DEVELOPMENT OF STRAW BASED RATION FOR FEEDING RUMINANTS

S. S. Kibria[1,2], M. R. Islam and C. K. Saha

Bangladesh Livestock Research Institute
Savar, Dhaka-1341, Bangladesh

Summary

A CRD experiment with thirty growing cross bred calves were assigned at random to three treatments rations. 1) T_0, 0% Urea + 20% M. O. cake, 2) T_1, 1% Urea + 10% M. O. cake and 3) T_2, 2% Urea + 0% M. O. cake to develop a rice straw based ration for ruminants.

Sweetish odour and yellowish colour were observed in good recovered silage. Organic matter varied from 87.45% to 89.63% whereas crude protein varied from 14.0% to 14.5% in each treatment. No significant differences were found among the nutrient composition of the ration. The dry matter intake (DMI) and dry matter digestibility was higher in T_0 (0% Urea) than those of ration containing 1% (T_1) and 2% Urea (T_2). The organic matter digestibility decreases with increasing doses of urea. The crude protein & nitrogen-free-extract digestibility were found higher in the ration T_1 containing 1% urea whereas crude fibre digestibility and available metabolizable energy (ME) were higher in T_0 containing no urea as compared to T_1 and T_2. Total digestible nutrient (TDN) decreases with the increase of urea level. The highest feed efficiency was found in T_0 having no urea and lowest was in T_2. The animals gained in weights from each ration. Highest gain in weight was found in T_0 ration, then followed T_1 and T_2. This is due to natural protein available in M. O. cake only.

It is concluded that supplementation of urea or M. O. cake with readily available energy source as molasses upto 20% of total dietary dry matter in a complete ration may increase the intake of low quality fibrous roughage only when nitrogen and mineral are not limiting factor.

(**Key Words**: Metabolizable Energy, Total Digestible Nutrients, Feed Efficiency).

Introduction

The crop residues like rice straw are fibrous in nature and contain high content of highly lignified cell wall. These by-products are not consumable by man directly. Since ruminants have the unique ability to utilize the fibrous materials through anaerobic fermentation in the rumen, therefore, rice straws are the integral part of ruminant's ration in more or less quantity throughout the year, especially during the dry season and scarcity period in Bangladesh. Straws contains 3 to 5 percent crude protein (Singhal & Atreja, 1985), therefore, animals on an unsupplemented straw diet will usually not gain any weight and very often will lose weight. Straw fed animals grow very slowly and attain the maturity very late. To obtain production in terms of meat or milk, the straw must be supplemented perferably with both nitrogen/protein and energy. For good health on straw diet, a level of 8 to 10 percent crude protein is needed for young stock.

Impregnation of crop residues with 1-2 percent urea, with or without 10-15 percent molasses and feeding with 4-5 kg green/day and mineral salt improves their voluntary intake and nutritive value; making them suitable as a maintenance diet (Verma, 1985). A supplement of urea at the rate of one percent of straw fed will raise its nitrogen content to a level about equal with the protein supplement (Singhal & Atreja, 1985). The present investigation was undertaken to develop a complete rice straw based diet for ruminants and evaluation of their performance on growing calves.

Materials and Methods

The experiment was conducted in the Animal Research Station at Pachuria (ARSP), Bangladesh Livestock Research Institute, Savar, Dhaka.

The rice straw was chopped at a length of 5 cm approximately for uniform mixing. All the

[1]Chief Scientific Officer and Head.

[2]Address reprint requests to Dr. S. S. Kibria, Scientific Officer, Animal Production Research Division Bangladesh Livestock Research Institute, Savar, Dhaka, Bangladesh.

Received December 28, 1990
Accepted May 13, 1991

TABLE 1. INGREDIENTS OF EXPERIMENT RATION (%, DM BASIS)

Ingredients	T_0	T_1	T_2
Rice straw	60	65	70
Wheat bran	8	7	6
Mustared oil cake (M.O. cake)	20	10	0
Molasses	10	15	20
Urea	0	1	2
Salt	1	1	1
Mineral mixture	1	1	1
Total:	100	100	100

feed ingredients were thoroughly mixed in the manger (earthen container) as presented in table 1 and three diets were fermented for three days with 50 percent tap water in the manger before feeding. The same diets also were prepared in plastic jars to observe the durability and preserved for 265 days. The colour, pH, odour, recovery & moisture contents were recorded.

Thirty cross bred male growing calves with uniform size, age and weight were used in the experiment. They were randomly arranged into three treatment such as T_0 (0% urea), T_1 (1% urea) and T_2 (2% urea) with 10 animals in each.

The chemical composition of each treatment were analyzed including the green roughage (AOAC, 1980). A separate conventional digestion trial was conducted for a period of 21 days and 14 days were allowed for adjustment period, then 7 days for collection period. The silage was given *ad-libitum* to the animals twice a day (8 am. and 4 pm.). Drinking water was made available at all times. During the collection period, feed intake, refusal and feces voieded were collected and recorded. Feed and feces samples of seven days of individual animal were composited to make a single sample and analysed for proximate components.

Experimental animals were weighed before and after for three consecutive days each at the end of preliminary period and at the end of collection period.

The same animals with group feeding was used upto 161 days using completely randomized design. The animals were weighed once a week. The animals were fed green grass in addition to silage at the rate of two kilogram per animal twice a day (morning and evening) as green roughage.

The metabolizable energy (ME) were calculated from digestible organic matter (DOM) where 1 kg DOM=15.09 MJME.

Data were analysed using F-test and DMRT (De Ramos and David, 1977) for comparing the means.

Results and Discussion

The rice straw varied from 60% to 70% in each ration. Wheat bran was used as carrier of urea, salt and mineral for homogeneus mixing. M. O. cake was partially replaced by urea and molasses was used as fermentable carbohydrate source.

In table 2, upon opening the plastic jars, smell of strong ammonia was prominent in straw based silages with 1% and 2% urea. Aromatic smell was also noticed in treatment with good recovery but non-aromatic or unpleasant smell was found

TABLE 2. PHYSICAL CHARACTERISTICS OF DIFFERENT SILAGES

Treatment	Smell	Colour	% Recovery	pH	% Moisture
T_0	Aromatic	Yellowish	92.1 ± 0.5	4.8 ± 0.1	57.2 ± 0.6
T_1	Pungent	Yellowish	98.8 ± 0.5	6.9 ± 0.3	52.9 ± 0.5
T_2	Pungent	Yellowish	96.9 ± 0.8	4.8 ± 0.2	56.4 ± 2.2

Column mean does not differ ($p > 0.05$).

in treatments which were slightly blackish in colour. In general, the colour of straw based silage was yellowish to yellowish black. Treatments with only oil cake smells sweetish and aromatic. The recovery of silage varied from 92.1% to 98.8% and highest recovery was found in T_1. pH value ranged from 4.8 to 6.9 whereas lowest pH was observed in T_0 and T_2 which may be due to interaction of urea and M. O. cake as in T_1. In table 3, all the rations were tried to make iso-nitrogenous. Organic matter varied from 87 .5%~89.6% whereas crude protein varied from 14% to 14.5%. No significant variations were found among the nutrient compositions of the ration. The chemical compositions of green grass fed were within the range.

In table 4, it was found that daily total dry matter intake (DMI) of animals fed with 0% urea containing 20% M. O. cake was same than those of ration containing 1% and 2% urea respectively as in T_1 and T_2. It indicates that 1% urea may replace 10% M. O. cake in the ration (Islam and Quddoos, 1972). Kibria et al. (1990a) informed that DMI of 5% urea treated straw based ration containg 0.1% fish meal was 2.5 kg per 100 kg BW/day in lactating cows which is very similar with present study. No significant differences was obtained in term of daily total dry matter intake.

In table 5, DM and OM digestibilities decreases with the increase of urea level. Lower digestibilities of DM and OM in only rice straw were observed by many workers (Wanapat et al., 1984; Ibrahim et al., 1984; Sannasgala et al., 1985). But Kibria et al. (1989) showed that addition of extra protein in concentrate mixture improved the organic matter digestibility of urea treated straw in dairy cow. This was true in case of the present study. CP digestibility was higher in T_1 as supported by Jackson (1981). Other similar results as in T_2 were obtained by Kibria et al. (1990b) and Singhal and Mudgal (1983). Ether extract and crude fibre digestibilities were higher in T_0 containing no urea. Saha (1989) observed the similar result. But many workers found increased digestibility of crude fibre in rice straw as a result of urea feeding (Kniga, 1961; Gallup et al., 1954; Chomyszyn et al., 1960). NFE digestibility was higher in T_1 ration as compared to T_0 and T_2. This may be due to the solubility of hemicellulose for 1% urea and molasses during the fermentation process (Hart, et al., 1939). Digestibilities of all the nutrients are found not

TABLE 3. CHEMICAL COMPOSITION OF THE DIET (DM BASIS)

Feed	Organic matter (%)	Crude protein (%)	Ash (%)
T_0	87.5 ± 0.3	14.5 + 0.3	12.5 ± 0.4
T_1	89.6 + 0.6	14.2 ± 0.2	10.3 ± 0.6
T_2	88.5 ± 0.6	14.0 ± 0.3	11.4 ± 0.9
Green grass	85.3 ± 0.2	7.6 + 0.3	14.7 ± 0.2
Rice straw	86.0 + 0.1	2.6 ± 0.2	14.0 ± 0.2

Column means of three rations do not differ ($p > 0.05$).

TABLE 4. VOLUNTARY DRY MATTER INTAKE OF STRAW BASED RATION AND GREEN GRASS ON DRY MATTER BASIS

Item	T_0	T_1	T_2
Daily dry matter intake:			
Rice straw silage intake (kg)	3.0^a ± 0	3.0^a ± 0.06	2.9^b ± 0.04
Green grass intake (kg)	0.5^a	0.5^a	0.5^a
Total (kg)	3.5^a ± 0.05	3.5^a ± 0.06	3.4^a ⊥ 0.04
Total dry matter intake percent of body weight	3.0^a ± 0.3	2.7^a ± 0.2	3.1^a ± 0.2
Total daily dry matter as $W_{kg}^{0.75}$	101.0^a ± 6.6	102.0^a ± 5.0	102.4^a ± 5.5

[a,b]having dissimilar supercripts in the same raw differ ($p < 0.05$)

TABLE 5. DIGESTIBILITY OF NUTR'ENTS BY GROWING CALF (%)

Item	T_c	T_1	T_2
Dry matter (DM)	56.5 ± 2.3	54.3 ± 1.4	49.6 ± 1.3
Organic matter (OM)	61.4 ± 2.6	58.8 ± 1.3	50.6 ± 1.5
Crude protein (CP)	79.0 ± 1.5	79.5 + 0.5	75.4 + 0.5
Ether extract (EE)	62.0 ± 3.5	60.8 ± 4.0	56.6 ± 1.9
Crude-fibre (CF)	56.0 ± 2.0	54.8 ± 1.4	48.9 ± 3.6
Nitrogen-free-extract (NFE)	49.7 ± 1.2	51 3 + 0.9	49.9 + 1.2

All values are not statistically significant ($p > 0.05$).

TABLE 6. AVAILABLE ME, TDN AND FEED EFFICIENCY

Item	T_c	T_1	T_2
Available ME (MJ/day/animal)	33.8 ± 2.5	30.9 ± 1.7	21.5 + 1.4
TDN* (kg)	2.2	2.0	1.4
Feed efficiency (Feed/gain)	11.6	12.7	17.1

All values are not statistically significant ($p > 0.05$).
*TDN was calculated as 1 kg TDN = 15.15 MJ ME.

TABLE 7. EFFECT OF RATION IN BODY WEIGHT, AND AVERAGE DAILY GA'N OF THE EXPERIMENTAL ANIMAL

Item	T_0	T_1	T_2
Initial average body weight (kg)	114.2 ± 7.8[a]	111.0 ± 6.3[a]	108.8 ± 6.5[a]
Initial metabolic weight (MBS) ($W_{kg}^{0.75}$)	34.9 ± 4.6[a]	34.2 ± 3.9[a]	33.7 ± 4.0[a]
Average final body weight (kg)	162.9 ± 8.2[a]	155.0 ± 9.1[a]	141.2 ± 9.9[a]
Average final metabolic weight ($W_{kg}^{0.75}$)	40.5 ± 4.8[a]	39.2 ± 5.2[a]	37.4 ± 5.2[a]
Average daily gain (g)	302.3[a]	273.4[a]	201.6[b]

[a,b]Means having dissimilar supercripts in the same raw differ ($p < 0.05$).

statistically significant.

Available ME (MJ/day/animal) were 33.8, 30.9 and 21.5 while TDN were 2.2, 2.0 and 1.4 kg for ration T_0, T_1 and T_2 respectively (table 6). Kearl (1982) indicated that ME and TDN requirement for 200 kg body weight should be as 26.7 MJ and 1.8 kg for maintenance only. The present results were in agreement. Feed efficiency was better in T_0 in which higher amount of M. O. cake served readily available protein for micro-organism and hence improved feed palatability. However no statistical significant among treatments were found.

In table 7, the animals gained in weights from each ration. Highest gain in weight was found in T_0 ration, then followed T_1 and T_2. Live weight changes in animals fed rice straw along have been measured by cattle (McLennan et al., 1981; Wannapat et al., 1982; Suriyajantratong and Wilaipon, 1985). They indicated that even if the animal consume sufficient digestible organic matter, the efficiency of use of the absorbed energy in the tissues may be limited by the supply

of some essential nutrients resulting in loss in weight. However a complete ration from rice straw with available ingredients will be possible if limited amount of green grass is available.

Acknowledgements

The authors will always fell indebted to the Director of Bangladesh Livestock Research Institute, Savar for better under standing and all out support in many ways during the experimental period. We thank Bangladesh Agricultural Research Council and World Bank for the financial support received thoughout this study. Lastly the authors extend their grateful acknowledgement to Divisional Officers and staff who help in many ways for these studies.

Literature Cited

A.O.A.C. 1980. Official method of analysis, 13th Edn. Association of Official Analytical Chemists, Washington, D.C.

Chomyszyn, M., A. Zielecka, M. Kuz Owicz and K. Bielingki. 1960. Ammoniated straw for fattening growing wethers. Rocz, Nauk Rol (B) 75:513-30 . 513-40. Cited by Michael H. Briggs, 1967. Urea as a protein supplement Oxford. N.Y.: Pergamon Press.

De Ramos, M. B. and L. P. David. 1977. Manual on design and Analysis of Experiment. Dept. of Statistics. CAS, UPLB. College, Laguna, Philippines.

Gallup, W. D., C. K. Whitehair and M. C. Bell 1954. Utilization of urea and protein nitrogen by ruminants fed high molasses and sugar rations. J. Anim. Sci. 13:594-600.

Hart, E. B., G. Bohsted, H. S. Denhald and M. I. Wegner. 1939. The utilization of simple nitrogenous compounds such as urea and ammonium bicarbonate by growing calves. J. Dairy Sci. 34:360.

Ibrahim, M. N. M., A. M. U. Wijeratne and M. J. L. Costa. 1984. Source of urease for use in reducing the storage time required to treat straw with ammonium hydroxide released from urea. In: The Utilization of Fibrous Agricultural Residues as Animal Feeds. pp. 145-155. Editor P. T. Doyle (School of Agriculture and Forestry, University of Melbourne, Park ville, Victoria)

Islam, Md. Muzharul and A. Quddoos. 1972. Effect of partial replacement of vegetable protein by urea nitrogen on crude protein digestibility by ruminants. Bang. Jour. Anim. Sci. Vol. 5, No. 1-2:4 3-51.

Jackson, M. G. 1981. Rice straw as Livestock feed Professer of Animal Nutrition. G. B. Part University, Partnagar 263145. India.

Kearl, Leonard C. 1982. Nutrient Requirement of Fuminant in Developing Countries. (International Feedstuffs Institute, Utah Agricultural Experiment Station, Utah-State University, Logan, Utah, USA)

Kibria, S. S., S. A. Chowdhury and S. K. Bayan. 1989. Development of straw based ration for feeding dairy cows. Paper presented in the Workshop of Bangladesh Agricultural Research Council, Feb., Dhaka.

Kibria, S. S., M. A. Majid, M. M. Rahman, S. A. Chowdhury and S. K. Bayan. 1990a. Evaluation of rice straw as a feed for dairy cow. Proce. of 15th Annual Bangladesh Science Conference held in Atomic Energy Research Establishment, Savar, Dhaka, Bangladesh, Association for the Advancement of Science (BAAS). pp. 12-15.

Kibria, S. S., D. B. Roxas and S. K. Ranjhan. 1990 b. A Ruminant feed based on water-hyacinth: Its Nutrient Digestibility. Indian. Jour. Anim. Sci. 60(8): 991-994.

Kniga, M. J. 1961. Milk yield and quantity of milk butter and cheese from cows given a supplement of urea. Vest. Sel. Khoz. Nuak 10, 78-82. Cited from Urea as protein supplement (M. M. Briggs, Editor, 1967. Oxford, N. Y. Pergamon Press).

McLennan, S. R., G. S. Wright and G. W. Blight. 1981. Effect of supplements of urea, molasses and sodium sulfate on the intake and live weight of steers fed rice straw. Australian Jour. of Expt. al Agri. and An. Husbandry 21, 367-370.

Saha, R. C. 1989. Growth of cross-bred Calves fed low priced Ration. Indian J. Dairy Sci. 42(2):212-215.

Sannasgala, Kshanika, S. C. Thirumavithana, J. Dharmaraa and M. C. N. Jayasuriya. 1985. The effect of level of fertilization and variety on quality of rice straw. In: The Utilization of Fibrous Agricultural Residues as Animal Feeds. pp. 68. Editor P. T. Doyle. (Int. Dev. Proj. of Aust. Uni. and College Ltd. IDP, Canberra).

Singhal, K. K. and P. P. Atreja. 1985. Crop residues poteintial and prospects. Indian Dairy man 37(12) 555-573.

Singhal, K. K. and V. D. Mudgal. 1982. Utilization of complete feed by goats. Indian J. Dairy Sci. 34(3):250-254. Nat Dairy Res. Inst., Karnal, India.

Suriyajantratong, W. and B. Wilaipon. 1985. Supplementing rice straw with Verano Stylo (*Stylosanthes hemata* C. V. Verano) for native cattle. In: The Utilization of Fibrous Agricultural Residues as Animal Feeds. pp. 149-153, Editor P. T. Doyle (IDP, Canberra).

Verma, M. L. 1985. Agricultural by-products for Animal Feeding in Asia and the Pacific: An Overview. Asian Livestock, APHCA/FAO, Bankok, Thailand. November issue; pp. 143-147.

Wanapat, M., P. Sriwattanasombat and S. Chanthai. 1984. The utilization of diets containing untreated rice straw, urea-ammonia treated rice straw and urea-ammonia treated rice straw and water-hyacinth.

In: The Utilization of Fibrous Agricultural Residues as Animal Feed. pp. 156-165. Editor P. T. Doyle (School of Agri. and Forestry, Uni. of Mel. Victoria).

Wanapat, M., S. Praserdsuk, S. Chanthai and A. Sivapraphagon. 1982. Effect on rice straw utilization of treatment with ammonia released from urea and/or supplementation with cassava chips. In: The Utilization of Fibrous Agricultural Residues as Animal Feeds. pp. 95-101. Editor P. T. Doyle (School of Agri. and Forestry, Uni. of Mel., Victoria).