factorial arrangement of treatments (2×3×3) i.e. two additives (corn and molasses), three additive levels (2, 4 and 6%) and two fermentation periods (30 and 40 days) to determine the best combination of additive type, its level and fermentation period. The statistical model used for all parameters was;

$$Y_{ijk} = \mu+\alpha_j+\beta_k+\gamma_l+(\alpha\beta)_{jk}+(\alpha\gamma)_{jl}+(\beta\gamma)_{kl}+(\alpha\beta\gamma)_{jkl}+\varepsilon_{ijkl}$$

Where, μ was overall mean,

α_j was the effect of additives (2 additives),

β_k was the effect of levels of additives (2, 4 and 6%),

γ_l was the effect of fermentation periods (30 and 40 days),

$(\alpha\beta)_{jk}$, $(\alpha\gamma)_{jl}$, $(\beta\gamma)_{kl}$ and $(\alpha\beta\gamma)_{jkl}$ were the interactions between factors AB, AC, BC and ABC, respectively, while ε_{ijkl} was the difference within treatment means (error term).

The data on each parameter (lag time, rate and extent of digestion of DM and NDF) was analyzed according to completely randomized design using the GLM procedure of SAS (1988). In case of significant differences ($p<0.05$), the means were subjected to pair wise comparison "Duncan's Multiple Range Test" (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

Chemical composition of Mott grass

The MG harvested at 50 days of age was used for subsequent trials in this study (Table 1).

Characteristics of Mott grass silage

The pH of MGS was not affected by the type and level of additive and fermentation periods (Table 2). Similarly, lactic acid content of MG ensiled with different levels of ground corn or molasses for all fermentation periods did not show any treatment effect (Table 2). However, the pH of MGS in all treatments was within the desirable range. Molasses addition to the grass before ensilation promoted the production of lactic acid (Yakota et al., 1998; Yahya et al., 2004) that led to rapid pH drop of the ensiled medium (Leibensperger and Pitt, 1998). Addition of molasses improved the fermentable carbohydrates of grass fodder thus increasing the growth of lactic acid producing bacteria

Table 2. Influence of different additives and fermentation periods on chemical composition of Mott grass silage

Additives	Corn						Molasses						SE	Main Effects		
Additive levels	2%		4%		6%		2%		4%		6%					
Fermentation days	30	40	30	40	30	40	30	40	30	40	30	40		A	B	C
pH	4.42	4.19	4.34	4.20	4.04	4.20	4.26	4.09	4.06	3.89	3.72	3.50	0.56	NS	NS	NS
Lactic acid	3.88	3.95	3.75	3.75	3.78	3.90	3.82	3.95	3.83	3.90	3.80	4.03	0.42	NS	NS	NS
Dry matter	16.3	16.7	15.7	16.7	16.2	16.4	16.5	17.0	16.5	16.9	16.3	16.8	0.39	NS	NS	NS
Crude protein	10.0	9.80	10.0	9.80	10.1	9.50	10.3	10.2	10.1	8.90	10.0	9.90	0.65	NS	NS	NS
True protein	4.90	4.65	5.30	4.60	5.00	4.20	5.50	5.20	5.40	4.90	5.20	4.75	0.47	NS	NS	NS
Neutral detergent fiber	83.2	82.6	82.5	81.8	82.5	81.8	82.7	82.6	82.5	82.6	82.4	82.5	0.40	NS	NS	NS
Acid detergent fiber	51.8	51.8	51.5	51.1	50.5	51.5	52.0	52.0	51.8	51.9	51.7	51.3	0.62	NS	NS	NS
Hemicellulose	31.4	31.0	31.5	31.1	31.6	31.4	30.7	30.6	30.8	30.7	30.7	31.0	0.68	NS	NS	NS
Cellulose	44.5	44.5	44.5	43.9	44.5	44.8	44.5	45.0	44.5	44.5	44.5	44.0	0.55	NS	NS	NS
Acid detergent lignin	7.40	7.25	6.90	7.25	7.60	6.75	7.60	7.00	7.25	7.40	7.20	7.35	0.25	NS	NS	NS
Ash	11.5	11.3	11.1	10.8	11.3	10.8	11.3	10.9	11.2	11.0	11.1	10.9	0.56	NS	NS	NS

All interactions among additive (A), additive levels (B) and fermentation time (C) were non-significant (NS) at p<0.05.

Table 3. Dry matter and neutral detergent fiber digestion kinetics of Mott grass[1] and its silage[2]

Parameters	Mottg grass	Mott grass silage	SE
Dry matter			
Digestibility[3] (%)	57.8^{b}	59.2^{a}	0.22
Lag time (h)	1.45	1.41	0.10
Rate of degradation (% h^{-1})	3.61	3.64	0.05
Extent[4] (%)	70.0	69.9	0.12
Neutral detergent fiber			
Digestibility	54.9^{b}	56.0^{a}	0.21
Lag time (h)	1.85	1.81	0.13
Rate of degradation (per h)	3.40	3.45	0.05
Extent (%)	70.9	70.9	0.04

Mean values within row bearing different superscripts differ significantly (p<0.05).
[1] Harvested at 50th day.
[2] 2% molasses as additive at 30th days of fermentation.
[3] Digestibility was determined at 48 hours of incubation.
[4] Extent of digestion was determined at 96 hours of incubation.

Yunus et al. (2000) which converted the fermentable sugars in to lactic acid and lowered the pH of the medium to terminate the microbial activity (Yahaya et al., 2001; Sarwar et al., 2003a). The non-significant pH and lactic acid concentration of MGS indicated that the both molasses and crushed corn were utilized at similar rate for the growth of lactic acid bacteria and production of organic acids.

Chemical composition of Mott grass silage

Dry matter of MGS was not affected by additives, their levels or fermentation periods (Table 2). Molasses addition to napier grass before ensiling enhanced the fermentation process and consequently avoided the DM loss (McDonald et al., 1991). Bolsen et al. (1996) reported that addition of molasses reduced nutrients lost by early stabilization of the medium.

Crude protein and TP contents of MGS were not affected by additive type, levels or fermentation periods (Table 2). During the fermentation process extensive proteolytic activity of microbes and plant proteolytic enzymes resulted in a break down of protein librating NH_3-N and other NPN compounds (Acosta et al., 1991). However, the plant proteolytic enzymes activity was inhibited at low pH (McDonald, 1981). In the present study, the proteolytic activity might have checked by the early pH decline in all treatments and thus has caused non-significant differences in TP (Kung et al., 2000; Jeon et al., 2003). Contrary to the present results, Garcia et al. (1989) reported decreased TP and increased NPN compounds of ensiled fodder that was attributed to the proteolytic activity of microbes and plant enzymes.

Additives, their levels and fermentation period did not influence the cell wall fractions (NDF, ADF, hemicellulose, cellulose and ADL) of MGS (Table 2). Selmer-Olsen et al. (1993) reported decrease in hemicellulose content during ensiling of perennial and Italian rye grasses and attributed this reduction to the acidic hydrolysis of hemicellulose due to microbial fermentation. In the present study, both additives caused the early decline in MGS pH and thus avoided the fiber fraction losses due to microbial attack.

Ash contents of MGS were ranged from 10.8 to 11.5% but the difference was non-significant across all treatment means (Table 2). The addition of fermentable carbohydrates has caused early pH decline in MGS and thus minimized the fermentation losses and leaving ash and organic matter contents unaffected (Yunus et al., 2000).

The results in the present study have indicated that ensilation of MG with either molasses or crushed corn at 2% of fodder DM for 30 days best preserved the fodder.

Digestion kinetics of Mott grass and its silage

Ruminal DM and NDF degradabilities of MGS were significantly (p<0.05) higher than that of MG (Table 3). The DM and NDF rate of degradation, lag time and extent of degradation was non-significant between MGS and MG. The higher ruminal degradation of DM and NDF of MGS than MG was probably a reflection of fermentation of MG during ensilation that improved its degradability by improving easily degradable structural polysaccharides during ensiling process (Beauchemin and Rode, 1997). Nadeau et al. (1996) reported that ensilation increased the DM and NDF degradability. Depression in silage degradability has been reported by various workers (Rook and Thomas, 1982; Garcia et al., 1989) who explained that during the ensiling process loss of readily degradable carbohydrate contents by lactic acid producing bacteria was the major reason for reduced degradability of silage.

CONCLUSION

The results in the present study have indicated that ensilation of MG with either molasses or crushed corn at 2% of fodder DM for 30 days best preserved the fodder and MGS comparable nutritive value to MG for buffaloes.

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