Effect of Graded Levels of Green Grass Supplementation on Nutrient Digestibility, Rumen Fermentation and Microbial Nitrogen Production in Cattle Fed Rice Straw Alone

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ABSTRACT : On an absolute straw diet, the effect of graded levels of green grass supplementation on intake, nutrient digestibility, rumen fermentation pattern and microbial N yield has been studied in cattle. Of the two trials conducted, 16 intact growing bulls of 304 kg weight and 32 months old, randomly allocated to four treatments in a completely randomized design in the 1st trial. While, in the 2nd trial, four rumen cannulated local bulls of about 60 months old and 400 kg weight were used in a 4 × 4 Latin square design with four treatments in four periods. In both the trials, in addition to a mineral mixture, animals were supplemented with graded levels of naturally grown green grass of 0 kg (T1), 2 kg (T2), 4 kg (T3) or 6 kg (T4) to an *ad libitum* rice straw diet. In the 1st trial, measurements were made on intake digestibility, growth rate, N balance and microbial N yield. While in the 2nd trial, in addition to the above parameters (except growth rate), rumen parameters were also studied.

All levels of grass supplementation decreased the straw DM intake and increased the substitution rate. The rumen NH_3-N concentration increased with the increase in grass level and ranges from 8-46 mg/l. The rumen pH and the rate and extent of DM degradability of straw were not affeceted by different rumen environments created by different levels of grass inclusion. At 48 h, straw DM degradability were 42, 44, 44 and 43% respectively for 0, 2, 4 and 6 kg grass supplementation daily. The whole gut digestibilities of DM, OM and ADF increased significantly ($p < 0.05$) only at 6 kg level daily. The microbial N yield was not affected by the levels of grass supplemented. The mean microbial N yield was 10 (SD 3.7) g/kg DOM apparently fermented in the rumen. The estimated minimum N loss and thus the maintenance requirement of tissue protein was 303 mg/kg $W^{0.75}$/d. All the animals lost live weight but 6 kg grass supplementation gave positive energy and N balances. Small amount of green grass supplementation is often recommended for optimization of rumen environment of a straw diet. However, under the present experimental condition, no such beneficiary effect observed up to 6 kg (26% of DM intake) level of supplementation.
(**Key Words :** Straw, Grass, Supplement, Microbial N, N-Balance)

INTRODUCTION

Rice straw is the major roughage source for feeding cattle in Bangladesh. It is essential energy feed, low in nitrogen (N), minerals and vitamins. As a result, as such it can not optimize rumen environment in terms of microbial requirement of readily fermentable carbohydrates, rumen ammonia and some minerals. Initiation of straw fermentation in the rumen probably depends on the pool size of the cellulolytic bacteria. Any manipulation which maintains a large pool of cellulolytic organism in the rumen may increase the rate of digestion of straw. Addition of readily and totally fermentable cellulose source to a diet can potentially increase the rate of colonization and degradation of straw particles (Nielsen, 1981). This led to the hypothesis that a little amount of green forage might influence the microbial growth and thus the celluloytic activity by providing essential cofactors (Preston and Leng, 1987). Silva and Ørskov (1988) as well as Nellovu and Buchanan-Smith (1985) observed that sheep fed a straw-based diet supplemented with a relatively low levels of high quality forage had increased digestibility of the basal diet. Reviews by Bamualim (1985) and Prasad et al. (1993) have shown the positive associative effect of graded levels of leucaena, glyricidia or stylo supplementation on intake and digestibility diet and growth rate of cattle and goats. However, in Bangladesh, cattle population receives approximately 1 kg green forages, mostly of agricultural weeds and/or from

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road side grasses (Tareque and Saadullah, 1988) Often these grasses are no better than straw as far as readily fermentable cellulose on N is concerned. Nothing is known on the effect of supplementation of these grasses on a straw diet in cattle. The present research has, therefore, been designed to determine the effect of supplementation of different levels of naturally grown green grass to a straw diet:

(a) on its intake, rumen fermentation and digestibility of different nutrients; and

(b) its effects on the microbial N production, nitrogen balance and growth rate of native growing bulls.

MATERIALS AND METHODS

Two trials were conducted, where feed intake, digestibility, microbial N yield and growth responses were measured in 16 intact growing bulls in the 1st trial and in the 2nd trial, in addition to the above parameters (except growth rate), the rumen fermentation pattern were also measured in four rumen cannulated bulls.

Experimental design, animals and diet

The 1st trial, on 16 intact indigenous growing bulls of about 32 months old and 304 kg live weight being randomly assigned to four treatments in a completely randomized design. The trial started from the June 1995 and continued for 33 days. In the 2nd trial, four rumen cannulated local bulls of about 60 months old and 400 kg live weight were used in a 4 × 4 Latin square design (LSD), in four different periods started from August, 1995 and continued for 3 months. In both trials, animals were supplemented with graded levels of green grass of 0 kg (T1), 2 kg (T2), 4 kg (T3) or 6 kg (T4) in addition to *ad libitum* chopped (15 cm) rice straw. Besides, they were given 100 g of common salt and 50 g of oyestershell powder as mineral sources (table 1).

Table 1. Feeding schedule of intact (1st trial) and cannulated bulls fed different diets. In addition to roughages all the animals received 100 g of common salt and 50 g of oyestershell powder

Treatments	Feed ingredients	Amount supplied
T1	Rice Straw	*Ad libitum*
	Grass	Nil
T2	Rice Straw	*Ad libitum*
	Green Grass	2 kg
T3	Rice Straw	*Ad libitum*
	Green Grass	4 kg
T4	Rice Straw	*Ad libitum*
	Green Grass	6 kg

The diets were offered twice daily in equal proportion (08:00 h and 17:00 h) and straw was given 15% in excess of intake. Rice straw was of unknown Aman (cultivated during the Monsoon) varieties collected from different sources. Mixed green grasses were collected daily from the low-lying area of the Bangladesh Livestock Research Institute over the course of experiment i. e., from June to October. The chemical composition of the grass and straw are shown in table 2. In both the trials, animals were housed in a Face-Out Stanchion Barn except during the digestibility measurement when they were moved to metabolic stalls having facilities of separate faeces and urine collections.

Table 2. Chemical composition of straw and grass used over the experimental period

Trial	Period	Feed Item	Dry matter (g/100 g)	g/100 g DM		
				OM	N	ADF
1st	Jun-Jul, 1995	Straw	96.60	77.57	0.902	45.82
		Grass	28.60	93.95	1.603	46.57
2nd	I (Aug., 1995)	Straw	88.81	77.60	0.811	47.66
		Grass	19.59	86.26	2.344	40.30
2nd	II (Aug-Sep, 1995)	Straw	85.14	79.33	1.147	43.72
		Grass	22.95	87.44	3.427	29.94
2nd	III (Sep-Oct, 1995)	Straw	88.57	79.95	1.186	39.41
		Grass	21.57	86.70	3.427	37.04
2nd	IV (Oct-Nov, 1995)	Straw	89.33	79.95	0.800	39.44
		Grass	16.09	97.34	3.064	37.08

Experimental techniques

(a) *Rumen Parameters: In sacco* nylon bag (17 × 9.5 cm, pore size 20-45 μm) studies (Ørskov and McDonald, 1979) were conducted by incubating 2 g of washed, dried & hammer milled (4 mm) rice straw and green grass (dried at 60℃ in a force draft oven) for 0, 8, 16, 24, 48, 72 and 96 hours in duplicate. Straw sample was incubated in four different rumen environments created by four different diets. While, the grass sample was incubated in four animals fed an straw diet. Following incubation, the bags were washed under running tap water until water obtained by gently squeezing the bags was clear. The bags and the contents were then dried at 60℃ in a forced-draught oven. The data of DM degradability of the test straw and grass were analyzed by the NAWAY computer programme of the exponential model $p = a + b(1 - e^{-ct})$ described by McDonald (1981), where p is the actual degradation in time t and a, b and c are constants. Constant a, represents the intercept, b is insoluble but potentially degradable material in time t and c is the rate constant of b. Rumen biochemical studies were conducted by using strained rumen fluid (SRL) at 0, 2, 5, 8.5 and 12 h post-morning feeding. Immediately after collection, the pH of the SRL was measured by a digital pH meter and the sample was stored at −20℃ with few drops of 6NHCl for analysing NH_3-N contents.

(b) *Live weight change*: In the 1st trial, animals were weighed weekly before the morning feed. Live weight change was calculated as the slope of the individual regression of live weight *vs* time.

(c) *Chemical analysis*: Samples of feeds, refusals and faeces were analysed for dry matter (DM), organic matter (OM) and N according to AOAC (1984). Urinary N also measured in the same way. The acid detergent fiber (ADF) was determined according to Goering and van Soest (1970). The urine samples were analyzed for determining purine derivatives (from allantoin + 15% correction for uric acid) to quantify microbial N (MN) yields in the rumen following the method described by Chen and Gomes (1992). Rumen NH_3-N concentration was measured by steam distillation of the SRL using the method of Tareque (1991).

(d) *Statistical analysis*: In the 1st trial, data on intake, digestibility, nutritive value, N balance, MN yield and live weight change were analyzed in an ANOVA of a completely randomized design (CRD) for the significant difference among the four diets. While in the 2nd trial, the response to four different diets on the intake, digestibility, nutritive value, N balance, MN yield and rumen parameters were analyzed by an ANOVA of a 4 × 4 Latin square design. Linear regression model of the form $y = a + bx$ was used where appropriate. Statistical method of Snedecor and Cochran (1967) used for the analysis.

RESULTS

Straw intake

In general, straw DM intake (SDMI) reduced with the

Table 3. Dry matter intake from straw and grass by the growing (1st trial) and the cannulated bulls (2nd trial)

	T1	T2	T3	T4	SED	Significance
1st Trial						
Straw DMI (kg/d)	5.46	4.49	4.38	4.78	0.629	NS
Grass DMI (kg/d)	0	0.57	1.14	1.72	–	–
Total DMI (kg/d)	5.46^{ab}	5.06^{b}	5.52^{ab}	6.50^{a}	0.626	$p < 0.05$
Straw DMI as % LWt (kg/d)	1.81	1.50	1.44	1.55	–	–
Straw DMI (g/kg $W^{0.75}$/d)	76^{a}	62^{b}	61^{b}	65^{b}	4.13	$p < 0.05$
Grass DMI as % of total DMI (kg/d)	0	11	20	26	–	–
Substitution rate (%)	0	18	20	9	–	–
2nd Trial						
Straw DMI (kg/d)	4.60	4.40	4.11	3.76	0.192	NS
Grass DMI (kg/d)	0	0.39	0.77	1.16	–	–
Total DMI (kg/d)	4.60	4.79	4.88	4.92	0.286	NS
Straw DMI as % LWt (kg/d)	1.27	1.25	1.30	1.28	0.029	NS
Straw DMI (g/kg $W^{0.75}$/d)	55	52	49	44	2.63	NS
Grass DMI as % of total DMI (kg/d)	0	8	16	25	–	–
Substitution rate(%)	0	4	10	18	–	–

[a,b] Values with different superscripts in the same row differ significantly.

increase in grass levels in both trials (table 3). However the extent of reduction varied between the two trials and within the treatments in a trial. In the 1st trial, SDMI at 0 grass level was 76 g/kg $W^{0.75}$/d and reduced in a curvilinear fashion (see figure 1a) to 62, 61 and 65 g/kg $W^{0.75}$/d at 11 (2 kg fresh grass), 20 (4 kg fresh grass) and 26% (6 kg fresh grass) level of grass supplementation. While in the 2nd trial, SDMI reduced linearly (r^2 = 0.988; $p < 0.01$), where unit increase in grass level reduced SDMI 0.435 g/kg $W^{0.75}$/d (see figure 1b). Similarly, substitution rate (SR) showed curvilinear response in the 1st trial (figure 1c) and in the 2nd trial, for unit increase in grass level, SR was increased by 0.725(± 0.063) percent (figure 1d).

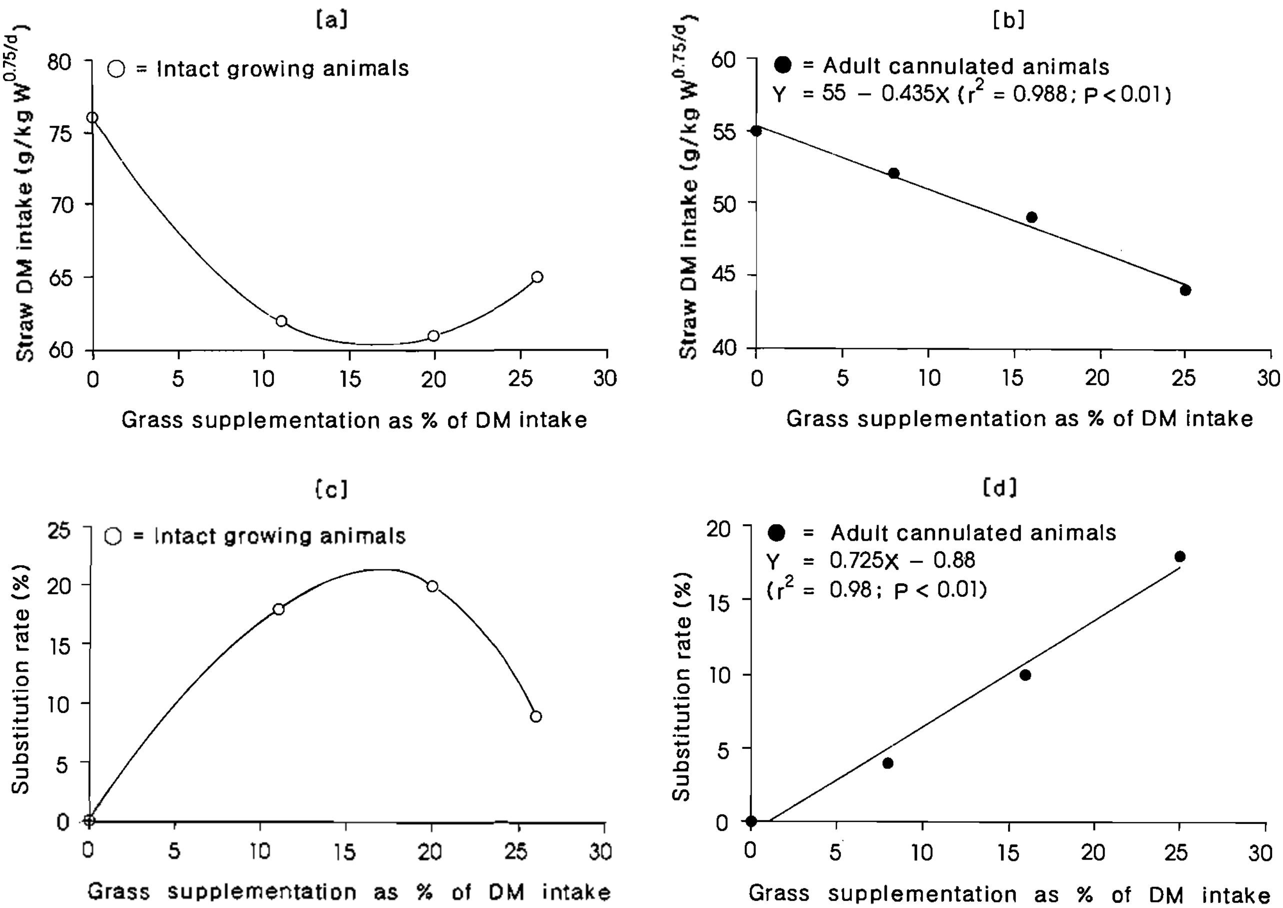

Figure 1. Response of different levels of green grass supplementation on a rice straw diet on: the straw DM intake of intact growing bulls of the 1st trial (figure a) or adult cannulated bulls of the 2nd trial (figure b) and also the substitution rate of animals of 1st trial (figure c) or 2nd trial (figure d). Each point represents the mean of four observations.

Nutrient digestibilities

Digestibilities of different nutrients in the two trials are presented in table 4. In the 1st trial, inclusion of green grass at the rate of 11 or 20% of the total diet reduced the DM digestibility (DMD) by 45 and 43% respectively over that of the control (51%), but increased (56%) when the grass level further increased to 26%.

In the 2nd trial, compared to that of the control (44%), DMD reduced at 8% (40%) but increased subsequently at 16% (46%) and 25% (54%) of green grass supplementation. In both the trials, digestibilities of OM and N showed the similar trends as DMD with the highest digestibility at 26% level of grass inclusion. No definite pattern was observed in the ADF digestibilities (ADFD) in response to graded levels of grass supply. In the 1st trials, highest ADFD was observed in diet with 25% green grass (64%) followed by diet containing straw alone (60%). While, in the 2nd trial, the ADFD was very similar in all four treatments, e. g., 51, 47, 52 and 46% in the control, 8, 16 and 25% level of supplementation.

Table 4. Digestibility coefficient (%) of different nutrients in the two trials

Nutrients	T1	T2	T3	T4	SED	Significance
1st Trial					Residual *df* = 12	
DM	51^{ab}	45^{b}	43^{b}	56^{a}	4.9	$p < 0.05$
OM	56^{ab}	51^{b}	51^{b}	62^{a}	3.5	$p < 0.05$
N	27^{b}	21^{b}	27^{b}	44^{a}	7.4	$p < 0.05$
ADF	60^{a}	52^{ab}	53^{bc}	64^{a}	3.9	$p < 0.05$
2nd Trial					Residual *df* = 6	
DM	44^{ab}	40^{b}	46^{ab}	54^{a}	5.2	$p < 0.05$
OM	47^{b}	44^{b}	49^{ab}	58^{a}	4.2	$p < 0.05$
N	43	43	45	52	7.7	NS
ADF	51	47	52	46	4.1	NS

[abd]Values in the same row with different superscripts differ significantly.

Rumen pH

Effect of different levels of grass supplementation on rumen pH at different hours after post-feeding (morning) is shown in table 5 and figure 2a. Rumen pH was not affected by the levels of grass inclusion. At 5 h post-feeding, the pH were 7.98, 7.89, 7.92 and 7.95 respectively at 0, 8, 6 and 16% level of grass inclusion.

Table 5. NH_3-N (mg/L) and pH level of rumen fluid collected at different hours after morning feeding from animals fed graded levels of green grasses

Hours	T1	T2	T3	T4	SED Residual *df* = 6	Significance
NH_3-N (mg/L)						
0	15	19	18	37	7.28	$p<0.05$
2	23	31	31	46	9.19	$p<0.05$
5	14	24	28	38	7.76	$p<0.05$
8.5	14	23	21	30	5.54	$p<0.05$
12	8	8	12	16	3.46	NS
pH						
0	–	–	–	–	–	–
2	8.01	8.06	7.98	8.03	0.095	NS
5	7.98	7.89	7.92	7.95	0.069	NS
8.5	7.97	7.88	7.79	7.84	0.082	NS
12	7.84	7.79	7.79	7.86	0.101	NS

Rumen ammonia

In the 2nd trial, rumen NH_3-N concentration of animals with different levels of green grasses at different hours post-feeding (morning) are shown in table 5 and figure 2b. In general, rumen NH_3-N concentration was very low in all four treatments. At 2 h post-feeding, rumen NH_3-N concentration were 23, 31, 31 and 46 mg/l respectively at 0, 8, 16 and 25% level of grass inclusion. NH_3-N concentration increased linearly with the increasing levels of grass inclusion, but the response was only significant ($p < 0.05$) at 25% level. At all the hours of sampling, relatively higher rumen NH_3-N concentrations were maintained with 25% grass.

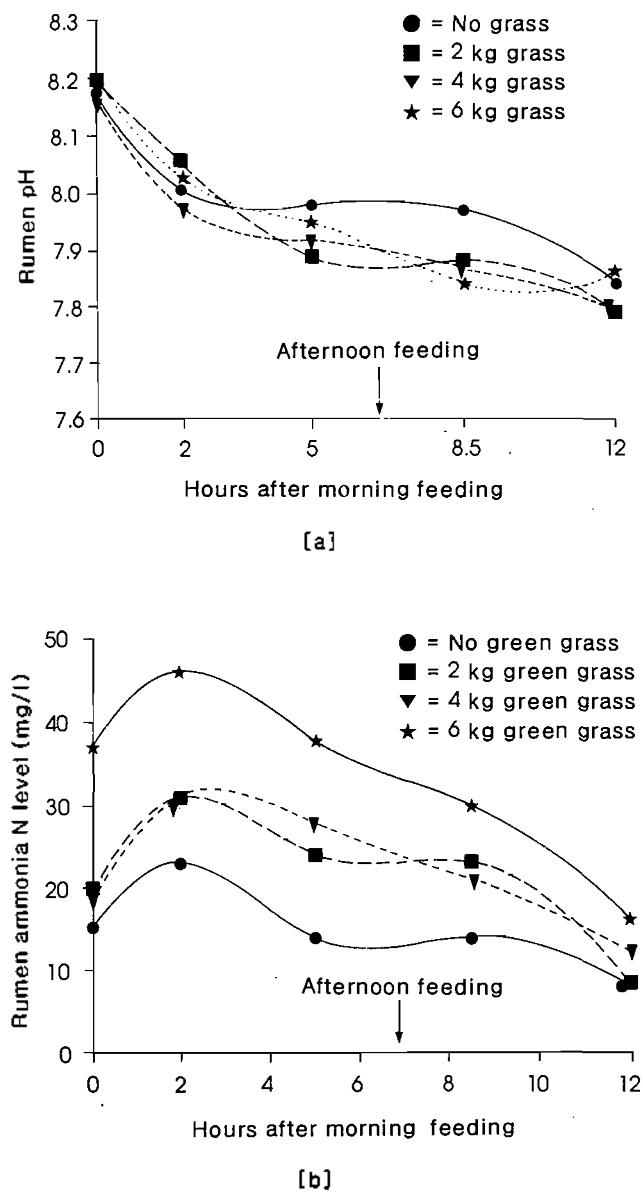

Figure 2. Response of different levels of green grass supplementation on a rice straw diet on the rumen pH (figure a) or ammonia (figure b) level in adult cannulated bulls. Each point represents the mean of four observations.

Straw DM degradability

The DM degradability of the test straw incubated in four different rumen environments created by four different levels of grass supplementation is presented in table 6 and figure 3a. Inclusion of different levels of grass had no effect on the rate (mean, 1.87%) or the extent (mean, 65%) of straw degradation. At 48 h, DM degradability were 42, 44, 44 and 43%, respectively at 0, 8, 16 and 25% level of grass supplementation.

Table 6. Straw DM degradation characteristics (%) in the rumen of animals fed different levels of green grasses. The factors of exponential equation $P = a + b\ (1 - e^{-ct})$ describing the degradation (p) with time (t)

Hours of incubation	T1	T2	T3	T4	SED Residual df = 6	Significance
NH_3-N (mg/L)						
8	8	9	8	8	0.53	NS
16	13	16	15	16	2.51	NS
24	21	21	22	23	1.19	NS
48	42	44	44	43	1.55	NS
72	45	46	46	46	1.72	NS
96	51	51	52	51	1.11	NS
Soluble fraction (a)	−2	−1	−2	−2	1.35	NS
Potential Dig. fraction (b)	62	70	65	62	7.78	NS
Digestion rate (c)	1.81	1.67	1.87	2.14	0.37	NS
Extent of digestion (a + b)	60	69	63	60	8.88	NS

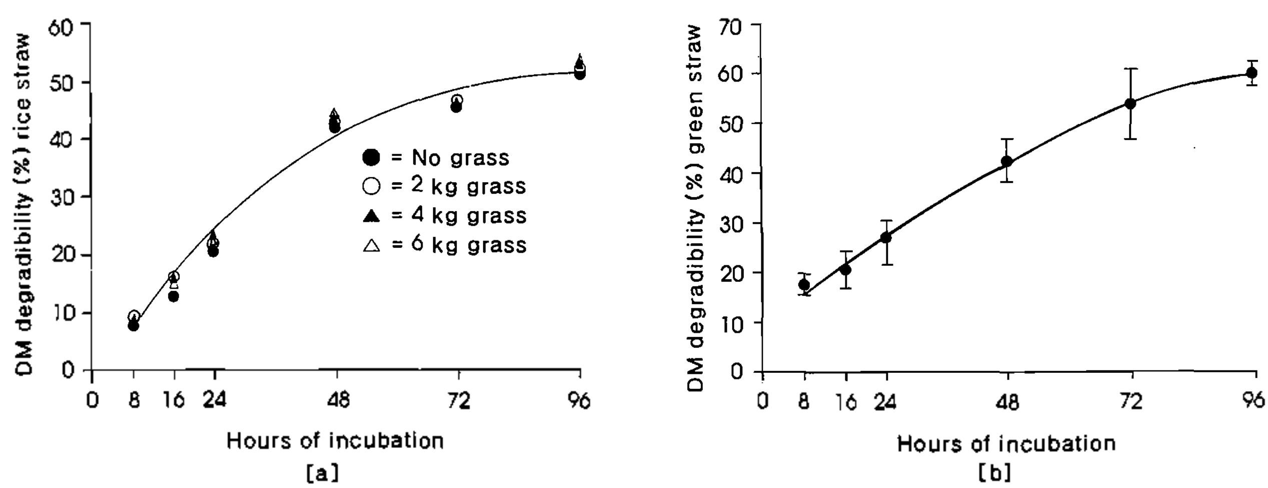

Figure 3. figure a. Effect on DM degradability of a test rice straw (washed, dried and hammer milled) incubated in four rumen environments of bulls fed rice straw supplemented either with 0, 2, 4 or 6 kg fresh green grass. figure b. DM degradability of a green grass (oven dried at 60℃ and hammer milled) incubated in the rumen of bulls fed straw diet. In either cases each point represents a mean of 4 observations with vertical bar as standard deviation (for grass only).

Grass DM degradability

The DM degradability of grass were 18, 21, 26, 42, 53 and 59%, respectively at 8, 16, 24, 48, 72 and 96 h of incubation (see figure 3b). The fitted exponential equation was $Y = 9.2 + 77.7(1 - e^{-0.0112t})$, where Y is the DM degradation in time. The rate and extent of degradation were 1.12% and 87% respectively.

Nitrogen utilization

Nitrogen utilization in the two trials by different groups of animals are shown in table 7. As expected, in both trials, increasing levels of grass inclusion increased ($p < 0.05$) N intake but had no significant effect on faecal or urinary N excretion. Regression between levels of grass inclusion (X, % of total DM intake) and N intake (Y, g/d) in the two trials were as follows:

$$Y = 45.6 + 0.798(\pm 0.2907)X ; (r^2 = 0.79 ; n = 4) \ldots \text{ 1st trial (figure 4a)}$$

$$Y = 46.1 + 1.190(\pm 0.010)X ; (r^2 = 0.99 ; n = 4) \ldots \text{ 2nd trial (figure 4a)}$$

Similarly, when N balances (Y, mg/kg $W^{0.75}$/d) were regressed against grass intake (X, % of total DM intake), in both groups, N balance increased linearly with the increasing levels of grass supply:

$$Y = -75 + 8.59(\pm 4.854)X ; (r^2 = 0.61 ; n = 4) \ldots \text{ 1st trial (figure 4b)}$$

$$Y = 80 + 8.66(\pm 1.196)X ; (r^2 = 0.96 ; n = 4) \ldots \text{ 2nd trial (figure 4b)}$$

Although the N balance at 0 grass level was very different (−75 *vs.* 80 mg/kg $W^{0.75}$/d) in the two trials, but incremental increase in N balance in response to unit (1%) increase in grass level, were very similar (8.59 *vs.* 8.66 mg/kg $W^{0.75}$/d).

Microbial N (MN) yield

MN yield in response to different levels of grass supplementation in the 1st and the 2nd trial are shown in table 7. In either of the trials, inclusion of different levels of grass had no significant effect on the total MN yield (see table 7). Besides, at any given level of supplementation, total MN yield was higher in the adult cannulated (2nd trial) than the young growing (1st trial) bulls (see figure 4c). In the 1st trial with young growing animals, MN yield per kg digestible organic matter apparently fermented in the rumen (DOMR) were 6.07, 7.84, 7.87 and 5.38 g respectively for 0, 11, 20 and 26% level of supplementation. With adult cannulated bulls in the 2nd trial, the MN yield/kg DOMR were 13.47, 15.35, 12.83 and 8.80 g for 0, 8, 16 and 25% level of green grass supplementation respectively.

Live weight changes

Live weight changes during the 33 d feeding trial in the 1st trial are shown in table 7. All the animals lost

Table 7. Nitrogen utilization of bulls fed rice straw with graded levels of green grasses

Particulars	T1	T2	T3	T4	SED	Significance
1st Trial (Intact growing bulls)					Residual *df* = 12	
Feed N Intake (g/d)	49^{b}	50^{b}	58^{ab}	71^{a}	8.06	$p < 0.05$
N intake (mg/kg $W^{0.75}$/d)	685^{c}	692^{bc}	802^{b}	969^{a}	53.25	$p < 0.05$
Faecal N Excr. (g/d)	37	40	42	40	7.35	NS
Urinary N Excr. (g/d)	12.4	12.9	13.7	15.2	3.79	NS
N Balance (mg/kg $W^{0.75}$/d)	-23^{c}	-43^{c}	26^{b}	229^{a}	14.6	NS
Live weight change (g/d)	-452^{a}	-334^{a}	-7^{c}	-179^{b}	58.83	$p < 0.05$
Microbial N yield (g/d)	9.306	10.451	11.76	11.445	7.2804	NS
Microbial amino acid N available at the tissue level (mg/kg $W^{0.75}$/)#	72	79	85	96	46.6	NS
Microbial N (g/kg) DOMR	6.07	7.84	7.87	5.38	–	–
2nd Trial (Cannulated bulls)					Residual *df* = 6	
Feed N intake (g/d)	46^{c}	56^{b}	65^{b}	76^{a}	3.9	$p < 0.05$
Feed N intake (mg/kg $W^{0.75}$/d)	553^{c}	657^{b}	775^{a}	859^{a}	36.6	$p < 0.05$
Faecal N excretion (g/d)	26^{b}	32^{b}	34^{a}	33^{b}	3.5	$p < 0.05$
Urinary N Excretion (g/d)	12.7	15.0	14.1	14.3	1.162	NS
N balance (mg/kg $W^{0.75}$/d)	97	124	220	304	85.9	NS
Microbial N production (g/d)	14.96	17.65	15.99	15.98	3.649	NS
Available microbial amino acid N (mg/kg $W^{0.75}$/d)#	94	104	88	75	25.4	NS
Microbial N (g/kg) DOMR	13.47^{ab}	15.35^{a}	12.83^{ab}	8.80^{b}	2.445	$p < 0.05$

[abc] Values with different superscripts in the same row differ significantly.

Assuming 0.8 of microbial N is amino acid N of which 0.85 is digestible and utilized with the efficiency of 0.8 (ARC 1984).

their weight and was −452, −334, −7 and −179 g/d at 0, 11, 20 and 26% levels of grass supplementation respectively. Significantly ($p < 0.05$) lower live weight loss at 20% level was due to live weight gain (155 g gain *vs* 61 g loss daily) by one of the animals in that group (see figure 4d).

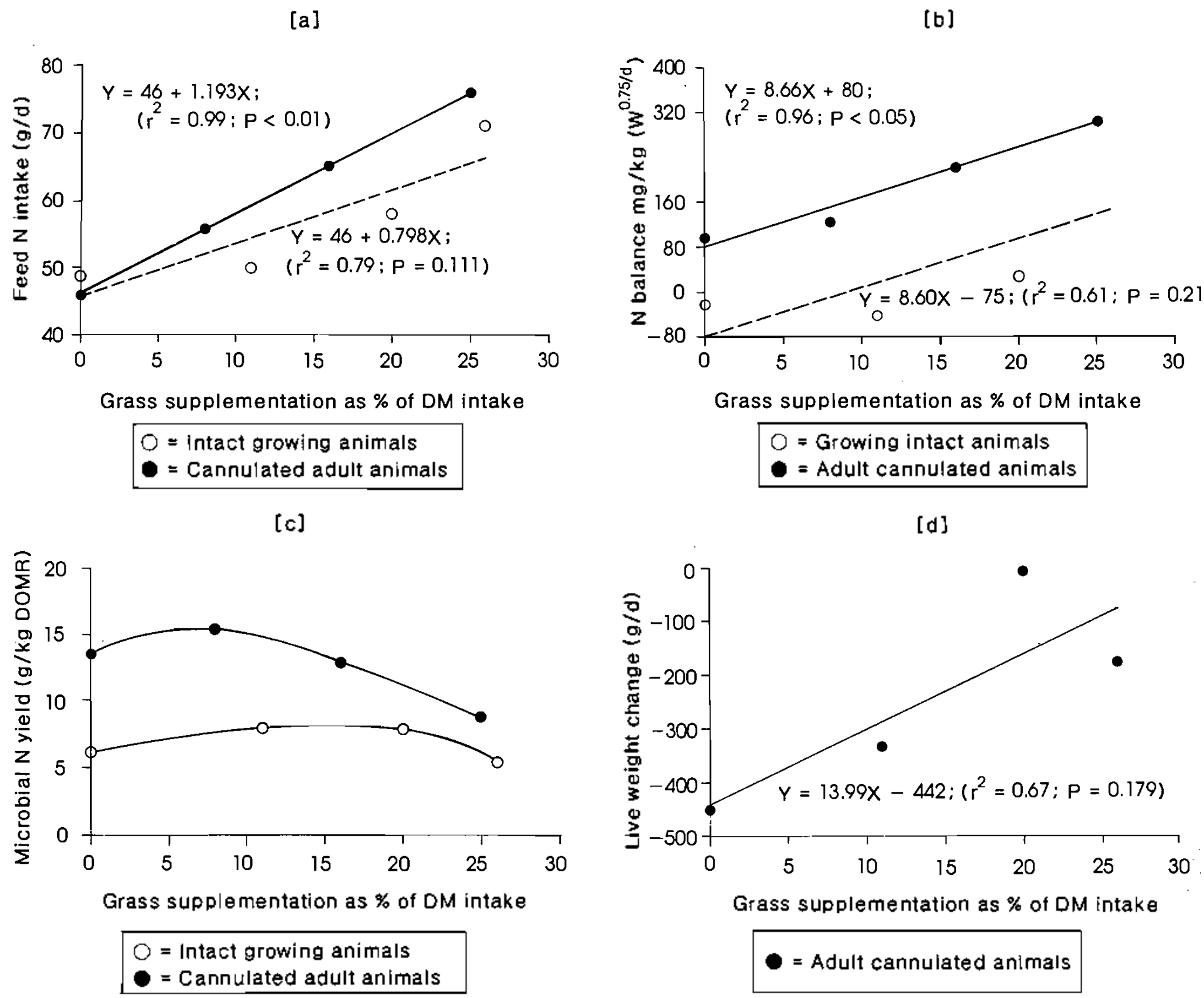

Figure 4. Response of different levels of green grass supplementation on a straw diet on: N intake (figure a) N balance (figure b), microbial N yield (figure c) and live weight changes (figure d) of intact growing (○, 1st trial) or adult cannulated (●, 2nd trial) bulls. Each point represents mean of four observations.

Estimated energy intake

Digestible organic matter (DOM), estimated (DOM × 15.8, Kearl, 1982) ME intake and the energy concentration of different diets in the 1st and the 2nd trial are presented in table 8. In the 1st trial, DOM and the estimated total ME intake increased significantly ($p < 0.05$) over that of the control, only at the 25% level grass inclusion (table 8 and figure 5a, b). Similar (but not significant) effect was also observed in the 2nd trial (figure 5a, b). At all levels of grass inclusion, ME intake expressed as metabolic body weight basis was higher in the 1st than the 2nd trial (see figure 5c). In both the trials, from 0 to 20% levels of grass inclusion, the energy concentration (MJ ME/kg DM intake) was very similar (appx. 6.24 MJ/kg DM), which increased to approximately 8.94 MJ/kg DM at about 25% grass level (see table 8 and figure 5d).

Table 8. Estimated energy availability to the bulls fed rice straw with graded levels of green grasses

Particulars	T1	T2	T3	T4	SED	Significance
1st Trial						
Dig. OM intake (kg/d)	2.36[ab]	2.05[b]	2.30[ab]	3.30[a]	0.518	$p < 0.05$
Total ME inake (MJ/d)#	37.29[b]	32.29[b]	36.35[b]	52.20[a]	4.033	$p < 0.05$
ME intake (kJ/kg $W^{0.75}$/d)	520[b]	452[b]	503[b]	692[a]	71.3	$p < 0.05$
M/D of the diet (MJ/kg DM)	6.83	5.76	6.49	8.04	–	–
2nd Trial						
Dig. OM intake (kg/d)	1.75	1.78	2.01	2.92	0.548	NS
Total ME intake (MJ/d)#	27.69	28.05	31.76	46.14	8.08	NS
ME intake (kJ/kg $W^{0.75}$/d)	328	324	385	519	98.3	NS
M/D of the diet (MJ/kg DM)	6.02	5.86	6.50	9.38	–	–

1 kg of DOM = 15.8 MJ ME (Kearl, 1982).
[ab] Values with different superscripts in the same row differ significantly ($p < 0.05$).

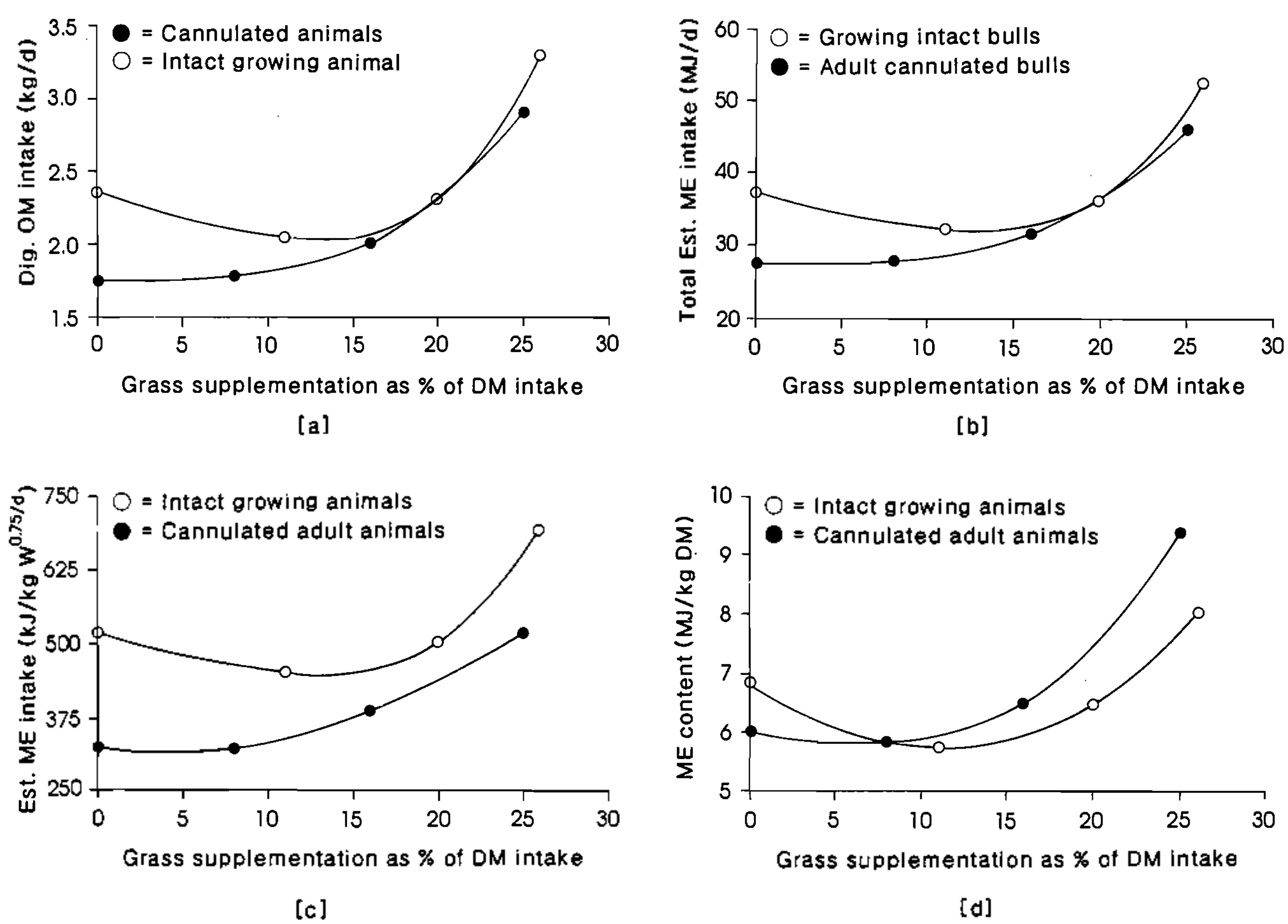

Figure 5. Response of different levels of green grass supplementation on a straw diet on: digestible OM intake (figure a), estimated total ME intake (figure b), ME intake kJ/kg $W^{0.75}$/d (figure c) and ME concentration of the diet (figure d) of intact growing (○, 1st trial) or adult cannulated (●, 2nd trial) bulls. Each point represents mean of four observations.

DISCUSSION

In the present study an attempt has been made to determine the effect of low levels (0 to 26%) of naturally grown fresh grass supplementation to a straw diet, on the optimization of rumen function so as to increase intake, digestibility, microbial N yield and growth rate. Of the two trials conducted, supplementary grasses showed little or no positive effects on the above parameters.

In both the trials, increasing levels of green grass inclusion resulted in a reduction of SDMI and increase in SR. This is in contrast with the observed positive associative effect on SDMI when supplemented with *Verano stylo* up to 30% of dietary intake (Suryajantratong and Wiliapon, 1985). However, Tharmaraj et al. (1989) observed a declined SDMI of both treated and untreated rice straw when supplemented with 0, 7, 12 or 26% levels of *Glyricidia* foliage. The observed reduction in SDMI and increase in SR with the increased levels of grass supplementation in the present trial, could be due to the combination of factors, such as a) palatability of the grass; b) poor quality (high in ADF and low in N content) of the supplied grass which may have increased the retention time of this indigestible matter in the rumen (Prasad et al., 1993). These factors can be understood from the facts that the whole gut ADF digestibility and the 48 h rumen degradability of the grass were 40 and 42% respectively, which are very similar to that of the rice straw of 42 and 42%. As a result, increasing grass supplementation linearly reduced the SDMI and increased the SR.

Grass supplementation did not improved the straw degradabilities or the whole gut fiber digestibility. This was different from the observation that 15% dietary supplementation of either of sugar beet pulp or dried grass, at a rumen ammonia level of 220 mg/l, increased straw DM degradability by 9 or 15% respectively (Silva and Ørskov, 1988). They suggested that the availability in the rumen of substrates like, cellulose and pentosans from sugar beet pulp or dried grass led to an increased growth of celluloytic organisms like *Bacteroides succinogens, Ruminococcus flavefaciens, Butyrivibrio fibrisolvens*, the major straw digester. In the present trial, absence of any significant positive effect of grass supplementation on ruminal activity could be due to the facts that: 1) the availability of readily fermentable cellulose from grass was not sufficient to increase straw degradation in the rumen; 2) the rumen ammonia N was < 50 mg/l even at the highest level of grass supplementation, which is below the rumen NH_3-N level 50 mg/l (Leng, 1990) for optimum fibre digestibility. At 25% of grass supplementation the intake, the OM digestibility improved significantly. Reduction in the intake of straw of high silica content probably improved the total OM digestibility in those animals, as silica content is negatively correlated ($r = -0.48$) with the OM straw and thus probably unable to meet critical nutrient deficiencies of the rice straw based diet.

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