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NUTRIENT DIGESTIBILITY AND GROWTH OF LOCAL BULL CALVES AS AFFECTED BY FEEDING UREA AND UREASE ENZYME SOURCES TREATED RICE STRAW

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Abstract

The experiment was conducted for a period of 75 days to study the effect of treatment of straw with urea or with urea and a urease containing chick pea seed meal and midden soil on chemical composition of treated rice straw, feed intake of the animals, nutrients digestibility, body weight gain, and feed conversion efficiency. For the study twelve indigenous growing bulls aged approximately 20 months and weighing 115.16 ± 1.50 kg were divided into four groups having three animals in each group. The animals of group A received 3.5% urea treated fresh straw, group B received 3.5% urea treated ensiled straw, group C received 3.5% urea + 2.5% midden soil treated ensiled straw and group D received 3.5% urea + 2.5% chick pea treated ensiled straw. All the animals were supplied with treated rice straw, green grass and concentrate mixture. Rice straw treated with 3.5% urea resulted an improvement in crude protein content of rice straw from 3.33 to 7.70 and 8.10 % (without ensiling and ensiling) which was further increased by 8.20 and 9.50% with the addition of 2.5% midden soil and 2.5% chick pea seed meal at the time of treatment. Significantly higher ($P<0.05$) daily dry matter intake was observed in animals fed diet D (4.42) followed by diet C (4.39), diet B (4.34) and diet A (4.12). The total CP intake by the animals of D groups was significantly higher ($P<0.01$) than that of the animals receiving diet A, B and C. During the 75 days trail, the total live weight gains were 30.50, 35.17, 38.17 and 39.83 kg for bull calves fed diet A (3.5% urea treated straw without ensiling), diet B (3.5% urea treated straw with ensiling), diet C (3.5% urea + 2.5% midden soil treated straw) and diet D (3.5% urea + 2.5% chick pea seed meal treated straw) respectively. The daily live weight gains were 0.41, .047, 0.51 and 0.53 kg in groups A, B, C and D respectively. Midden soil and chick pea seed meal addition with treated rice straw not only significantly ($P<0.01$) increased the coefficient of digestibility of DM, CP, and CF but also significantly ($P<0.05$) increased the coefficient of digestibility of OM, NFE than only urea treated straw (both without ensiling and ensiling). Addition of urease sources also increased ($P<0.01$) the digestible crude protein (DCP), digestible ether extract (DEE). Digestible nitrogen free extract (DNFE), digestible organic matter (DOM) and total digestible nutrients (TDN) contents were significantly ($P<0.05$) higher in diet D in comparison to diet A, B and C.

Key words: Bull calves, Digestibility, Midden soil, Urea, Urease

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Introduction

In the country, there are about 22.87 million cattle, 1.21 million buffaloes, 20.75 million goats and 2.68 million sheep (DLS, 2008). These large numbers of animals are suffering from serious shortage of feeds both in quality and quantity. The roughage and concentrate available for feeding livestock can meet only 50 and 10% respectively of the requirement (Haque *et al.*, 2007). Rice straw alone contributes 87% of the roughage feed of animals. The value of rice straw to bovines is limited by low voluntary intake, slow rate of digestion and low content of available energy, protein, minerals and vitamins. Extensive research has been carried out for several decades on improving nutritive value of cereal straws for livestock using physical, chemical and biological treatments and varying degree of success has been reported from technical aspect, however, economic benefit and social acceptance of these technologies have been very limited (Rangnekar, 2005). Pre-treatment of straw is one of the possible alternatives for better utilization and improves the digestibility of straw. To improve the quality of straw through chemical treatment with caustic soda was investigated over a hundred years ago (Lehmann, 1991). Different treatment procedures are available to upgrade the nutritive value of straws (Doyle *et al*., 1996). The "urea treatment" is the result of two processes which occur simultaneously within the mass of forage to be treated: ureolysis which turns urea into ammonia, and the subsequently generated effect of the ammonia on the cell walls of the forage. Khan *et al*. (1999) reported that urea pre-treatment of straw by adding plant extract as a source of urease has proved as one of the technologies in improving nutrient content and feeding value of various types of straw. By using plant urease the treatment time of straw could successfully be reduced from 2-3 weeks to 5 days (Jayasuriya and Pearce, 1983). The research work was undertaken to upgrade the nutritive value of rice straw by process of treating with urea and urease containing chick pea and midden soil.

Materials and Methods

Collection of feed ingredients and processing

The experiment was conducted in the Shahjalal Animal Nutrition Field Laboratory of Bangladesh Agricultural University, Mymensingh from March to June, 2009. Maize, rice polish, mustard oil cake, soybean seed meal, dicalcium phosphate and salt were purchased from a local market. Green grasses were cultivated in the fodder plot of Animal Nutrition Field Laboratory. Rice straw was chopped at a particle size of 4 to 6 cm prior to treatment. Green grasses were also chopped prior to offer to animals. Chick pea seeds and midden soil were ground to powder by an automatic grinder, were thinly spreaded on a paper to remove heat generated during grinding. Commercial fertilizer grade granulated urea (NH_2-CO-NH_2, 43% N) was purchased prior to treatment.

Treatment of rice straw

Ten (10) kg of rice straw was spreaded on a clean, hygienic concrete floor. Then commercial urea at the rate of 3.5% (on straw DM basis) was dissolved in 10 litres of water. The urea solution was sprayed throughout the chopped straw with a hand garden sprayer and the straw

was mixed properly to achieve uniform wetting by the hand. In this way, total quantity of straw was mixed with urea solution. Treated straws were kept into a pre-prepared silo pit, squeezed sufficiently to expel excess air and covered by double layer polythene sheet to ensure anaerobic condition. This preserved straw was kept for 7 days before feeding to the animals of group B. For group C and D, finely ground 2.5% midden soil and 2.5% chick pea seed meal were thoroughly added with urea treated straw at the time of treatment and preserved for 7 days before feeding animals.

Experimental design and dietary treatments

Twelve male bull calves of 20 months of age with an average body weight of 115.16 ± 1.50 kg were selected for this study following Completely Randomized Design (CRD). The animals of group A received 3.5% urea treated straw (fresh), group B received 3.5% urea treated ensiled straw, group C received 3.5% urea + 2.5% midden soil treated ensiled straw and group D received 3.5% urea + 2.5% chick pea treated ensiled straw. Animals were supplied treated rice straw *ad libitum*, 2 kg green grass and 400 g concentrate mixture (rice police, maize, mustard oil cake, soybean seed meal, dicalcium phosphate and salt @ 43:30:21:3:2:1 per 100 kg live body weight of animal.

Feed intake

Experimental diet was supplied to all the animals twice daily and left over was weighed in the following morning. Feed intake recorded was inevitable found after subtracting left over from the feed supplied. The values were expressed as fresh and dry matter basis. During the experimental period, the animals consumed all the green grasses and concentrate but refused a small quantity of straw every day.

Collection of faeces

Faeces were collected manually from each animal throughout the day and night during the collection period and then kept in polythene bags to avoid the losses of volatile nitrogen and contamination with dirt and urine. The total quantity of faeces voided was weighed and recorded against each animal. About 10% of the every day well mixed faeces of each animal were collected, sun dried and stored in polythene bags. At the end of the collection period the sun dried faeces were composites together and then ground in 1 mm sieve which was used for proximate components analysis except two components DM and CP which were determined from fresh faeces. The daily feed intake and left over were also recorded during that period. Keen observation was taken with the unwanted mixing of urine and feces in that time.

Chemical analysis

Chemical analysis for crude protein (CP), crude fiber (CF), ether extract (EE), Ash and nitrogen free extract (NFE) were done with respective samples of feed, left over and faces following the methods of AOAC (2004). Analysis of urine was done only for total nitrogen content. All the samples were analyzed in duplicate and mean values were recorded.

Statistical analysis

For every parameter, the data were analyzed using the "MSTAT" statistical programme to compute analysis of variance (ANOVA) for a completely randomized design (CRD) and the mean values with standard error deviation (SED) were recorded. Duncan's Multiple Range Test (DMRT) was also done for different parameter to compare the treatment means.

Results and Discussion

Chemical composition of feed ingredients

The chemical composition of rice straw, urea treated rice straw, urea + chick pea seed meal treated rice straw, urea + midden soil treated rice straw and other feed ingredients is presented in Table 1. It can be seen from the Table that rice straw contained 3.33% crude protein which was increased to 7.70% by treatment with 3.5% urea (without ensiling) and to 8.10% with 3.5% urea (ensiled). The value was increased further by addition of chick pea seed meal and midden soil meal at the time of urea addition which is 9.50% with the addition of 2.5% chick pea seed meal and 8.20% with the addition of 2.5% midden soil meal. Similar observation was also made by Khan *et al.* (1999) who stated that addition of urease sources increased the rate of urea hydrolysis and crude protein content of treated straw. This finding was supported by Malek *et al.* (2008) who reported that CP concentration of straw treated with soybean seed meal showed highest value followed by cowpea seed meal, midden soil and only urea against 4.2 % in untreated straw and the difference among treatments were highly significant ($P<0.01$). Untreated rice straw contained 36.50% CF which was decreased by treatment with 3.5% urea (33.98%) and 32.20% when it was ensiled (Table 1). The value has been also decreased further by addition of different urease sources at the time of treatment which were 31.98% with addition of 2.5% chick pea seed meal (D) and 33.16% with addition of 2.5% midden soil (C). By using 4% bean seed meal and 4% pea seed meal as a source of urease with urea treated straw helped to reduce the CF%. Treatment of straw with urea helps in increasing cell wall porosity which makes polysaccharides more available to enzymatic hydrolysis because addition of plant urease at the time of urea (ammonia) treatment act on roughages by cleaving ester linkages between cell wall polymers (Goto, 1995). From Table 1 it was seemed that untreated rice straw contained 42.45% NFE where in group C (2.5% midden soil) and group D (2.5% chick pea) with 3.5% urea observed in lower NFE content (40.10% and 41.08%). It was seen from the Table that rice straw contained 16.47% ash which reduced to 16.11% and 14.88% by the treatment with 3.50% urea + 2.5% midden soil treated straw and 3.50% urea + 2.5% chick pea treated straw respectively. But the value was increased to 17.75% with 3.50% rice straw treated group (ensiled).

Feed Intake and conversion

The daily feed (DM basis) consumption during 75 days of experimental period by growing bull calves was 309.01, 325.88, 329.56 and 331.98 kg for diet A, diet B, diet C and diet D respectively. It is evident from the Table that the animal receiving midden soil and pea seed meal as a source of urease with urea at the time of treatment (Group C and D) consumed

more total DM than group A and B. However, there were no significant (P>0.05) differences among the groups. This observation contradict with the findings of Ahmed *et al.* (2003) who obtained significantly (P<0.05) higher dry matter intake in growing cattle fed 4% urea + 4% soybean meal treated straw. Crude protein (CP) intake was higher in animal receiving diet C and diet D than diet A and diet B have been showed in Table 2. Total CP intake by 75 days experimental period in group A, B, C and D were 26.61, 29.00, 29.58 and 33.06 kg respectively. The total CP intake by the animals of D groups was significantly higher (P<0.01) than that of the animals receiving diet A, B and C. Similarly, Narayan *et al.* (2004) also found a higher CP intake in urea treated straw.

Table 1. Proximate composition of diets and feed ingredients (g/100g DM)

Feed Ingredients	DM g/100g	Composition (g/100 gDM)					
		OM	CP	CF	EE	NFE	Ash
Rice straw	88.9	83.53	3.33	36.50	1.25	42.45	16.47
3.50% urea treated straw (fresh)	44.85	83.81	7.70	33.98	2.05	40.08	16.19
3.50% urea treated straw (ensiling)	46.15	82.25	8.10	32.20	2.15	39.80	17.75
3.50% urea + 2.50% midden soil (ensiling)	49.50	83.89	8.20	33.16	2.43	40.10	16.11
3.50% urea + 2.50% chick pea (ensiling)	49.15	85.12	9.50	31.98	2.56	41.08	14.88
Urea	96.12	-	264.00	-	-	-	-
Midden soil	89.98	-	3.06	-	-	-	-
Green grass	21.21	89.70	7.44	33.07	2.05	47.14	10.30
Concentrate mixture	91.82	84.81	16.06	6.16	11.73	50.89	15.2
Chick pea	88.90	94.09	25.09	6.01	16.00	46.99	5.91

Live weight gain

The total live weight gains were 30.50, 35.17, 38.17 and 39.83 kg for bull calves fed diet A, diet B, diet C and diet D respectively. Live weight gain of the animal on different groups was non significant (P>0.05). It can be seen from the same Table 2 that the daily live weight gains were 0.41, 0.47, 0.51 and 0.53 kg in groups A, B, C and D respectively and no significant differences was observed among the groups. On the other hand, Khan *et al.* (1996) obtained higher body weight of lambs receiving soybean meal as protein source (P<0.05). Same result was also found by Hossain and Rehman (1981) that 5% urea treated straw provided 0.31 kg more DOM and produced extra gain of about 60-80 g/day on urea supplemented straw.

Apparent digestibility of nutrient

The DM digestibility of the animals fed urea + chick pea seed meal treated straw (63.57%) was significantly higher (P<0.05) compared with that of animals fed urea + midden soil treated straw (61.12%), urea treated straw with ensiling (59.67%) and urea treated straw without ensiling (56.55%). Significantly higher (P<0.05) OM digestibility was found in diet

D containing urea + chick pea seed meal treated straw than those in diet C, diet B and diet A. This result was supported that addition of soybean seeds, watermelon seeds, pumpkin seeds, jack bean seeds and winged seeds reduced treatment time and increased in vitro OM digestibility (Ibrahim *et al*., 1985). The CP digestibilities of different diets are 64.42, 68.37, 70.23 and 73.62% in group A, B C and D respectively (Table 3) and CP digestibility was significantly higher (P<0.01) in group D in comparison with group A, B and C. Addition of 3.5% chick pea seed meal with urea solution may helped in hydrolyzing urea which resulted better digestibility by the animals of this groups. This positive result on CP digestibility support the facts that associative effects of small quantities of supplement such as minerals or proteins enhances rumen fermentation leading to increased intake and digestibility. According to Dajayanegra *et al*. (1989) reported both urea treatment and urea supplementation increased intake, rate of digestion and digestibility of nutrients. Table 3 showed apparent digestibility of CF in animal of groups A, B, C and D were 56.53, 59.33, 61.56 and 63.54 respectively. Significantly higher (P<0.01) CF digestibility was found in diet D containing urea + chick pea seed meal treated straw than those in diet C containing urea + midden soil treated straw, diet B containing urea treated straw with ensiling and diet A only containing urea without ensiling.

Table 2. Growth performance of bull calves fed different experimental diets

Parameters	Diets #				SED	Level of Sig.
	A	B	C	D		
Initial live weight (kg)	116.67	115.17	115.17	114.84	4.34	NS
Final live weight (kg)	147.17	150.33	153.33	154.67	5.66	NS
Total live weight gain (kg)	30.50	35.17	38.17	39.83	1.77	NS
Daily live weight gain (kg)	0.41	0.47	0.51	0.53	0.02	NS
Total DM intake (kg)	309.01	325.88	329.56	331.98	12.52	NS
Average DM intake (kg/d)	4.12^{b}	4.34^{ab}	4.39^{ab}	4.42^{a}	0.05	*
Daily DM intake (kg/100 kg BW)	3.54^{b}	3.77^{ab}	3.81^{ab}	3.85^{a}	0.04	*
Total CP intake (kg)	26.61^{c}	29.00^{b}	29.58^{b}	33.06^{a}	0.77	**
Average CP intake (kg/d)	0.35^{c}	0.38^{bc}	0.39^{b}	0.44^{a}	0.01	*
Total OM intake (kg)	261.27^{d}	272.08^{c}	279.24^{b}	281.12^{a}	2.37	**
Average OM intake (kg/d)	3.48^{d}	3.62^{c}	3.72^{b}	3.74^{a}	0.03	**
Feed conversion efficiency (kg DMI/kg LWG)	10.11^{a}	9.29^{b}	8.74^{c}	8.57^{c}	0.22	*
Protein conversion efficiency (kg CP/kg LWG)	0.87^{a}	0.82^{b}	0.77^{c}	0.83^{b}	0.01	**

Diet-A = 3.5% urea treated rice straw (fresh); Diet-B = 3.5% urea treated rice straw (ensiled); Diet-C = 3.5% urea + 2.5% midden soil treated straw (ensiled); Diet-D = 3.5% urea + 2.5% chick pea treated straw (ensiled)

^{a,b,c} means, values having different superscripts in the same row differ significantly (P<0.05)

SED = Standard error deviation; NS = Non-significant; * = 5% Level of significance; ** = 1% Level of significance

Table 3. Apparent digestibility of different experimental diets

Parameters	Diets #				SED	Level of Sig.
	A	B	C	D		
Nutrient digestibility (%)						
Dry matter (DM)	56.55^{b}	59.67^{abc}	61.12^{ab}	63.57^{a}	0.83	**
Organic matter (OM)	58.15^{c}	60.54^{b}	62.15^{ab}	63.90^{a}	0.78	*
Crude protein (CP)	64.42^{d}	68.37^{c}	70.23^{b}	73.62^{a}	1.12	**
Crude fibre (CF)	56.53	59.33	61.56	63.54	0.85	**
Ether extract(EE)	72.71	74.86	75.61	76.49	0.58	NS
Nitrogen free extract (NFE)	56.00^{b}	57.77^{ab}	59.81^{a}	60.29^{a}	0.64	*

Diet-A = 3.5% urea treated rice straw (fresh); Diet-B = 3.5% urea treated rice straw (ensiled); Diet-C = 3.5% urea + 2.5% midden soil treated straw (ensiled); Diet-D = 3.5% urea + 2.5% chick pea treated straw (ensiled)

^{a,b,c} means, values having different superscripts in the same row differ significantly (P<0.05)

SED = Standard error deviation; NS = Non-significant; * = 5% Level of significance; ** = 1% Level of significance

Digestible nutrients and nutritive value

The DCP contents of the different diets were 6.68, 7.19, 7.40 and 8.80 for diet A (3.5% urea treated straw without ensiling), diet B (3.5% urea treated straw with ensilng), diet C (3.5% urea + 2.5% midden soil treated straw) and diet D (3.5% urea + 2.5% chick pea seed meal treated straw) respectively appeared in Table 4. The differences were significant (P<0.05) among treatment groups. The results indicated that DCP content increased with added plant urease source such as midden soil and pea seed meal with urea treated straw based diet. This findings correspond well with the results of Ahmed *et al.* (2003) who reported that addition of 4% soybean meal with 4% urea treated straw significantly (P<0.05) increased the DCP content of rice straw in comparison to 4% urea treated straw. Addition of urease enzyme sources (chick pea and midden soil) to urea treated straw at the time of treatment helped in increment of digestible crude fibre (DCF) value of group D (15.07%) and group C (14.85) although the difference was not statistically significant (P>0.05) that showed in Table 4. Table also has been presented that DEE of group D is significantly higher (P<0.01) than group A, B and C. Digestible nitrogen free extract (DNFE) of diet A, diet B, diet C and diet D were 25.77, 26.53, 27.53 and 27.93 respectively. Values for TDN have been presented in Table 4. when it is evident that total digestible nutrient (TDN) of group D (3.5% urea + 2.5% chick pea seed meal treated rice straw were significantly higher (P<0.05) than group C (2.5% midden soil and 3.5% urea treated rice straw), group B (3% urea treated rice straw with ensiling) and group A (3% urea treated rice straw without ensiling). This difference of TDN content among diets varied significantly (P<0.05).

Table 4. Nutritive values of different diets

Parameters	Diets #				SED	Level of Sig.
	A	B	C	D		
Nutritive value (%)						
Digestible CP	6.68^{c}	7.19^{b}	7.40^{b}	8.80^{a}	0.24	**
Digestible CF	13.79	14.12	14.85	15.07	0.23	NS
Digestible EE	3.83^{bc}	3.97^{b}	4.08^{ab}	4.16^{a}	0.04	**
Digestible NFE	25.77	26.53	27.53	27.93	0.36	NS
Digestible OM	50.07^{c}	51.81^{c}	53.86^{b}	55.96^{a}	0.75	*
Total digestible nutrients	54.85^{d}	56.77^{c}	58.96^{b}	60.88^{a}	0.82	*

Diet-A = 3.5% urea treated rice straw (fresh); Diet-B = 3.5% urea treated rice straw (ensiled); Diet-C = 3.5% urea + 2.5% midden soil treated straw (ensiled); Diet-D = 3.5% urea + 2.5% chick pea treated straw (ensiled)

^{a,b,c} means, values having different superscripts in the same row differ significantly ($P<0.05$)

SED = Standard error deviation; NS = Non-significant; * = 5% Level of significance; ** = 1% Level of significance

Conclusion

Nutritive value of rice straw in terms of nutrient composition, digestibility, TDN value and body weight gain of animals was improved significantly through treatment with urea in addition with chick pea and midden soil as urease sources. It may be suggested to treat rice straw with 3.5% urea + 2.5% chick pea / midden soil and fed to the animal after 7 days of ensiling.

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