

Effects of Feeding Urea and Soybean Meal-Treated Rice Straw on Digestibility of Feed Nutrients and Growth Performance of Bull Calves

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ABSTRACT : The experiment was conducted for a period of 56 days with twelve Bangladeshi bull calves of average body weight of 127.20 ± 11.34 kg. The calves were divided into 3 groups having 4 animals in each. The animals were fed urea-treated rice straw designated as A) 4% urea-treated rice straw, B) 4% urea+4% soybean-treated rice straw and C) 4% urea+6% soybean-treated rice straw. In addition, all the animals were supplied 2 kg green grass, 350 g Til-oil-cake and 100 g common salt per 100 kg body weight of animals. Straw was treated with 4% urea solution and soybean meal at 4 and 6% were added to treated straw and kept for 48 h in double layer polythene bags under anaerobic condition. Urea treatment improved crude protein (CP) content of rice straw from 2.68 to 8.70% and it was further increased by 10.74 and 12.12% with the addition of 4 and 6% soybean meal. Dry matter (DM) intake (kg) was higher ($p < 0.05$) in C (4.2) followed by B (4.1) and A (4.0). Crude protein intake was significantly higher ($p < 0.05$) in group B and C than group A. Total live weight gains were 20.2, 24.8 and 25.6 kg for calves of group A, B and C respectively ($p < 0.01$). The addition of soybean meal to treated rice straw did not affect the coefficients of digestibility of DM, OM, EE and NFE. However, CP and CF digestibility were significantly higher in group B and C ($p < 0.05$). The values for digestible crude protein (DCP), digestible ether extract (DEE), digestible nitrogen free extract (DNFE) and total digestible nutrients (TDN) were significantly ($p < 0.05$) higher in diet C and B in comparison to diet A, but there were no significant difference in digestible organic matter (DOM) and digestible crude fibre (DCF) value among the groups. It may be concluded that 4% urea treated rice straw can be fed to growing bull calves with 2 kg green grass and a small quantity of concentrate without any adverse effect on feed intake and growth. Moreover, soybean meal at 4 and 6% can be added to urea treated rice straw at the time of treatment for rapid hydrolyzing of urea, which resulted an improvement in nutrient digestibility and better utilization of rice straw for growth of growing bull calves. (*Asian-Aust. J. Anim. Sci. 2002, Vol 15, No. 4 : 522-527*)

Key Words : Urea, Urease, Bull Calves, Nutritive Value

INTRODUCTION

About 92 per cent (478.7 million ton) of world straw production is in Asia, including Bangladesh (FAO, 1990). So, in Asian countries, the potential use of rice straw as an animal feed is considerable, as it constitutes the staple diet of ruminants. Its especial importance in Bangladesh lies in the fact that rice straw as dry roughage contributes 46.4% of total dry matter consumed by ruminant animals (Tareque and Saadullah, 1988). It is very low in nitrogen and high in cellulose and hemicellulose contents which are only partly available to animals because of poor digestibility due to the presence of higher amount of inhibitory elements like lignin and silica (Singh and Oosting, 1991). Low intake and low digestibility of the straw by ruminants have limited its use as feed, particularly in high production systems (Males, 1987). So, it is important to improve the quality of rice straw to increase efficient utilization by the gastrointestinal tract of ruminants, since 81 percent of total roughage available for ruminant animal feeding in Bangladesh comes from rice straw.

Urea-treatment (straw ensiling) is found to improve the digestibility (Jayasuriya and Perera, 1981) and availability of cellulose and hemicellulose (Silva and Orskov, 1988) as well as improve nitrogen content (Saadullah et al., 1981b). Urea feeding as a urea molasses block along with rice straw to cattle, sheep and buffalo has been found to give a satisfactory improvement of straw digestibility (Leng, 1984; Tiwari et al., 1988). However, this method is not yet easily adopted by the village level farmers because this method is tedious and involves much labor and time. As a result, development of easy technology for incorporation of urea into straw based ration, which can be acceptable to the village farmers, is of paramount importance.

Soybean contains a significant amount of urease, which acts directly on urea for proper hydrolysis. Addition of plant urease to urea at the time of treatment has been found to give positive results on hydrolyzing urea within the shortest possible time, at the same time improving digestibility of straw (Khan et al., 1999; Ibrahim et al., 1985). Therefore, incorporation of soybean seed meal at the time of urea treatment of rice straw may be an easily adaptable technique for reducing treatment time as well as improving quality of straw. Because urea is cheap and at the same time urease-containing soybean is available throughout the country, improvement of nutritive value of rice straw by

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Received August 21, 2001; Accepted November 27, 2001

treatment with urea and soybean will be helpful in solving nutrient problems of our livestock.

The research was undertaken to improve the nutritive value of rice straw for growing bulls by treating with urea and soybean seed meal containing urease and evaluate feasibility of economic use by farmers.

MATERIALS AND METHODS

Animals and management

The experiment was conducted in the Animal Nutrition Field Laboratory of Bangladesh Agricultural University, Mymensingh in the months of September and October, 1999, using soybean seed meal as a source of urease in urea ensiled straw to determine the effects of its feeding on the performance of growing bull calves. Twelve male bull calves (20 months: 127.20 ± 11.34 kg BW) were randomly grouped into three having four animals in each. The calves were housed in a well-ventilated cement floored barn having individual feeding facilities. All the animals were examined for parasitic infestation and de-wormed before the experiment and kept under strict hygienic and uniform management throughout the experiment.

Treatment of rice straw

Rice straw was chopped into 4 to 6 cm lengths and 10 kg was treated with 400 g urea dissolved in 4 liter tap water. Urea solution was sprayed with a hand garden sprayer on the chopped straw and mixed properly to achieve uniform wetting. For experimental groups, 4 and 6% ground soybean seed meal were well mixed before ensiling. Treated straws were ensiled in an airtight compact condition in double layer big polythene bags. The material was kept for 48 h in a cold and dry place before feeding to the animals.

Feeds and feeding

All the animals were supplied with 6 kg treated rice straw, 2 kg green dal grasses and 350 g til oil cake per 100 kg live weight. The animals of group A received 4% urea-treated rice straw, group B 4% urea and 4% soybean meal-treated straw and group C 4% urea and 6% soybean meal-treated straw. Nutrient requirements were calculated according to ARC (1990) using the composition (table 1 and 2) of feed and feed supplements.

Treated rice straw was taken out from the bag and kept for two hours in the air before feeding to remove the pungent smell. Dal grass was chaffed and mixed up with the straw. Til oil cake was also mixed well with the straw immediately before feeding.

Total feed of individual animal was divided into two

halves and supplied to the animal at 08:30 and 16:30. Feed intake was recorded after subtracting left overs from the supplied amounts. Animals were supplied with 100 g NaCl daily. Clean and fresh drinking water was offered twice a day to all animals individually. Body weight was recorded at seven day intervals before feeding and watering for three consecutive days during 56 days of experimental feeding.

Digestibility trial

A digestion trial was conducted for a period of 8 days at the end of experimental period. Daily feed intake and feces voided was recorded individually. Feces were collected manually just at the time of defecation from each animal throughout the days and nights during the collection period. The total quantity of feces voided was weighed and recorded for each animal. Every day, 10% well mixed feces of each animal were separated, sun dried and stored in polythene bags. At the end of collection period the sun dried feces were composited together and ground through a 1 mm sieve and analysed for proximate components, except DM and CP components which were determined from fresh sample. The daily feed intake and left over was also recorded during that period.

Analytical methods

Proximate components, dry matter (DM), crude protein (CP), crude fiber (CF), ash, ether extract (EE) and nitrogen-free-extract (NFE) were determined as per AOAC (1990). Metabolizable energy value of feed ingredients used in ration formulation was calculated as suggested by Walli et al. (1993).

Statistical methods

The experiment was conducted as a completely randomized design and data were analyzed for significant differences among various treatments by using MSTAT-C program. Duncan's Multiple Range Test (DMRT) was also done to compare the treatment means for different parameters statistically at 5 and 1% level of probability.

RESULTS AND DISCUSSION

Composition of feed ingredients

Table 1 shows that the rice straw contained 2.68% CP, increased to 8.70% by treatment with 4% urea. The value was increased further to 10.71 and 12.12% by addition of 4% and 6% soybean meal respectively. Crude fibre content of urea treated straw (A) was 33.78%; addition of 4 and 6% soybean meal along with urea at the time of treatment, resulted in a decrease in CF content to 32.64 and 31.96% in

Table 1. Proximate composition of feeds (g/100 g DM)

Ingredients	DM (%)	Composition					
		OM	CP	CF	EE	NFE	Ash
Rice straw	90.15	82.13	2.68	36.11	1.02	42.32	17.87
4% urea treated rice straw	51.45	83.92	8.70	33.78	2.35	39.08	16.08
4% urea+4% soybean treated rice straw	51.54	85.21	10.74	32.64	2.68	39.15	14.79
4% urea+6% soybean treated rice straw	51.87	85.44	12.12	31.96	2.87	38.49	14.56
Dal grass	18.56	89.93	7.56	31.78	2.56	48.03	10.07
Til oil cake	89.48	83.84	35.57	5.72	9.33	33.22	16.16
Soybean meal	90.15	94.34	42.15	6.38	20.62	26.19	4.66

Table 2. Formulation and chemical composition of rations

Parameters	Diets ^a		
	A	B	C
Diets (kg/day)			
Treated rice straw	7.71	7.65	7.53
Green Dal grass	2.57	2.55	2.51
Til oil cake	0.45	0.45	0.44
Nutrient composition			
Dry matter (kg/100 kg Feed)	45.01	45.18	45.42
Crude protein (kg/100 kg DM)	10.79	12.45	13.57
Metabolizable energy (MJ/kg/100 kg DM)	831.26	832.02	830.67

^aDiets: A-4% urea treated rice straw.

B-4% urea+4% soybean treated rice straw.

C-4% urea+6% soybean treated rice straw.

B and C, respectively. According to Goto (1995) addition of plant urease at the time of urea (ammonia) treatment acts on roughages by cleaving ester linkages between cell wall polymers. Using 4 and 6% soybean meal as a source of urease with urea treated straw helped to reduce the CF% in experimental diets B and C by increasing cell wall porosity, which makes polysaccharides more available to enzymatic hydrolysis. The present findings well correspond with the results of Kiangi et al. (1981) who reported a decrease in cell wall constituents with ammonia treatment when urease was added in the treatment process. Khan et al. (1999) stated incorporation of soybean and Jack bean meal along with urea treated straw was effective in reducing modified acid detergent fibre (MADF).

Organic matter and EE content of rice straw were 82.13 and 1.02%, respectively, but these values were increased by urea treatment. Similarly OM and EE contents were further increased by addition of 4 and 6% soybean meal with the urea at the time of treatment in diets B and C (table 1).

Feed intake and conversion

The animals receiving different levels of soybean

meal at the time of treatment (Group B and C) consumed significantly ($p < 0.05$) more DM than group A (table 3). There were no significant differences in the total DM intake between the B and C groups. This is supported by Sarwar et al. (1994) in an experiment with wheat straw, where crushed cow pea and soybean was added with urea at the time of treatment. Similarly Joy et al. (1996) observed 15% more DM matter intake by rams eating treated barley straw with urea and 3% soybean. Their findings are in agreement with the present results. Total CP intake by 56 days of experimental period in group A, B and C were 25.5, 27.2 and 27.8 kg respectively. Crude protein intake by B and C groups was significantly higher ($p < 0.05$) than that of the animals receiving diet A, but there was no significant ($p > 0.05$) difference between groups B and C. Daily organic matter intake by the animals of groups A, B and C were 3.4, 3.5 and 3.6 kg, respectively and the difference among groups were not statistically significant ($p > 0.05$). Feed conversion efficiency (kgDMI/kg LWG) were 11.83 ± 3.22 , 9.39 ± 1.16 , 9.43 ± 2.10 and CP conversion rates (kg CPI/kg LWG) were 1.35 ± 0.39 , 1.11 ± 0.12 and 1.12 ± 0.22 , for group A, B and C, respectively; these values are statistically similar ($p > 0.05$) (table 3).

Body weight gain

The total live weight gains were 20.24, 24.75 and 25.58 kg in groups A, B and C respectively (table 3). Body weight gain of the animal on 6% soybean meal along with urea-treated rice straw (C) was significantly higher ($p < 0.01$) than animals of group A; no significant difference was observed between groups B and C. Significantly higher body weight gains of the animals of groups B and C in comparison to the animals of group A may be due to the fact that addition of 4 and 6% soybean meal with urea at the time of treatment helps to supply more protein to the animals of these groups and also resulted in higher digestibility of CP, CF and OM (table 3).

This finding is also supported by Hossain and Rehman (1981) who reported that 5% urea treated straw provided

Table 3. Performance of growing bull calves fed different diets

Parameters	Diets ^a			SEM	Level of significance
	A	B	C		
Growth performance (kg)					
Initial live weight	128±10.76	127.5±8.82	125.5±13.19	9.63	NS
Final live weight	148.81±6.64	152.31±10.83	151.08±11.80	9.12	NS
Total live weight gain	20.24 ^b ±4.78	24.75 ^a ±2.22	25.58 ^a ±3.84	1.20	**
Feed and nutrient utilization					
Total DM intake (56 days)	224.44 ^b ±12.17	229.82 ^a ±7.78	233.93 ^a ±21.77	2.14	*
Dry matter intake/100 kg BW	3.13±0.18	3.22±0.25	3.33±0.12	0.13	NS
Crude protein intake (56 days)	25.58 ^b ±1.94	27.25 ^a ±0.67	27.81 ^a ±1.22	0.57	*
Daily CP intake/100 kg BW	0.355±0.02	0.383±0.03	0.398±0.03	0.03	NS
Organic matter intake (kg/day)	192.79±7.30	197.97±6.46	198.84±8.24	10.24	NS
Feed efficiency (kgDMI/kg LWG)	11.83±3.22	9.39±1.16	9.43±2.10	1.67	NS
Crude protein for weight gain (kgCPI/kgLWG)	1.35±0.39	1.11±0.12	1.12±0.22	0.20	NS
Carcass yield (kg/day/animal)	0.19±0.03	0.24±0.01	0.24±0.16	0.03	NS
Co-efficient of digestibility (%)					
Dry matter	49.6±4.7	55.2±3.8	60.1±2.1	3.68	NS
Organic matter	55.7±4.5	62.2±4.2	65.1±2.1	4.24	NS
Crude protein	49.3 ^b ±4.4	51.9 ^{ab} ±4.2	59.0 ^a ±1.7	3.11	*
Crude fibre	66.2 ^b ±1.4	70.3 ^a ±2.1	68.4 ^{ab} ±3.4	0.99	*
Ether extract	69.1±3.3	74.6±2.1	77.9±4.7	3.25	NS
Nitrogen-free-extract	62.5±0.7	65.9±1.7	66.8±2.5	1.57	NS

^aDiets: A-4% urea treated rice straw.

B-4% urea+4% soybean treated rice straw.

C-4% urea+6% soybean treated rice straw.

^{ab} Values having different superscripts in the same row differ significantly at 5% (*) and 1%(**) level of probability.

0.31 kg more DOM and produced extra gain of about 60-80 g/day on urea supplemented straw. Saadullah et al. (1981b) reported improved intake and weight gain on urea supplemented and urea treated rice straw. Studies carried out by Sharma and Singh (1988) on the feeding of urea treated straw indicated that without concentrate or green supplementation treated straw can support a growth rate of 7-318 g/day depending on the type of animal and level of intake of treated straw and types of supplement.

Co-efficient of digestibility

The DM and OM digestibility of diets did not differ significantly ($p>0.05$). However highest digestibility of DM and OM was observed in the diet C containing soybean meal at 6%, followed by diets B and A. Dias et al. (1988) stated urea treatment as well as addition of soybean improved *in vitro* OMD significantly ($p<0.01$). Khan et al. (1999) also found positive effects on OMD from addition of soybean and Jackbean meal to urea treated straw. Wanapat (1983) observed increased OM digestibility of barley straw, from 52.4 to 59.0, by addition of a small amount of soybean meal to the urea solution as a source of urease.

Aminullah (1996) stated that the treatment of rice straw with urea alone or with mixture of urea and soybean extract increased organic matter digestibility and energy content.

Crude protein digestibility was significantly higher ($p<0.05$) in group C (59.0) in comparison with group A (49.3); there was no significant difference ($p>0.05$) between diet B (51.9) and C. Addition of soybean meal with urea solution may result in better digestibility by hydrolyzing urea. Dajayanegra and Doyle (1989) reported increased intake and digestibility with both urea treatment and urea supplementation.

Coefficient of digestibility of CF in groups A, B and C were 66.2, 70.3 and 68.4%, respectively and the difference among groups was statistically significant ($p<0.05$). Djajyanegana and Doyle (1989) reported that urea treatment of rice straw improved NDF and ADF digestibility by 3.9% and 5.7% as compared to untreated straw. Treatment of straw with urea increases its nutritional value by making cellulose more available to the cellulolytic bacteria in the rumen (Silva and Ørskov, 1988), resulting in an improvement in the digestibility of the fibrous component.

Table 4. Nutritive value of different diets

Parameters	Diets ^a			SEM	Level of significance
	A	B	C		
Digestible nutrients (%)					
Digestible organic matter	46.66±4.41	54.51±5.36	54.04±3.71	4.51	NS
Digestible crude protein	5.18 ^b ±0.036	5.87 ^b ±0.48	7.66 ^a ±0.25	0.31	**
Digestible crude fibre	23.89±1.30	24.84±0.82	24.79±0.63	1.05	NS
Digestible ether extract	2.00 ^b ±0.12	2.15 ^{ab} ±0.23	2.37 ^a ±0.15	0.11	*
Digestible nitrogen-free-extract	16.89 ^b ±1.95	20.46 ^a ±1.42	22.35 ^a ±0.90	1.36	*
Total digestible nutrient	50.45 ^b ±3.33	56.03 ^{ab} ±2.88	60.13 ^a ±1.47	2.60	*

^aDiets: A-4% urea treated rice straw.

B-4% urea+4% soybean treated rice straw.

C-4% urea+6% soybean treated rice straw.

^{ab} Values having different superscripts in the same row differ significantly at 5 (*) and 1% (**) level of probability.

This is also true for the present experimental findings. Addition of soybean to the urea in this experiment improved digestibility of CF of rice straw by solubilization of the hemicellulose and alteration of the crystalline structure of cellulose. Coefficients of digestibility of EE and NFE were 69.1, 62.5, 74.6, 65.9 and 77.9, 66.8% for group A, B and C, respectively, but the differences were not significant.

Digestible nutrients and nutritive value

It is evident from table 4 that the digestible nutrients are higher in the diets C and B where soybean as a source of protein and urease was added with urea during treatment of rice straw. Addition of 6% soybean meal with urea in the diet of group C significantly improved ($p<0.01$) the digestible CP value in comparison with the diets of group B and C; among groups B and C there was no significant difference ($p>0.05$). This finding is supported by Jayasuria and Pearce (1983) who reported that the addition of a urease source can successfully help in improving digestibility of nutrients in rice straw.

Digestible organic matter between groups A, B and C showed no significance difference (table 3). This finding is supported by Dias et al. (1988) who stated that the addition of an exogenous source of urease has no practical advantage. On the other hand Wanapat (1983) found increased digestibility of organic matter (OM) with the addition of a small amount of soybean meal to the urea solution as a source of urease.

Addition of soybean meal to urea at the time of straw treatment helped to increase the DCF value of group B and C, but the difference was not significant ($p>0.05$). Dias et al. (1988) stated that urea treatment significantly ($p<0.01$) reduced neutral detergent fibre (NDF) content; the effect increased with time but was independent of moisture and soybean addition.

Digestible EE of group C was significantly higher ($p<0.05$) than group B and A (table 4). This may be due to addition of more soybean meal (6%) in group C compared to groups B (containing 4% soybean) and A (without soybean meal). However, results showed no significant difference ($p>0.05$) between diets A and B. Digestible nitrogen-free-extract (DNFE) of group B and C was significantly higher ($p<0.05$) than group A; there was no significant difference observed between group B and C.

Total digestible nutrient value of group C (60.13%) increased when 6% soybean was added with 4% urea-treated rice straw; the value was 56.03% for B when 4% soybean was added with 4% urea-treated rice straw and lowest (50.45%) for group A fed soybean free but 4% urea-treated rice straw. This difference in TDN content among diets varied significantly ($p<0.05$). Addition of 4% soybean with urea at the time of treatment gave 5% more TDN value (56.03%) than diet A (50.45%) but the difference is not significant. High OM and low ash content in soybean meal may have a positive effect on higher nutrient digestibility which ultimately resulted higher TDN content in diets B and C containing soybean meal. Khan et al. (1999) reported that an exogenous source of urease is necessary in order to hydrolyse the urea to produce a more rapid improvement in the nutritive value of straw. Addition of soybean to urea at the time of treatment supported their view by giving more TDN value in the diets B and C than diet A.

Soybean meal not only provided protein and minerals, but its urease showed a positive effect on hydrolysis of urea and higher digestibility of CP and CF. Khan et al. (1999) stated that urease from soybean seed rapidly hydrolyzes the urea benefiting microbial multiplication. Ultimately the host animals gets more available amino acid for body growth compared to animals fed only urea treated straw. Carcass yield, based on the value of 53.4 for dressing percentage as reported by Wanapat (1990), was higher in group C (243 g)

and lower in group A (192 g). From the experimental findings it may be concluded that feeding the treated rice straw (with 4% urea and 4 or 6% soybean meal) with 2 kg green grass and a little concentrate may be successful for the fattening of growing bull calves.

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