Effect of Urea-Molasses Cake Supplementation of Swamp Buffaloes Fed Rice Straw or Grasses on Rumen Environment, Feed Degradation and Intake

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ABSTRACT : Two experiments were carried out concerning the effects of urea-molasses cake (UMC) and its separate components as supplements on rumen environment, *in sacco* feed degradability and intake of swamp buffaloes fed rice straw, grasses or a mixture of grasses and rice straw. Experiment 1 was a change-over design with 4 animals and 6 treatments. The buffaloes were fed rice straw *ad libitum*, and the experimental treatments were: no supplementation (R); 700 g of the complete urea-molasses cake (RUMC); 53.2 g urea (RU); 276 g rice bran and 52.5 coconut meal (RRC); 26.6 g salt, 26.6 g bone meal and 2.1 g trace minerals (RMi); and 25 g molasses (RMo). Experiment 2 was a Latin square design with four diets and four animals. The treatments were: rice straw *ad libitum* and mixed grass (RG) at 2.5 g dry matter per kg live weight (LW); RG plus 700 g urea-molasses cake (RGUMC); mixed grass *ad libitum* (G); and G plus 700 g cake (GUMC). In both experiments the supplements were fed once daily. In Exp. 1 although the rumen pH was significantly different ($p<0.05$) among diets, it varied only from 6.90 to 7.06. The ruminal ammonia was also significantly ($p<0.05$) different among the diets with RUMC significantly higher than R. Total bacterial and protozoal counts were significantly ($p<0.05$) higher for the RUMC, RU, RMo and RRC diets. Total feed and rice straw intakes were highest for RUMC ($p<0.05$) and lowest for the RMi and RMo diets, but *in sacco* degradability of four different roughages were not significantly different among diets. In Exp. 2, rumen pHs of the diets differed significantly and ($p<0.01$) ranged from 7.04 - 7.19. Ruminal NH_3-N concentrations (mg/100 ml) were also significantly different ($p<0.05$), and higher for the RGUMC, G and GUMC diets. The total counts of bacteria and protozoa were significantly ($p<0.05$) higher for the RGUMC, G and GUMC diets. The total feed intake and roughage intake were significantly ($p<0.05$) higher for the RGUMC, G and GUMC diets compared to the RG diet. Correspondingly, LW changes also differed among treatments ($p=0.06$). It was concluded that there were significant increases in rumen NH_3-N concentration, microbial populations and feed intake in the buffaloes by UMC supplementation, whereas the significant difference in *in sacco* DM degradation was not found by any type of supplementation. There seemed to be a need of a combination of urea, molasses, minerals and other protein nitrogen sources to enhance rice straw intake. Adding grass to the rice straw diet at 0.25% LW (DM) should also be considered to maintain buffalo rumen function and production with UMC supplementation, when rice straw is the main roughage. (***Asian-Aust. J. Anim. Sci. 2001. Vol. 14, No. 5 : 631-639***)

Key Words : Swamp Buffaloes, Urea-Molasses Cake, Rice Straw, Grasses, Rumen Environment, Feed Degradation, Intake

INTRODUCTION

Swamp buffaloes have played a very important role in providing draught power and meat for people in the Mekong delta of Vietnam. Although, farmers have benefited much from the swamp buffalo, there are very few studies on how to improve their performance as well as farmers profit. Extensive grazing and crop residue feeding without supplementation has been dominating in these areas and resulting in slow growth rates for the buffaloes, a low working performance and poor health in the dry and working season. In many cases, the animals have been sold for slaughter. To alleviate the serious malnutrition of farmers animals, urea-molasses cakes (UMC) have been produced at Cantho University in the form of soft block (1.4 kg) which include urea, molasses, rice bran, coconut meal, salt and minerals (Thu et al., 1991). The cakes are easy to transport and used for supplementation of the swamp buffaloes and other ruminants. Results have shown that the cake supplementation improves working capacity, growth rate and milk production of ruminants in the Mekong delta (Thu et al., 1991; Thu and Udén, 2000a). Recently, some efforts have been made to introduce cattle and goats into in the acid sulfate soil area of the Mekong delta, but both species have so far done poorly due to the harsh conditions including lack of green feeds and drinking water, toxic substances, anti-nutritional compounds in the plants, etc. affected by the acid soils. The swamp buffaloes, however, are known to survive reasonably well under these conditions. The main objectives of this study were to investigate the effect of UMC and its separate components on rumen environment and feed intake of swamp buffaloes.

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MATERIALS AND METHODS

Experimental animals and supplementation

Two experiments were carried out at the experimental farm of Cantho University in 1997 and 1998. In Experiment 1, four rumen fistulated swamp buffaloes (216±14kg) were used in a change-over design with 4 animals, 6 treatments and 6 periods to study the separate effects of the minerals, N sources or sugars contained in urea-molasses cakes (UMC) on rumen environment, *in sacco* feed degradation and intake of the buffaloes. The buffaloes were fed rice straw *ad libitum*, and the experimental treatments were: no supplementation (R); 700 g of the complete urea-molasses cake (RUMC); 53.2 g urea (RU); 276 g rice bran and 52.5 coconut meal (RRC); 26.6 g salt, 26.6 g bone meal and 2.1g trace minerals (RMi); and 25 g molasses (RMo). In Experiment 2, four rumen fistulated buffaloes *ca.* two years old with an average live weight of 200±17 kg was used in a 4×4 Latin square design for studying effects of the cake supplementation associated with the basal diets of rice straw and native grasses or native grasses only. The treatments were: rice straw and mixed grass (RG) at 0.25% of live weight (LW) on a dry matter basis; RG plus 700g urea-molasses cake (RGUMC); mixed grass *ad libitum* (G); and G plus 700g cake (GUMC). The UMC used in both experiments contained (%): B molasses 37.9, urea 7.6, coconut oil meal 7.5, rice bran 39.4, bone meal 3.8, NaCl 3.8, and trace minerals 0.15. The supplemented groups received 700g UMC per day, equivalent to 220 g CP from urea, coconut meal and rice bran and 4.5 MJ coming mainly from molasses.

Feeds and feeding

In both experiments, the experimental periods were two weeks consisting of ten days for adaptation and followed by four days for measurements. Rumen *in sacco* incubation were made using samples of the grasses *Paspalum conjugatum, Eleocharis dulcis, Oryza rufipogon* and rice straw. The feed samples were collected in the acid sulfate soil area of Hoa An village, Phung Hiep district of Cantho province. The experimental animals were kept in individual pens and roughages were fed twice daily at 7.00 am and 14.00 pm while the supplements were offered once at 7.30 am. The animals had free access to water. The UMC, molasses, minerals, and rice bran and coconut were completely consumed by the animals within 15 min after feeding, while it took approximately 60 min for the urea.

Sampling and analysis

Rumen sampling was done once daily from 6.30 - 6.45 am before feeding during four consecutive days. Rumen fluid was taken by suction through a tube (1 cm i.d.). Rumen contents were collected by using tube (length=70 cm; id=3 cm) with sealed bottom end and four large openings along the side through which rumen content could enter. Samples were mixed by following the method described by Warner (1962) to measure rumen pH, ammonia N (NH_3-N), protozoa and total bacteria populations. Rumen pH was measured by a pH meter and NH_3-N was analyzed by the Kjeldahl method according to the procedure of AOAC (1980). For counting protozoa the preparation of the rumen content samples followed the procedure of Dehority (1984) using a 0.2 mm deep chamber under 100× magnification. Total bacteria populations were directly counted in a Neubauer chamber under 400× magnification after the preparation of rumen content samples following the procedure of Warner (1962) and Navas-Camacho et al. (1993). Feeds and refusals were collected daily and pooled weekly for analysis of DM to calculate feed intake. All samples were dried at 105℃ overnight to determined dry matter (DM). Organic matter (OM) was determined by ashing in a furnace at 500℃ for 4 hrs. Crude protein was determined by the Kjeldahl method (AOAC, 1980). The analysis of neutral detergent fiber (NDF) was done according to described by Van Soest et al. (1991). Acid detergent fiber (ADF) and acid detergent lignin (ADL) were analyzed following methods suggested by Robertson and Van Soest (1981). Animals were weighed on two consecutive days at the beginning of the experiment and at the end of each experimental period to calculate live weight changes.

The dry feed samples for the *in sacco* degradation study were cut by hand into 2-3 mm length in Exp. 1, while they were ground through a 1 mm sieve in Exp. 2 and dried at 55℃ in an oven 24h for the rumen incubations. *In sacco* incubation was made for 6, 12, 24, 36, 48, 72 and 96 hours in triplicates to measure feed degradability following the method of Ørskov et al. (1980). In both experiments, rice straw fed to the animals originated from villages around Cantho city. The rice was grown on good soils which were not considered acid (pH>6.0), while the *in sacco* samples were collected from areas with soil pHs from 2.0 - 4.0 at the Acid Sulfate Soil Research Station in Hoa An village of Cantho province, Vietnam.

Biometric analysis

The data was subjected to an analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of Minitab (1998), and when the F test was significant ($p<0.05$), Tukeys test for paired comparison was used. The data of *in sacco* degradability was fitted to the non-linear model (Ørskov et al., 1980): $DMD=a+b(1-e^{-ct})$ without lag after finding insignificant lag times when fitting the same model with lag included. In the present model DMD=dry matter disappeared after time (t), a=y intercept, c=fractional degradation rate (h^{-1}) and a+b=curve asymptote representing the potential degradability. The Maximum Likelihood program (MLP) of Ross (1987) was used for curve fitting and also for comparisons of treatment differences by parallel curves analysis (CPCA). The CPCA and subsequent F-testing was done in three steps. First individual parameter sets were generated for each treatment, then the parameter sets were derived assuming common rate parameters (c) and finally one parameter set was derived for the pooled treatments. The total residual sum of squares for each step was used for testing of parallelism (common rates) or displacement (common a and/or b) by common F-test.

RESULTS

Chemical composition of the feeds in Exp. 1 and 2 are presented in tables 1 and 2. *Eleocharis dulcis* had a somewhat higher contents of lignin and NDF compared to the others. The rice straw produced from the acid soil areas had a higher lignin content than that produced from the normal soil, while the ash content of the rice straw in the acid soil was only 8.10% compared to 14.6% for the straw from the normal soils.

Results of Experiment 1 are showed in table 3. Although there was a significant ($p<0.05$) difference on rumen pH between the treatment, the differences were small. The highest pH occurred when feeding RMo diet (7.02), while lowest was seen in the RU and RUMC diets (6.92 and 6.90). Ruminal NH_3-N levels were 5.52, 9.55, 8.59, 7.19, 6.76 and 10.5 mg/100ml in diets of R, RU, RRC, RMi, RMo and RUMC, respectively ($p<0.05$). Bacterial counts were significantly ($p<0.001$) higher for the supplemented

Table 1. Chemical composition of feed samples collected in the acid soil areas for rumen incubation studies in Exp. 1 and 2 (% of DM)

Feed sample	DM	OM	CP	NDF	ADF	Lignin	C	HC	Ash
Paspalum conjugatum	19.9	88.9	8.2	73.6	36.3	5.1	31.2	37.3	11.1
Eleocharis dulcis	23.2	84.9	11.6	61.8	37.9	10.1	27.8	23.9	15.1
Oryza. Rufipogon	24.9	83.9	13.5	70.3	37.1	5.5	31.6	33.3	16.1
Rice straw	82.4	91.9	6.1	77.5	47.3	7.2	40.1	30.2	8.1

DM=dry matter, OM=organic matter, CP=crude protein, NDF=neutral detergent fiber, ADF=acid detergent fiber, C=cellulose (ADF-lignin), HC=hemi-cellulose (NDF-ADF).

Table 2. Chemical composition of roughages fed, and of the urea-molasses cake (UMC) and its ingredients in Exp. 1 and Exp. 2 (% of DM)

Item[A]	DM	OM	CP	NDF	ADF	Lignin	C	HC	Ash
Rice straw	83.3	85.4	3.9	79.0	46.9	6.5	40.4	32.1	14.6
Native grasses	15.2	89.8	9.7	69.9	38.0	5.5	32.5	31.9	10.2
Cocount meal	94.4	91.2	21.2	54.2	28.1	6.0	22.0	26.1	8.7
Rice bran	87.9	92.8	12.9	19.8	10.3	5.5	4.8	9.5	7.2
UMC	81.4	88.5	38.7	18.2	11.7	3.9	7.9	6.4	11.5

DM=dry matter, OM=organic matter, CP=crude protein, NDF=neutral detergent fiber, ADF=acid detergent fiber, C=cellulose (ADF-lignin), HC=hemi-cellulose (NDF-ADF). UMC=Urea-molasses cake.

Table 3. Ruminal-NH_3, protozoal and bacterial counts of rumen fluid collected at 6 AM before feedings as affected by diet supplementation of swamp buffaloes fed rice straw in Exp. 1

Item	R[A]	RU	RRC	RMi	RMo	RUMC	±SE/P
pH	7.03^{ab}	6.92^{ab}	7.06^{ab}	7.06^{a}	7.02^{ab}	6.90^{b}	±0.04/=0.025
NH_3-N (mg/100 ml)	5.52^{a}	9.55^{ab}	8.59^{ab}	7.19^{ab}	6.76^{ab}	10.5^{b}	±1.28/=0.019
Bacteria ($\times 10^{-8}$/ml)	8.49^{a}	12.2^{b}	11.6^{b}	11.0^{b}	10.4^{b}	12.1^{b}	±0.55/<0.001
Protozoa ($\times 10^{-5}$/ml)	3.10^{a}	3.76^{b}	3.55^{b}	3.34^{ab}	3.58^{b}	3.75^{b}	±0.13/=0.003
Totalfeedintake (gDM/kg$W^{0.75}$/day)	79.1^{a}	79.4a	77.4^{a}	73.3^{a}	74.8^{a}	93.1^{b}	±2.18/<0.001
Rice straw intake (gDM/kg$W^{0.75}$/day)	79.1^{a}	78.9a	74.0^{a}	72.7^{a}	72.3^{a}	86.6^{b}	±2.19/<0.001
Live weight change (kg/14 d)	-9.25^{a}	-3.14^{ab}	-6.93^{ab}	-3.59^{ab}	-1.07^{ab}	4.85^{b}	±3.95/<0.05

[A] R: Rice straw only; RRU: rice straw and urea; RRC: rice straw, rice bran and coconut meal; RMi: rice straw and minerals; RMo: rice straw and molasses; and RUMC: rice straw and Urea-molasses cake; SE: Standard error of difference; P: probability of significant levels. [a,b] Means with different letters within the same rows are significantly different $p<0.05$.

diets compared to the R diet. Protozoal numbers were significantly lower for the R and RMi diets ($p<0.01$). The differences in total feed intake and rice straw intake among the diets were significantly ($p<0.001$) higher for the RUMC diet compared to the others. During the 14-day feeding period the buffalo live weight changes were negative in all diets, except in the RUMC diet (4.85 kg) and it was particularly serious in the R diet (-9.25 kg). The results of the *in sacco* DM degradation of *Paspalum conjugatum, Eleocharis dulcis, Oryza rufipogon* and rice straw are presented in tables 4 and 5. Supplementation did not significantly affect DM degradation kinetics of individual incubated samples, therefore the overall mean values (a, b and c) of these roughage samples were presented. The degradation rates (h^{-1}) and potential degradabilities were 0.021 and 79.5; 0.015 and 50.2; 0.017 and 80.0 and 0.011 and 64.6 for the *Paspalum conjugatum, Eleocharis dulcis, Oryza rufipogon* and rice straw, respectively.

Table 6 shows that rumen pHs before morning feeding in Exp. 2 only varied between 7.06 and 7.16. In spite of this they were significantly ($p<0.01$) different. Rumen NH_3-N concentrations were significantly different among diets and ranked GUMC>G>RGUMC>RG ($p<0.001$). Bacterial and protozoal populations differed significantly among diets ($p<0.001$) with the same ranking as for NH_3-N concentrations. Total feed and roughage intake significantly increased when UMC was used as a supplement. Rougahe intake was 66.1, 78.2, 73.0 and 78.6 gDM/kg $LW^{0.75}$ for the RG, RGUMC, G and GUMC diets, respectively. Live weight changes of the buffaloes were positive in all treatments except for RG. Results of the *in sacco* incubation are presented in tables 7 and 8. Based on the curve analysis, no significant differences in DM feed degradation affected by different diets were found. The degradation rates (h^{-1}) and potential degradabilities were 0.024 and 75.5; 0.021 and 57.0; 0.022 and 71.8 and 0.014 and 70.3

Table 4. Test for curve parallelism (common rate, c) or displacement (common a and/or b) in the model $y=a+b(1-e^{-ct})$ as affected by treatments when incubating four different roughages in Exp. 1

	P. conjugatum			*E. dulcis*			*Oriza rufipogon*			Rice straw		
Source[B]	df[A]	MS	F	df	MS	F	df	MS	F	df	MS	F
Curve	11	8.27	0.81[ns]	11	4.74	1.68[ns]	11	5.62	0.52[ns]	11	6.87	2.27[ns]
Displacement												
Common nonlinear	5	0.89	0.09[ns]	5	0.66	0.23[ns]	5	3.57	0.32[ns]	5	1.01	0.33[ns]
Within curves	24	10.20		4	2.82		24	11.20		24	3.02	

[A] df: degree of freedom; MS: mean sum of squares; ns: non-significant.
[B] for interpretation see Biometric analysis.
F=MS (curve displacement or common nonlinear)/MS (within curves).

Table 5. Overall means of the model parameter values (LSM±SE) for *in sacco* dry matter degradation of *Paspalum conjugatum, Eleocharis dulcis, Oryza rufipogon* and rice straw as affected by dietary supplements, and means of the values of the incubated samples of individual roughage in buffaloes eating rice straw in Exp. 1

	Parameter B		
Item	a	b	c
Diet[A]			
R	6.3±1.12	59.5±11.7	0.017±0.007
RU	6.0±1.10	57.9±10.7	0.019±0.008
RRC	6.7±1.20	60.9±14.1	0.016±0.007
RMi	6.5±1.40	55.3±15.1	0.016±0.008
RMo	7.5±1.50	63.7±13.1	0.014±0.008
RUMC	6.4±1.10	57.5±6.57	0.018±0.008
Incubated samples			
Paspalum conjugatum	7.5±0.29	62.0±2.67	0.021±0.002
Eleoocharis dulcis	9.4±0.32	40.8±3.87	0.015±0.003
Oryza rufipogon	5.4±0.36	74.6±3.70	0.017±0.002
Rice straw	3.7±0.30	60.9±6.09	0.011±0.002

[A] R: no supplement, RRU: rice straw and urea, RRC: rice straw, rice bran and coconut meal, RMi: rice straw and minerals, RMo: rice straw and molasses, RUMC: rice straw and Urea-molasses cake.
[B] parameters of the model: $y=a+b(1-e^{-ct})$ fitted to the data, where c corresponds to fractional degradation rate (h-1) and a+b to potential degradability.

for the *Paspalum conjugatum*, *Eleocharis dulcis*, *Oryza rufipogon* and rice straw, respectively.

DISCUSSION

Feeds for buffaloes in the Mekong delta are natural grasses and crop residues. In the acid soil regions, grasses eaten by buffaloes commonly include *Panicum repens*, *Sacciolepis indica*, *Eleocharis dulcis*, *Paspalum conjugatum*, *Eichornia crassipes* and *Oryza rufipogon*. Minh (1996) mentioned that in Vietnam, during the rainy season an area of 500.000 hectares in the Mekong delta has problems with acid water contaminated. Toxic elements such as aluminum, are

Table 6. pH, NH_3-N, protozoal and bacterial counts in rumen fluid of swamp buffaloes fed different diets in Exp. 2

	RG[A]	RGUMC	G	GUMC	±SE/P
pH	7.2[ac]	7.0[b]	7.1[a]	7.2[c]	±0.03/=0.009
NH_3-N (mg/100 ml)	6.3[a]	9.6[b]	12.9[c]	18.0[d]	±0.72/<0.001
Bacteria ($\times 10^{-8}$)	9.9[a]	12.0[b]	14.8[c]	16.9[d]	±0.40/<0.001
Protozoa ($\times 10^{-5}$)	3.6[a]	4.0[b]	4.1[b]	4.5[c]	±0.03/<0.001
Total feed intake (gDM/kg$W^{0.75}$/day)	66.1[a]	98.2[c]	73.0[b]	98.6[c]	±2.02/<0.001
Roughage intake (gDM/kg$W^{0.75}$/day)	66.1[a]	78.2[b]	73.0[b]	78.6[b]	±2.02/=0.003
Live weight change (kg/14 d)	-8.37	8.7	3.7	7.3	±5.25/=0.059

[A] RG: Rice straw and grass, RGUMC: Rice straw, grass and urea-molasses cake, G: Grass, GUMC: Grass and urea-molasses cake.

[a,b,c,d] Means with different letters within the same rows are significantly different at the 5% level.

Table 7. Test for curve parallelism (common rate, c) or displacement (common a and/or b) in the model y=a+b $(1-e^{-ct})$ as affected by treatments when incubating from different roughages in Exp. 2

	P. conjugatum			*E. dulcis*			*O. rufipogon*			*Rice straw*		
Source[B]	df[A]	MS	F	df	MS	F	df	MS	F	df	MS	F
Curve displacement	6	2.31	0.27[ns]	6	2.32	0.90[ns]	6	1.51	0.29[ns]	6	0.99	0.76[ns]
Common nonlinear	3	1.35	0.16[ns]	3	3.10	1.21[ns]	3	2.43	0.46[ns]	3	1.97	1.51[ns]
Within curves	16	8.71		16	2.57		16.	5.27		16	1.31	

[A] df: degree of freedom; MS: mean sum of squares; ns=non-significant.

[B] for interpretation see Biometric analysis.

F=MS (curve displacement or common nonlinear)/MS (within curves).

Table 8. Overall means of model parameter values (LSM±SE) for *in sacco* dry matter degradation of *Paspalum conjugatum, Eleocharis dulcis, Oryza rufipogon* and rice straw as affected by supplements, and means of the values of incubated samples of individual roughage in buffaloes eating rice straw and grasses or grasses in Exp. 2

Item	Parameter[B]		
	a	b	c
Diet[A]			
RG	5.5±1.95	62.7±6.92	0.022±0.008
RGUMC	8.9±2.4	63.5±11.4	0.017±0.008
G	6.7±1.58	57.5±5.79	0.024±0.009
GUMC	7.7±2.12	63.4±8.68	0.019±0.008
Incubated samples			
Paspalum conjugatum	7.2±0.22	68.3±2.15	0.024±0.002
Eleocharis dulcis	8.1±0.15	48.9±1.46	0.021±0.002
Oryza rufipogon	6.3±0.13	65.5±1.49	0.022±0.002
Rice straw	4.1±0.14	66.2±3.06	0.014±0.001

[A] RG: Rice straw and grass, RGUMC: Rice straw, grass and urea-molasses cake, G: Grass, GUMC: Grass and urea-molasses cake.

[B] parameters of the model: $y=a+b(1-e^{-ct})$ fitted to the data, where c corresponds to fractional degradation rate (h^{-1}) and a+b to potential degradability.

present in high concentrations. The low ash content in the rice straw grown on acid soils, could have been caused by low amounts and low availability of calcium and phosphorus in the acid soil. Donahue et al. (1971) indicated that phosphorus availability is low in acid soils because of binding to iron and aluminum.

Rumen pH and ammonia concentration

In a continuous culture, digestibility of organic matter, neutral detergent fiber, and nitrogen was significant depressed at pH 5.8, markedly increased at pH 6.2 and only increasing slightly at pH 7.0. Production of total volatile fatty acid was highest between pH 6.2 and 6.6. Means for acetate production increased, but propionate and butyrate production decreased from 5.8 to 6.2 (Shriver et al., 1986). Erfle et al. (1982) reported that the ammonia concentration in culture fluid *in vitro* may vary from 4 to 6 mM at pH 6 and 7, but 0.2 mM at pH 5.5 and 5.0. The proteolytic organisms concentration was from 0.5 from 1.0×10^8 cells per ml the fluid at pH 6 and 7, while none could be detected (less than 10^4 cells per ml) at pH 5. Seijas et al. (1994) found high pHs of grazing cattle varying between 7.1 and 7.2 for animals with and without supplementation of Gliricidia, urea-mineral block and Gliricidia and urea-mineral block of rumen fluid samples. The rumen fluid samples taken at 08:00 h and every 3 h until 23:00h. Wanapat et al. (1991) reported that the pH of animals with and without high quality feed block (HQFB: molasses, urea, cassava, oil seed meals, minerals, and sulfur) supplementation was 6.6 and 6.6 in swamp buffaloes, 6.6 and 6.9 in beef cattle and 6.9 and 7.1 in dairy cattle (the rumen fluid samples taken at 0 h, 3 h and 6 h post-feeding). The pH value in the present study were approximately 7.0 indicating good rumen pH conditions in all treatments for microbial growth.

Kennedy et al. (1995) found that in swamp buffaloes fed with rice straw and dry *leucaena* the ammonia concentration in rumen fluid was significantly higher than that of cattle and it was significantly higher for the supplemented *leucaena* diets or grass diets compared to rice straw diet (Moran et al., 1983). Wanapat et al. (1991) stated that supplementation with the HQFB markedly enhanced NH_3-N concentration. The results also showed that the ruminal NH_3-N concentration in animals with and without HQFB was 59.8 and 97.1 in buffaloes, 76.0 and 118 in beef cattle and 54.1 and 165 mg/l in dairy cattle, respectively, (rumen fluid sampled at 0 h, 3 h and 6 h post-feeding). In the present experiments supplying 220 g CP in the form of UMC increased ruminal NH_3-N concentration from approximately 6 to 10 on the rice straw diet and from 13 to 18 (mg/100 ml) on the grass diet 24 h after feeding.

Microbial growth

In an experiment adding Na_2CO_3 or $NaHCO_3$ (10% of the concentrate) to rice straw diets (swamp buffaloes), Jachja et al. (1996) reported total bacterial counts from 1.65 to 2.67 ($\times10^8$/ml) and protozoal counts from 5.40 to 14.2 ($\times10^4$/ml). Using ammonium bicarbonate at levels of 0 to 600 g/d to manipulate ruminal NH_3-N concentrations in swamp buffaloes fed concentrates and rice straw, Pimpa et al. (1996) found responses in ruminal NH_3-N concentration of 7.1 to 34.4 mg/100 ml, respectively. Total bacteria concentrations ranged from 1.4 to 3.7 ($\times10^8$/ml) and total protozoal concentration from 6.4 to 10.7 ($\times10^5$/ml). However, the highest bacterial counts were found at 13.6 mg NH_3-N/100 ml (3.7×10^8), the highest protozoa concentration at 17.6 mg NH_3-N/100 ml (10.7×10^5) and the highest rice straw digestibility and intake at 13.6 mg NH_3-N/100 ml. In the present study, bacteria and protozoa populations were also higher for the all supplemented diets in both experiments except for protozoal counts in the RMi diet. These increases were likely due to the supplementation of nitrogen or energy or both. Maeng et al. (1989) concluded that in continuous cultures, the optimum ratio of non-protein nitrogen to amino acids for rumen microbial growth was 75% urea nitrogen plus 25% amino acid nitrogen. In the present study the ruminal microbial counts were increased in the treatments with increased total feed intake. The review of Clark et al.(1992) suggested that DM intake is one of the most importance factors affecting microbial yield. The importance of feed intake level on the efficiency of microbial protein synthesis was also clearly demonstrated in the study of Volden (1999).

Rumen feed degradation

In both experiments, *in sacco* degradabilities were not significantly affected by either UMC or UMC component supplementation (tables 4, 5, 7 and 8). Wu and Liu (1995) concluded that a urea-mineral lick block improved the digestion of fiber in the rumen of lambs on low quality roughage, but that the block did not greatly influence *in sacco* degradation of either DM or CP. Kanjanapruthipong and Leng (1998) showed that the densities of total viable and cellulolytic bacteria in ruminal fluid significantly increased with increasing ammonia levels by N supplements but that *in sacco* OM digestibility did not differ. In the present study urea-molasses cake supplementation clearly increased NH_3-N concentrations and microbial counts, but without any effects of *in sacco* degradation kinetics. In a study by Thu and Udén (2000b) feeding rice straw to buffaloes with or without urea-molasses based supplements, showed a positive *in vivo* DM and NDF digestibility response to the supplement, without any response *in sacco*. Similarly, Hadjipanayiotou (1996) also reported no significant improvement in *in sacco* DM degradability by urea-molasses block supplementation, while animal performance as improved by the supplementation. The lack of supplementation effect on the *in sacco* DM degradation in the present study was perhaps caused by a lower solid-associated microorganisms activity in the bag contents compared to rumen contents as suggested by Nozière and Michalet-Doreau (1996).

Feed intake and live weight change

In an experiment with swamp buffaloes fed rice straw or rice straw and natural grasses (0.5% body weight, DM basis) with and without UMC supplementation, Thu (1997) reported that there was a significant increase of feed intake for the diet supplemented with urea-molasses cake. Kunju (1986) also showed an increased straw intake from 4.4 to 5.7 kg per day, when replacing 1 kg concentrates with 560 g urea-molasses lick block. In Exp. 1 there were significantly higher total feed and rice straw intakes for the RUMC diet as compared to the UMC component diets. Although the criterion of live weight changes of buffaloes in the study are of limited value due to a short measurement period, the responses corresponded well with changes in feed intake. Pearce (1973) observed that the effects of urea-molasses lick blocks were more effective when the quality of the basal ration was poor. Schiere et al. (1989) concluded that the inclusion of a small proportion of green grass, only provides some supplementary plant protein but also readily available carbohydrates, which may be the cause for a additive effect to urea-molasses lick block. In many instances, a small amount of green grasses could therefore be a more economic alternative to the farmers. In studies on cattle Kunju (1986) concluded that urea-molasses lick block supplementation of a straw-based diet increases digestibility, feed intake, live weight gain and the net return. There is a considerable evidence that solidified molasses-block supplementation increases intake and digestibility of many roughage -based diets, and that macro-and micro-elements can be easily incorporated in the blocks thereby correcting multi-nutritional deficiencies of ruminants in developing countries (Leng, 1984; Wanapat et al., 1991; Garg and Gupta, 1992; Yan et al., 1997; Hosmani et al., 1998 and Wanapat et al., 1999).

CONCLUSIONS AND IMPLICATIONS

It is concluded that urea-molasses cake supplementation of rice straw and grass diets increases rumen NH_3-N concentration, microbial populations and intake in buffaloes, but that significant improvements of *in sacco* DM degradability may not be found. The effects of the separate cake components on the above measurements are not apparent, but improvement in intake and LW change are seen if a combination of urea, molasses, minerals and other protein nitrogen sources are used. The results also suggested that adding grasses at a level of 0.25% live weight (DM basis) to the rice straw diet should be considered to maintain the buffalo rumen function and performance with UMC supplementation. Studies on different levels of UMC intake should be implemented for the next steps to optimize the utilization of dietary nutrients and to improve production in buffaloes fed low quality roughages.

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