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Research Article

LOW-COST FORAGE PRESERVATION AND EVALUATION IN RELATION TO NUTRIENT INTAKE, DIGESTIBILITY AND RUMEN FERMENTATION CHARACTERISTICS OF INDIGENOUS CROSS BRED CATTLE

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ABSTRACT

An experiment was conducted to evaluate the nutrient intake, digestibility and rumen fermentation characteristics of maize (*Zea mays*) and napier (*Pennisetum purpureum*) silages preserved in Bamboo-mat Fenced Chamber (BFC) in comparison with fresh napier fodder. Three cannulated indigenous cross-bred animals with similar live weight (170±5 kg) and age (5-6 years old) were assigned into 3×3 Latin Square Design (LSD) in 3 consecutive studies. Each study period was continued for 21 days in which 14 days were considered as adjustment period followed by 7 days for collection and measurement period. Maize and napier fodder were ensiled with 2% molasses (on DM basis) in Bamboo-mat Fenced Chamber (BFC) for 30 days. Napier fodder diet (T_0) contained 35% DM from napier fodder while diets of maize silage (T_1) and napier silage (T_2) contained 35% DM from maize and napier silage respectively. In addition to 30% DM from rice straw and 35% DM from concentrates in all diets. Total DM and nutrient intake (OM, CP, ADF and NDF) was insignificant ($P>0.05$) in cattle fed napier grass, maize and napier silage based diets. Apparent digestibility of DM and OM was significantly ($P<0.05$) higher in maize silage than napier fodder and napier silage diets. However, the digestibility of DM and OM were not significantly differ between napier fodder and napier silage diets. Meanwhile, digestibility of ADF and NDF was significantly ($P<0.05$) higher in maize silage than napier fodder and napier silage diets but CP digestibility of which was significantly ($P<0.05$) higher in napier fodder than that of maize and napier silage. The higher non-fiber carbohydrates (NFC) presence in maize silage than napier fodder and napier silage. Overall ruminal pH of napier fodder, maize and napier silages preserved in BFC were around normal physiological range (6.4-7.0). Post feeding, NH_3-N concentration of napier silage was significantly ($P<0.05$) higher than maize silage and napier grass. At 1, 2, 3 and 4 hrs after feeding, average NH_3-N concentrations obtained in this present experiment above 50 mg/l were thought to be optimum value for microbial protein synthesis and ruminal volatile fatty acids (VFA) concentrations (mM/l) was not significantly ($P>0.05$) changed. Results of nutrient intake, digestibility and rumen fermentation characteristics of maize and napier silage in comparison with napier fodder proved that the forages can be preserved in BFC without any harmful effects of nutritional and rumen fermentation characteristics.

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INTRODUCTION

Acute shortage of feeds and fodder is one of the single most important obstacles to livestock development in Bangladesh. The availability of green fodder and concentrate are 51.16 and 5.19 million tons DM against the requirements of 73.8 and 26.61 million tons DM (Huque *et al.,* 2014). Besides, the availability of green grass is mostly seasonal, only in monsoon, when plant growth is high. It is highly deficient in dry season and during flood. Seasonal deficits can considerably be reduced by the conservation of excess forage produced in monsoon season and feeding to animals in periods of the deficiency. The most widely ensiled fodder is maize due to its high contents of non-fiber carbohydrates (NFC). In addition to maize fodder, dairy farmers of Baghabarighat (Sirajgonj) milk pocket in Bangladesh have recently received much attention in producing napier grass (*Pennisetum purpurium*) like other South Asia. Moreover, napier has been introduced both in Bathan (basin-like pasture land along river side) as well as in arable land along side with HYV Boro rice. Chowdhury (2009) reported that napier placed highest rank (24.32%) among different proportion of cultivated non-legume fodders in Bangladesh. For better preservation, fodder must have high concentrations of fermentable carbohydrate, low buffering capacity, relatively low DM content (20-30%) and adequate lactic acid bacteria. However, napier fodder contains low concentrations of fermentable carbohydrates (Nisa *et al.,* 2005) and thus various additives like molasses (Bolsen *et al.,* 1996 and Khan *et al.,* 2006) can be used as a source of fermentable sugars to achieve better fermentation and preservation.

There is a need to develop silage making technology under local conditions with particular emphasis on smallholders in Bangladesh. The daily harvesting of green forage of traditional “cut and carry” system throughout the year also poses problems, particularly when family labor is insufficient. However, few attempts have been made to ensile locally available fodders and scientific literature is limited in our country on the effects of ensiled fodders on the performance of cattle. Meanwhile, because of continuous use of fresh green fodders over the years through the cut and carry system farmers in our country believe in a myth that feeding silage could reduced the nutrient content of the fodder. So, the appropriate low cost preservation technique of fodder should need to know Keeping this view in mind, the present study was undertaken to evaluate the maize and napier silage as alternative to conventional green fodder during scarcity of green grass and to study the effects of feeding maize and napier silage on intake, digestibility and rumen fermentation characteristics of indigenous cross bred cattle.

MATERIALS AND METHODS

Fodder cultivation

Maize and napier fodders were cultivated for silage making in two different field plots. Lands for fodder cultivation were ploughed and cross ploughed to obtain desirable soil texture. Maize and napier fodders were cultivated with the application of 120 kg N and 20 kg P per hectare and were harvested at 60 days of age about 15 cm above the ground level. Fodders were wilted to several hours in reducing moisture content. For providing fresh napier fodder to the animals a separate land was allocated for napier cultivation which was divided into 63 plots. On the first day of napier cultivation, first plot was ploughed and cross ploughed by spade and was planted napier cuttings and on the second day, second plot was prepared with napier cuttings as in the first plot and so on up to the 63rd plot on the 63rd day. Fresh napier fodder was harvested at 60 days of age on plot by plot when feeding trial was started.

Low-cost silage making

Low-cost silo pits were made from the available silo inputs found in local markets around the farmers (Table 1, Figure 1).

Table 1 Cost of making low-cost silo pit

Items	BDT[1]
Bamboo-mat (prepared from bamboo slices)	305.0
Polythene sheet	456.0
Bamboo pieces	345.0
Brick/sand for floor space	178.0
Making charge & others	202.0
Total cost/silo	**1486.0**
Total space, cft	**150**
Cost/cft	**9.91**

[1]BDT = Bangladeshi Taka; 1 US$ = 70 BDT (2009)

Figure 1 Bamboo-mat fenced chamber

Silo pits were Bamboo-mat Fenced Chamber (BFC) which was the chamber like house made of 4 bamboo mats (local name was ‘chatai’) with the volume of 150 cft (height × length × width = 5 × 5 × 6). Outer surface of BFC was plastered by a mixture of mud, rice husk and cow dung in order to make it compact and airtight. The floor of BFC was prepared by brick and sands and inner surface was lining with polythene sheet to confirm BFC completely airtight. Cost of making silo pit was BDT 1486.0 (US$ = 21.0). Maize and napier fodders were chopped (3 cm) using a locally manufactured grass chopper so that the ensiling material was pressed properly in the silo pit to remove air and thereby attain anaerobiasis. Wilted fodders were filled into silo pits with the addition of 2% molasses on fresh basis. When silo pits were filled with green fodder, each of silos was covered with a 10 cm thick layer of rice straw, followed by a polythene sheet. The polythene sheet was then plastered with a blend of straw and pressed by brick to avoid leakage during silage making. When silage was used, polythene sheet was removed, and silage was withdrawn starting with the upper layer and working downwards to the lower layers. After an amount of fermented fodder was taken out from each silo pit, just sufficient for one day’s feeding, the polythene film was put back to keep the pit sealed. Fermentation and chemical composition of napier fodder, maize silage and napier silage is presented in Table 2.

Table 2 Fermentation and chemical composition of napier grass (T_0), maize silage (T_1) and napier silage (T_2)

Parameters	Napier grass[1]	Maize silage[2]	Napier silage[2]
pH	-	3.90	4.43
NH_3-N, % of total N	-	13.60	14.52
DM, %	19.20	23.50	23.80
CP, %	8.73	8.80	7.75
ADF, %	39.86	39.30	46.30
NDF, %	72.60	70.90	73.28
EE, %	2.31	3.10	2.00
Total ash, %	13.34	11.82	14.65
NFC, %	3.02	5.38	2.32
ME, MJ/kg DM	9.68	9.20	9.15
NE_L Mcal/kg DM	1.28	1.29	1.09

[1]Napier fodder was harvested at 80 days of age
[2]Maize and napier fodder ensiled with 2% molasses on fresh basis in BFC for 4 weeks
NE_L (Mcal/kg DM) = (1.0876 – 0.0127 × ADF%) × 2.20.
NFC (Non fiber carbohydrates) = 100 – (CP% + NDF% + Ash% + Ether extract%)

Animals and diets

Three cannulated cross bred indigenous animals with similar live weight (170±5 kg) and age (5-6 years old) were assigned into 3×3 Latin Square Design (LSD) in different periods. The whole experimental period was 63 days with 3 consecutive studies in which each study period was continued for 21 days. A period of 14 days was considered as adjustment period which was followed by 7 days for collection and measurement period. Animals were housed in a 5×8 cm cemented floor pen with stanchion inside. The ME (MJ/kg DM) and CP (g/100 g) requirements were calculated by measuring body weight of experimental animals. Three *iso*-nitrogenous and *iso*-caloric diets were formulated using NRC (2001) standards in order to fulfill the energy and protein requirements. Napier fodder diet (T_0) contained 35% DM from napier fodder while diets of maize silage (T_1) and napier silage (T_2) contained 35% DM from maize and napier silage respectively. In addition to 30% DM from rice straw and 35% DM from concentrates in all diets. Ingredients and chemical composition of experimental diets are shown in Table 3. Each cattle was offered with one of the three experimental diets at the rate of 3% DM of the body weight. Both roughage (silage and green grass) and concentrates were fed separately and concentrates were given first and then roughage. Total amount of required concentrate, rice straw, green grasses and silages were weighed out daily and divided into two halves and were supplied to the cattle twice daily, one half in the morning at 07:30 a.m. and remaining at 4:00 p.m. Drinking water was always available to the animals.

Measurement of feed intake

Intake of straw, green grass and silages were determined by subtracting the leftover from the supplied amount of feed to the animal. The amount of refusals was collected every morning before feeding and stored for chemical analysis. Faeces was collected manually by floor scraping immediately after voiding and kept in polythene bags to avoid the evaporation losses of nitrogen and contamination of faeces with dirt and urine. The faeces was weighed every 24 hrs against each animal for 7 days. Total faeces was mixed properly and about 5% the well mixed faeces of each animal was taken and then sun dried and stored in polythene bags. Fifty gram of mixed fresh faeces sample was taken and kept in the refrigerators for dry matter and nitrogen estimation. At the end of the collection period, the sun dried faeces of 7 days were pooled and ground to pass through 20 mm screen sieve for chemical analysis. About 400 ml of rumen liquor was collected on day 21 from each cannulated animal just before morning feeding (0 h) and thereafter 1, 2, 3 and 4 h after feeding. Rumen liquor was collected from each animal inserting a tube with gauge at its tip through the fistula and liquor was drawn by means of pump and collected into the graduated conical flask. The pH of the rumen liquor was measured by a digital pH meter immediately after collection. The collected rumen liquor was taken into bottle and total volatile fatty acids (TVFA) and NH_3-N were measured immediately.

Chemical analysis

The fresh fodder and silage samples were dried at 55^0 C for 72 hrs in a forced drying oven to determine forage DM level. The sun-dried samples were subjected to analyze OM and CP following the procedure of AOAC (2003). Acid detergent fiber (ADF) and Neutral detergent fiber (NDF) were determined by Tecator Fibertec systems (VELP Scientifica, Italy) according to the procedures of Georing and Van Soest (1970). *In-vitro* OMD and ME (MJ/kg DM) was calculated according to the procedure described by Menke *et al*. (1979). Net energy for lactation (NE_L) was calculated using the equation as described by Undersander *et al*. (1993). In pH determination, thirty grams of silage sample from each silo were followed by adding 200 ml distilled water and mixed thoroughly by rigorous stirring. The extracts were filtered through filter paper and pH of the silage sample as well as rumen liquor was determined using a laboratory pH-mV meter (inoLab, Germany). NH_3-N was determined by Markham distillation procedures. Total volatile fatty acids (TVFA) were determined by steam distillation procedures followed by titration with 0.05M NaOH solutions.

Statistical analysis

Data on feed intake, nutrient digestibility, and rumen fermentation parameters were analyzed by computing the Statistical program for Social Studies (SPSS) and the significant differences between different treatment means were analyzed by Least Significance Differences (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Fermentation and chemical composition

The fermentation and chemical composition of napier grass (T_0), maize silage (T_1) and napier silage (T_2) are shown in Table 2. The pH of maize silage and napier silage was 3.9 and 4.43 respectively. At the same time, the NH_3-N (% of total N) of the maize and napier silage was 13.60 and 14.52 respectively. The pH and NH_3-N of these silage samples produced in BFC indicated good fermentation quality. However, the lower pH of maize silage could be due to higher water soluble carbohydrates present in maize fodder which enhanced lactic acid production than napier silage (Yunus *et al.,* 2000). Moreover, the NH_3-N was slightly higher in napier silage (14.52) than maize silage (13.60). This could be due to the degradation of crude protein into NH_3-N excessively. The CP content was slightly lowered in napier silage (7.75%) than napier fodder (8.73%) with concomitant increased of NH_3-N also indicated the degradation of CP in napier silage.

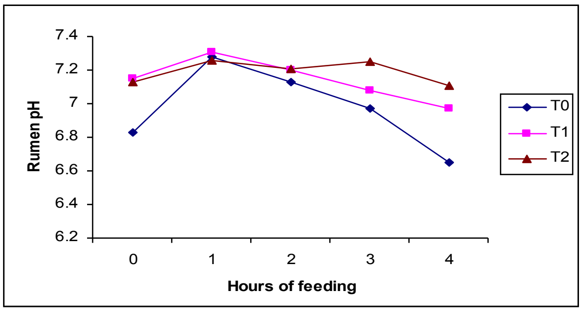

Figure 2 Pattern of rumen pH between 0 to 4 hrs averaged from fistulated cows fed napier fodder (T_0), maize silage (T_1) and napier silage (T_2) on the last day of digestion trial.

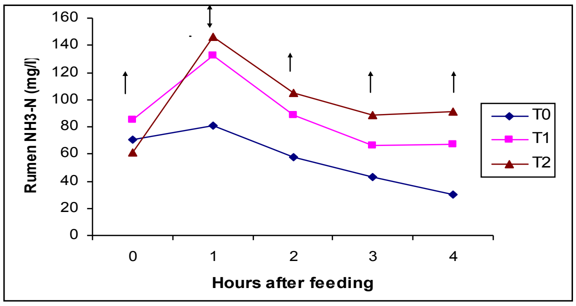

Figure 3 Pattern of rumen NH_3-N concentration (mg/l) between 0 to 4 hrs averaged from fistulated cows fed napier fodder (T_0), maize silage (T_1) and napier silage (T_2) on the last day of digestion trial.
†P<0.05, P<0.01

DM content of napier grass, maize silage and napier silage were 19.2, 23.5 and 23.8% respectively (Table 2). The higher DM content was observed in maize and napier silage than napier fodder which was due to wilting of maize and napier fodder in making silage. Pilipavicius *et al.* (2003) reported 34.0% DM, 7.80% CP, and 19.0% CF in maize silage but in the present experiment maize silage contained 23.5% DM, 8.80% CP and 39.30% ADF (Table 2). The DM percent of maize silage was lower than reported by Pilipavicius *et al.* (2003). This was due to higher level of humidity exists in the air at the time of harvesting maize fodder so that it was difficult to reduce moisture presence in maize fodder by wilting. However, the CP content in maize silage (8.80%) was almost similar as observed by Pilipavicius *et al.* (2003). The ADF contents of napier silage (46.30%) was relatively higher than maize silage (39.30%) and napier fodder (39.86%). Meanwhile, the ME content (MJ/kg DM) was relatively higher in napier fodder (9.68) and maize silage (9.20) than napier silage (9.15) which could be due to higher ADF contents in napier silage (Table 2). Similarly, the NE_L (Mcal/kg DM) was also higher in napier fodder (1.28) and maize silage (1.29) than napier silage (1.09) because the NE_L was calculated from the ADF contents of silage sample. However, the NDF percentage of napier silage were almost same in napier fodder indicated that forages preserved in BFC could not reduce the nutritional quality of silage.

Nutrient intake and digestibility

Daily forage and silage nutrient intake of animals fed on napier fodder (T_0), maize silage (T_1) and napier silage (T_2) based diets are shown in Table 4. It was found that the total dry matter intake (DMI) was insignificant (P>0.05) in indigenous cattle fed napier grass (4.75 kg/d), maize silage (4.23 kg/d) and napier silage (4.06 kg/d) based diets. It was observed that the DMI was slightly higher in fresh napier grass than silage based diets. Lower DMI with silage based diets was probably because of low pH of silage. Similarly, the total DMI of napier silage (4.06 kg/d) was lower than maize silage (4.23 kg/d) may be due to higher NH_3-N (14.52%) observed in napier silage. Wilkins *et al.* (1978) reported that the intake is reduced in silages which have high ammonia-N contents as well as volatile fatty acids. Ruiz *et al.* (1992) reported lower intake of silage due to the presence of fermentation products. They also reported that the DMI was negatively correlated with silage pH. The nutrient intake also followed a similar trend as was observed in DMI. The organic matter (OM), crude protein (CP), acid detergent fibre (ADF) and neutral detergent fiber (NDF) intake of animals fed napier fodder (T_0), maize silage (T_1) and napier silage (T_2) based diets are presented also in Table 4. The OM intakes (kg/d) for T_0, T_1 and T_2 diets were 4.09, 3.60 and 3.54 respectively. Intake of CP (kg/d) for T_0, T_1 and T_2 diets was 0.45, 0.40 and 0.36 respectively and for ADF, the values were 2.02, 1.96 and 1.89 respectively. Again, the NDF intakes (kg/d) were 3.12, 2.98 and 3.24 for T_0, T_1 and T_2 diets respectively. The difference among the treatments for OM, ADF, NDF and CP intake were not significant (P>0.05). It can be seen from the Table 4 that the DM, OM, CP, ADF and NDF intake of fresh napier grass diet were always higher than silage based diets. This results are in accordance with, Sarwar *et al.* (2004) observed that the DM, CP and NDF intake were lower in berseem and lucern silage based diets compared with berseem fodder because of the presence of fermentation products in silage diets.

Table 3 Ingredients and chemical composition of experimental diets

Parameters	Diets[1]		
	T_0	**T_1**	**T_2**
Ingredients composition (%)			
Straw	30.00	30.00	30.00
Napier grass[2]	35.00	-	-
Silage[3]	-	35.00	35.00
Maize grain (crushed)	12.75	12.50	12.25
Wheat bran	7.25	7.50	7.75
Rice polish	7.25	7.50	7.25
Sesame oil cake	5.50	5.25	5.50
DCP powder	0.75	0.75	0.75
Salt	0.50	0.50	0.50
Mineral mixture	0.25	0.25	0.25
Chemical composition and Nutritive value			
DM, %	36.70	36.80	37.00
CP, %	8.78	8.80	8.42
ADF, %	36.54	36.34	38.96
NDF, %	57.17	56.55	57.42
EE, %	3.03	3.32	2.92
Total ash, %	12.44	11.88	12.91
NFC, %	18.57	19.42	18.31
ME[4], MJ/kg DM	10.38	10.39	10.27
NE_L[5], Mcal/kg DM	1.35	1.36	1.28

[1]T_0 (Control), T_1 and T_2 diets contained 35% DM from napier fodder, maize silage and napier silage respectively in addition to 30% DM from rice straw and 35% DM from concentrates in all diets.
[2]Napier fodder was harvested at 80 days of age for feeding
[3]Maize and napier fodder were ensiled in BFC with 2% molasses on fresh basis
[4]ME (MJ/kg DM) = 0.16 x OMD%, where, OMD% = 75.73 – (0.296 × ADF%)
[5]NE_L (Mcal/kg DM) = (1.0876 – 0.0127 ×ADF%) × 2.20

Table 4 Nutrient intake and digestibility of different experimental diets

Parameters	Treatments[1]			SEM	Level of Significance
	T_0	T_1	T_2		
	Feed and nutrient intake (kg/d)				
Fodder/Silage DM	2.07	1.90	1.93	0.27	NS
Total DM	4.75	4.23	4.06	0.53	NS
OM	4.09	3.60	3.54	0.37	NS
CP	0.45	0.40	0.36	0.06	NS
ADF	2.02	1.96	1.89	0.22	NS
NDF	3.12	2.98	3.24	0.32	NS
	Nutrient digestibility (%)				
DM	56.22^b	59.79^a	55.22^b	3.05	*
OM	59.97^b	63.92^a	58.37^b	2.53	*
CP	61.47^a	57.92^b	55.47^b	6.86	*
ADF	54.66^b	62.52^a	52.43^b	6.11	*
NDF	55.24^b	60.42^a	54.63^b	5.58	*

[1]T_0 (Control), T_1 and T_2 diets contained 35% DM from napier fodder, maize silage and napier silage respectively in addition to 30% DM from rice straw and 35% DM from concentrates in all diets
NS = Non significant, * = Significant at 5% level of probability
[abc]Mean values having different superscripts in a row differ significantly (P<0.05)
SEM = Standard error of means

Apparent digestibility of DM, OM, CP, ADF and NDF in different diets of the present experiment is also shown in Table 4. The apparent digestibility (%) of DM and OM were significantly (P<0.05) higher in maize silage diet (59.79 and 63.92) than napier grass (56.22 and 59.97) and napier silage (55.22 and 58.37) based diets. However, the digestibility of DM and OM were not significantly changed between napier fodder and napier silage diets. The DM and OM digestibility were higher in maize silage diet could be due to higher concentration of soluble carbohydrates creates optimum fermentation during ensilation in BFC as well as fermentation decomposition of cell wall parts. Moreover, the higher non fiber carbohydrates (NFC) presence in maize silage (5.38%) than napier fodder (3.02%) and napier silage (2.32%) may have some contribution to release greater energy value in maize silage-based diet leading to higher DM and OM digestibility (Table 2). The results are in accordance with Broderick *et al*. (2001) who reported that the lower ash and greater NFC could be possible reasons for releasing greater energy values and increasing nutrient digestibility during fermentation. Despite the addition of fermentable sugars (2% molasses) in napier silage during ensilation in BFC, the DM and OM digestibility were not as high as in maize silage would be due to the presence of higher ADF contents in napier silage (46.50) than napier fodder (39.86) and maize silage (39.30) (Table 2). The digestibility of CP of napier grass was significantly (P<0.05) higher from maize and napier silage and the values were 61.47, 57.92 and 55.47% respectively for napier grass, maize silage and napier silage diet (Table 4). However, the difference between maize silage diet (T_1) and napier silage diet (T_2) was not significant (P>0.05). This could be due to higher degradable protein present in fresh grass than maize silage and napier silage which stimulate the growth of microbes helps to increase digestibility. Apparent digestibility of ADF in T_0, T_1 and T_2 was 54.66, 62.52 and 52.43% respectively. The highest digestibility of ADF (62.52%) in maize silage was observed in this experiment (Table 4) which was significantly (P<0.05) higher from napier grass (T_0) and napier silage (T_2). The lower level of fiber fractions with higher NFC in maize silage (Table 2) may contribute to release available fermentable sugars for increasing digestibility.

However, the insignificant difference of ADF digestibility between napier fodder and silage indicated the usefulness of BFC as a low cost forage preservation technique. Alike ADF digestibility, NDF digestibility of maize silage diet was higher (P<0.05) than napier fodder and silage-based diets. However, the digestibility of DM, OM, ADF and NDF in napier fodder were not significantly reduced when napier fodder ensiled in BFC.

Rumen fermentation characteristics

The data on pH values of the rumen liquor of different dietary treatments collected at different time intervals are presented in Figure 2. The pH of maize and napier silage in the present experiment was 3.90 and 4.43 respectively. The overall ruminal pH (mean values) of napier grass, maize silage and napier silage were 6.97, 7.14 and 7.19 respectively. There were not significant (P>0.05) effect on ruminal pH in cattle fed napier grass, maize silage and napier silage. However, all the pH values were around normal physiological range (6.4-7.0). Although the pH values were no significant but the tendency of pH value is higher in maize and napier silages diets (T_1 and T_2) than napier grass (T_0) at 2, 3 and 4 hrs after silage feeding was due to increased level of ammonia concentration in rumen liquor which is alkaline in nature. The results are in agreement with findings of Hossain (2001) who observed a higher range of pH values after 1 to 2 hrs after silage feeding. Lowest pH value was observed at 4 hrs after feeding in the present experiment. Similarly, Van Vuuren *et al.* (1986) observed lowest rumen pH at 3 hrs after feeding. They concluded that the gradual decreasing of pH may have been affected more by forage fermentation rather than starch fermentation.

The data for NH_3-N concentration of rumen liquor in the animals fed on different diets are presented in Figure 3. The average concentration of NH_3-N showed a significant effect (P<0.05) between napier grass and silage based diets sampled at 1, 2, 3 and 4 hours after feeding. The overall NH_3-N concentration (mean values) of napier grass, maize silage and napier silage were 56.53, 87.73 and 98.33 mg/l respectively. The enhanced NH_3-N concentration in rumen liquor from napier silage diets could be due to increased protein degradation into rumen ammonia fed napier silage diets leading to higher pH of 4.43. In addition, some clostridial activity may contribute to secondary fermentation and is potentially detrimental because of the production of butyric acid and ammonia from degradation of carbohydrates, lactic acid and amino acid (McDonald *et al.,* 1991). Again, from the Figure 3, the overall NH_3-N concentration (mg/l) showed higher in maize silage than napier grass but the differences was insignificant. The fermentable carbohydrates, which might have minimized the microbial production of NH_3-N (Yang, 2004) in napier grass as well as in maize silage. Low pH of maize silage (3.90) also inactivates plant proteolytic enzymes accompanied by reduction in proteolysis (Muck, 1988). The lower CP percent in napier silage (7.75) than in napier fodder (8.73) indicated the degradation of CP level during ensilation. The higher moisture level (76.20%) in napier silage could be another reason for clostridial fermentation. Similarly, Muck (1988) also reported that the high moisture (>70.0%) and moderate pH (>4.5) generally favor clostridial fermentation. The highest NH_3-N concentration was occurred in all the treatments at 1 hr after feeding. Ruminal NH_3-N concentration (mg/l) of napier grass, maize silage and napier silage diet was 81.00, 132.67 and 146.00 at 1 hr after feeding respectively and the values were significantly (P<0.01) different between each other. This may be due to easy degradation of protein fractions by rumen microbes of fermented feeds rather than green grass. In all the treatments, NH_3-N concentration began to increase abruptly at 1 hr after feeding and then dropped which was due to readily digestible portion of forages may have supplied sufficient energy for the microbial population to utilize NH_3-N gradually (Hossain, 2001). At all the time after feeding, the NH_3-N concentration of napier silage was significantly (P<0.05) higher than maize silage and napier grass. The rumen NH_3-N concentrations obtained in the present experiment above 50 mg/l were thought to be optimum value for microbial protein synthesis (Satter and Styler, 1974).

Total volatile fatty acids (TVFA) concentrations (mM/l) in the rumen liquor collected from the animals fed on different dietary treatments are shown in Figure 4.

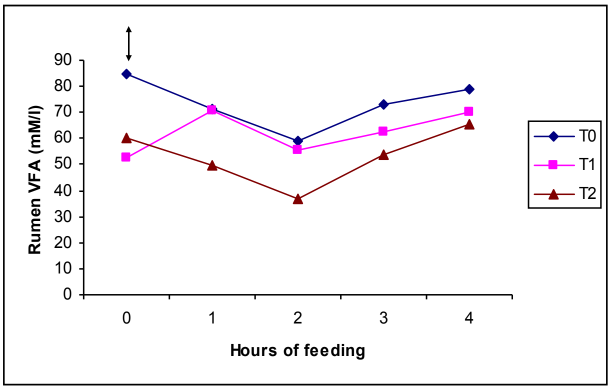

Figure 4 Pattern of rumen VFA concentration (mg/l) between 0 to 4 hrs averaged from fistulated cows fed napier fodder (T_0), maize silage (T_1) and napier silage (T_2) on the last day of digestion trial.
P<0.01

The average ruminal VFA concentrations (mM/l) was not significantly (P>0.05) different between treatments (T_0, T_1 and T_2) after feeding at 1, 2, 3 and 4 hrs except before feeding (0 hr) of green grass and silage feeds. Meanwhile, the overall (mean values) TVFA concentrations (mM/l) in rumen liquor fed napier grass (73.40), maize silage (62.27) and napier silage (53.20) were significantly (P<0.05) different. The lowered pH of maize silage reflected higher TVFA concentrations in maize silage than napier silage. The results are in similar with the findings of Yang (2005) who observed that the higher NH_3-N together with higher pH level is indicative of increased deamination or inadequate carbohydrate availability. The fermentable carbohydrates presence in napier silage would not be sufficient enough breakdown the higher level of fibrous part (46.50% ADF) of napier silage. The tendency of ruminal VFA production was relatively higher in napier grass followed by maize silage and napier silage. Similarly, the rumen pH was (Figure 2) slightly lower in the diet of napier grass than maize silage and napier silage based diets. Ruminal VFA production were higher in all diets at 4 hrs post feeding was due to increased ruminal microbial activities having more OM from concentrate feeds being fermented in the rumen. The significant (P<0.01) difference before feeding (0 hr) could be the reflection of starch fermentation at previous day. Higher TVFA production at higher level of NH_3-N in fresh napier grass before feeding (0 hr) could be due to increased microbial activity leading improved rumen fermentation.

CONCLUSION

The results of nutrient intake, digestibility and rumen fermentation characteristics (pH, NH_3-N and TVFA) of maize and napier silage in comparison with napier fodder in the present experiment proved that the forages can be preserved in Bamboo-mat Fenced Chamber (BFC) without any detrimental effects of nutritional and rumen fermentation characteristics. The constrains could be overcome by spreading this technique in the rural level properly, it would have accurate result. The findings of this study can be used by the farmers and researchers for preserving green grass in the rural level in BFC when surplus green grass production occur and fulfilling the demand from green roughage in Bangladesh during scarcity period as alternative to conventional green fodder.

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