

## Nutritional Quality of Napier Grass (*Pennisetum purpureum* Schum.) Silage Supplemented with Molasses and Rice Bran by Goats

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**ABSTRACT** : In order to improve silage quality and utilization of napier grass (*Pennisetum purpureum* Schum.) by goats, the grass was ensiled with molasses (MOL) and/or defatted rice bran (DRB). Napier grass was harvested at the growing stage in July and cut into 3 cm length. The grass was mixed with 4% MOL and/or 15% DRB, ensiled 15 kg each into plastic bags and stored for 9 months. Dry matter content of the silage ensiled with MOL (MOL-silage) was 13.4%, but increased to 20% with DRB addition. The addition of MOL decreased pH value and ammonia nitrogen content, but increased lactic acid content. MOL-silage contained about 6% spoilage, but addition of DRB decreased spoilage to less than 1%. Goats were fed the silage at a level of 2.25% (DM basis) of their body weight. Goats fed DRB- or MOL/DRB-silages maintained nitrogen retention, but goats fed MOL-

silage did not. The rumen fluid of goats fed DRB-silage tended to be higher in acetic acid and lower in propionic acid than those fed the other silages. Ammonia in the rumen fluids, urea nitrogen in the blood and the urinary nitrogen excretion were the lowest in goats fed MOL/DRB-silage. As the result, the ratio of retained nitrogen to nitrogen intake was the highest in goats fed MOL/DRB-silage.

In conclusion, addition of DRB to napier grass increased DM of silage and decreased the volume of spoilage. The combination of MOL and DRB can improve the fermentation quality and thus enhance the utilization of the silage by goats, more than the MOL or DRB being as a single treatment.

**(Key Words** : Napier Grass, *Pennisetum purpureum* Schum., Silage, Rice Bran, Nutritional Quality, Goats)

### INTRODUCTION

Napier grass (*Pennisetum purpureum* Schum.), which grows in the tropical and sub-tropical regions, is dependent on rain fall for high dry matter productivity. The grass is usually managed by grazing or cut-and-carry. To ensure the availability of the grass throughout the year, the grass is either conserved as silage or hay. The grass contains a fairly high moisture which affects the fermentation of silage and hay making.

Yokota et al. (1991) reported that the grass could provide a good quality silage when it was supplemented with molasses (MOL) as the fermentation quality was not affected by the high storage temperature (40°C). The silage, however, contained some effluent in the bag silo, because of the high moisture content (13.4%) in young grass. Yokota et al. (1992) also indicated that napier grass silage obtained from the July harvest was a better feedstuff than a second-cut timothy hay in terms of digestibilities of dry matter and nitrogen, nitrogen

retention and body weight changes by goats. They also showed that the silage was deficient in energy when fed as a single feed. Napier grass silage generated 9% of effluent when dry matter of the original material was 11.4 % and the grass was ensiled in 15 kg-size-bag silo (Yokota et al., 1995). In order to increase dry matter of napier grass silage, Yokota and Ohshima (1997) used raw and defatted rice brans, which are easily available. They concluded that defatted rice bran (DRB) was a better additive on the fermentation quality of the silage.

The present study reports the silage quality of napier grass ensiled with MOL and/or DRB in terms of fermentation, volume of effluent produced, and the nutrient content utilization by goats. Utilization of nutrients was also discussed from the concentrations of rumen fluid and blood constituents.

### MATERIALS AND METHODS

#### (1) Preparation of silages

First growth of napier grass was harvested at the

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growing stage on July 12, 1989. Average sward height of the grass was 272 cm with 91.4% moisture. After hand-harvested, the grass was cut into about 3 cm length and ensiled with 4% MOL and/or 15% of DRB on the fresh grass basis. The Treatments were as follows: 1) 4% MOL, 2) 15% DRB and 3) 4% MOL and 15% DRB. Fifteen kg of the materials were mixed with the additive (s), ensiled into a plastic bag and stored for 9 months in a dark room at an ambient temperature.

## (2) Feeding trial:

Three castrated male Shiba strain goats with a body weight of 15.8 kg were individually housed in metabolism cages and given the 3 kinds of diets for 13 days each according to a 3 × 3 Latin-square design. The whole duration of the animal trials was 39 days. Feeds were given at 2.25% of the body weight daily on dry matter basis in two equal meals at 09:00 and 17:00 hours. Mineral mixture (salt block) and water were freely available. From day 8 to day 12, all the faeces and urine were collected. All faeces for 5 days were dried and composited into one sample. Urine was also preserved with less than 1 ml concentrated sulfuric acid each day and also composited. On day 13 ruminal fluid and blood were taken at 0, 1, 2, 4 and 8 hours after the morning meal. The former was taken by means of a stomach tube and the latter was taken into heparinized tubes from the cervical vein.

## (3) Analysis

Nitrogen and toluene DM (Dewar and McDonald, 1961) contents of silage were determined from fresh silage sample. Other chemical components of feeds and faeces were determined using air-dried samples in a forced air oven at 60°C for 48 hours. Fermentation quality of silages was determined from the cold water extract (Ohshima et al., 1991). The pH values were determined

with a glass rod electric pH meter. Lactic acid was analysed photometrically by the method of Barnett (1951). Volatile fatty acids (VFA) and ammonia nitrogen were determined by steam distillation method and molar ratio of VFA was analysed by a gaschromatograph. Analyses of NDF and ADF were done by the methods of Van Soest and Vine (1967) and Van Soest (1963), respectively.

## (4) Statistical analysis

The data were subjected to analysis of variance as a Latin square design and the repeated measurements of rumen fluid and blood samples were collected (5 determinations of each animal × 3 animals), and statistical significance among treatment means was determined by Student's t test.

## RESULTS AND DISCUSSION

### (1) Silage quality of napier grass

As shown in table 1, DM content of the napier grass was low (8.62%), because of the cloudy weather at harvesting and the rainy condition during ensilage, and some rain drops mixed with the grass. Mean sward height of the grass was 272 cm at harvest. The nitrogen content was lower and NDF and ADF contents were higher than those of the previous paper (Yokota et al., 1995), in which the grass was harvested on July 5 as the same season as the present experiment at the height of 212 cm. Crude fat content of DRB used in the present experiment was 2.01%, although that of rice bran is 18.5% (AFFRCS, 1987).

The chemical and fermentation characteristics of the silages are shown in table 2. The pH value of the silage ensiled with MOL (MOL-silage) was 3.85, with DRB (DRB-silage) 4.47 and with both MOL and DRB (MOL/DRB-silage) 4.05. Lactic acid content was the highest in MOL-silage and the lowest in DRB-silage. Contents of

**Table 1.** Chemical composition of the napier grass, defatted rice bran (DRB), molasses (MOL) and MOL-, DRB- and MOL/DRB silages

		napier grass	DRB	MOL	Mol-silage <sup>1)</sup>	DRB-silage <sup>2)</sup>	MOL/DRB-silage <sup>3)</sup>
Dry matter	(%)	8.62	87.81	73.20	13.44	20.15	22.46
Organic matter	(%DM)	85.31	86.63	88.39	84.84	83.73	84.48
Nitrogen	(%DM)	1.57	3.21	0.72	1.35	2.65	2.34
NDF	(%DM)	67.61	29.10	0.00	58.07	53.73	48.66
ADF	(%DM)	46.08	12.16	0.00	40.12	30.44	26.47
Lignin	(%DM)	6.26	4.67	0.00	5.24	6.92	5.82

<sup>1)</sup> Napier grass silage with 4% molasses.

<sup>2)</sup> Napier grass silage with 15% defatted rice bran.

<sup>3)</sup> Napier grass silage with 4% molasses and 15% defatted rice bran.

**Table 2.** Fermentation quality of napier grass silages ensiled with molasses (MOL) and/or defatted rice bran (DRB)

	MOL-silage <sup>1)</sup> (n=9)	DRB-silage <sup>2)</sup> (n=5)	Mol/DRB-silage <sup>3)</sup> (n=4)
pH	3.85 <sup>bd)</sup>	4.47 <sup>a</sup>	4.05 <sup>ab</sup>
Lactic acid (%DM)	7.98 <sup>a</sup>	1.73 <sup>b</sup>	5.36 <sup>ab</sup>
Acetic acid (%DM)	0.64 <sup>c</sup>	6.67 <sup>a</sup>	3.13 <sup>b</sup>
Propionic acid (%DM)	0.02 <sup>b</sup>	1.41 <sup>a</sup>	0.15 <sup>b</sup>
Butyric acid (%DM)	0.02 <sup>a</sup>	0.05 <sup>ab</sup>	0.01 <sup>b</sup>
NH <sub>3</sub> -N (%TN)	7.02 <sup>a</sup>	11.16 <sup>a</sup>	4.22 <sup>b</sup>
Spoilage (g/kg)	56.2 <sup>a</sup>	0.3 <sup>c</sup>	3.0 <sup>b</sup>

<sup>1), 2), 3)</sup> See table 1.

<sup>4)</sup> Means within a row with different superscripts are significantly different ( $p < 0.05$ ).

acetic and propionic acids in the silages were increased by the addition of DRB. Addition of both MOL and DRB decreased ammonia nitrogen content of the silage. It was suggested that addition of DRB increased dry matter content of silage and MOL accelerated initial lactic acid fermentation by increasing substrates for lactic acid producing microbes. Spoilage, which was a part of silage with mold and did not feed to goats, was highest in MOL-silage followed by MOL/DRB-silage (table 2). The least amounts of spoilage was shown in DRB-silage. These results were attributed to the fact that DRB-silage produced the highest content of propionic acid which generally shows anti-mold-generating activity.

**(2) Nitrogen utilization**

Dry and organic matter digestibilities of silages were not affected by dietary treatments, but crude protein digestibility of the MOL-silage was lower than the DRB- and MOL/DRB-silages ( $p < 0.05$ , table 3). These results may be due to the digestibility of supplemented DRB. The digestibility of crude protein in DRB was 73% (AFFRCS, 1987). In fact 75% of crude protein in DRB- and MOL/DRB-silage were from the supplemented DRB in the silages.

Nitrogen balance in the feeding trials is also shown in table 3. Because DM intake was adjusted to the body weight of the goats in the present trial, nitrogen intake was different and the lowest in the goats fed MOL-silage ( $p < 0.05$ ). Faecal and urinary nitrogen excretion, however, was the lowest in the goats fed MOL/DRB-silage. Retained nitrogen was not different between DRB- and MOL/DRB-silage, but ratio of retained nitrogen to

**Table 3.** Digestibility of some nutrients and nitrogen balance of goats fed napier grass silages ensiled with molasses (MOL) and/or defatted rice bran (DRB)

	MOL-silage <sup>1)</sup> (n=9)	DRB-silage <sup>2)</sup> (n=5)	Mol/DRB-silage <sup>3)</sup> (n=4)
Body weight (kg)	15.7	16.1	15.7
Dry matter intake (g/day)	351	368	349
Apparent digestibility (%)			
Dry matter	70.7	66.0	69.4
Organic matter	67.8	63.5	67.3
Crude protein	49.7 <sup>bd)</sup>	72.4 <sup>a</sup>	78.0 <sup>a</sup>
Neutral detergent fiber	72.3 <sup>a</sup>	64.2 <sup>ab</sup>	61.9 <sup>b</sup>
Acid detergent fiber	75.8 <sup>a</sup>	54.2 <sup>b</sup>	48.6 <sup>b</sup>
Nitrogen balance (g/day)			
Intaked nitrogen	4.78 <sup>b</sup>	9.79 <sup>a</sup>	8.16 <sup>a</sup>
Faecal nitrogen	2.40 <sup>a</sup>	2.71 <sup>ab</sup>	1.80 <sup>b</sup>
Urinary nitrogen	3.47 <sup>a</sup>	4.05 <sup>a</sup>	2.48 <sup>b</sup>
Retained nitrogen	-1.10 <sup>b</sup>	3.03 <sup>a</sup>	3.89 <sup>a</sup>
RN/TN (%)	-	30.9 <sup>b</sup>	47.7 <sup>a</sup>

<sup>1), 2), 3)</sup> See table 1.

<sup>4)</sup> Means within a row with different superscripts are significantly different ( $p < 0.05$ ).

nitrogen intake was much higher in goats fed MOL/DRB-silage than those fed DRB-silage.

**(3) Ruminant fermentation characteristics**

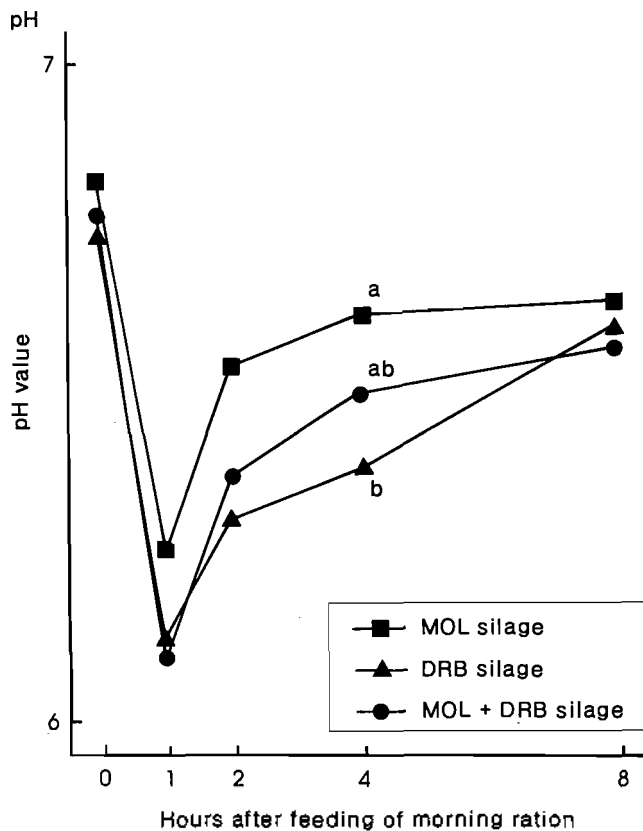
Characteristics of rumen fluids of goats fed the 3 types of silages are shown in table 4. Although samples of rumen fluids were collected at 0, 1, 2, 4, 8 hours after morning feeding, mean values were calculated from 15 values (5 times  $\times$  3 goats). Time course changes of pH value of rumen fluids are also shown in figure 1. The pH values of rumen fluids of goats fed MOL-silage were always higher than those fed the other silages, and were significantly different from that of goats fed MOL/DRB-silage 4 hours after feeding. Cellulolytic activity of rumen microbes was high in higher pH value of the rumen fluid (Terion et al., 1982). Digestibilities of NDF and ADF in DRB added silages were lower than those of MOL-silage. Ammonia nitrogen content of rumen fluids and blood urea contents of goats fed MOL/DRB-silage were lower than those fed the other two silages (table 4). Addition of MOL at ensiling improved nutritional quality of silage

**Table 4.** Characteristics of rumen fluids and blood urea nitrogen (BUN) of goats fed napier grass silages ensiled with molasses (MOL) and/or defatted rice bran (DRB)

	MOL-silage <sup>1)</sup>	DRB-silage <sup>2)</sup>	Mol/DRB-silage <sup>3)</sup>
pH	6.46	6.43	6.58
Total VFA (mmole/dl)	5.84 <sup>4)</sup>	7.40 <sup>a</sup>	6.67 <sup>ab</sup>
Molar % of VFA			
Acetic acid	71.3 <sup>ab</sup>	75.2 <sup>a</sup>	68.9 <sup>b</sup>
Propionic acid	20.9 <sup>ab</sup>	18.3 <sup>b</sup>	24.9 <sup>a</sup>
Butyric acid	6.9 <sup>a</sup>	4.7 <sup>b</sup>	4.9 <sup>ab</sup>
NH <sub>3</sub> -N (mg/dl)	26.7 <sup>a</sup>	28.7 <sup>a</sup>	14.0 <sup>b</sup>
BUN (mg/dl)	19.1 <sup>a</sup>	20.9 <sup>a</sup>	9.7 <sup>b</sup>

<sup>1), 2), 3)</sup> See table 1.

<sup>4)</sup> Mean (n=15) within a row with different superscripts are significantly different ( $p < 0.05$ ).



**Figure 1.** Time course changes of pH values of rumen fluids of goats fed molasses (MOL), defatted rice bran (DRB) or molasses and defatted rice bran (MOL+DRB) supplemented silages in the morning rations. Different letters shows significantly different ( $p < 0.05$ ).

containing DRB by enhancing availability of nitrogen: namely retained nitrogen to nitrogen intake increased, but digested energy was almost the same between the two silages.

In this experiment energy utilization was not determined. Minson (1990) reported that digestible energy intake of animals was almost the same, when they were fed the same amount of diets of similar digestibilities. And utilization efficiency of metabolizable energy of ruminants was 2 times higher at feeding of concentrates than that of forages (MacRae and Loble, 1982; Tyrill et al., 1978). In this experiment it appeared that goats fed MOL-silage could not utilize their metabolizable energy at the same rate on the other two feeding regimes. Therefore goats fed MOL-silage had decreased nitrogen utilization: they could not utilize ammonia which was generated in the rumen at a higher level (table 4) in spite of a low level of nitrogen supply from the diet (table 3). Consequently ammonia was absorbed in the rumen wall and metabolized into urea in the liver resulting in higher urea nitrogen in the blood, and urinary nitrogen. Thus retained nitrogen/nitrogen intake was negative in goats fed MOL-silage.

Increasing of propionic acid in the rumen fluid accelerated protein synthesis of ruminal microbes, utilization of metabolizable energy in Holstein steers (Glenn et al., 1989) and nitrogen retention (Eskeland et al., 1974). These suggested that the goats fed DRB-silage might utilize dietary energy at a lower level of utilization efficiency, because they showed the higher proportion of acetic acid in the ruminal fluid (table 4). Furthermore DRB-silage generated increased ammonia content, which was higher than those fed MOL/DRB-silage. Although nitrogen intake was higher in goats fed DRB-silage than in goats fed MOL/DRB-silage, nitrogen retention was lower in the former than the latter.

In conclusion DRB supplementation was effective in both increasing DM content in silage and improving utilization of napier grass. Addition of MOL to the DRB-silage improved silage fermentation characteristics and utilization of napier grass silage by goats.

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