METHODS TO IMPROVE UTILIZATION OF RICE STRAW
III. EFFECT OF UREA AMMONIA TREATMENT AND UREA MOLASSES BLOCKS SUPPLEMENTATION ON INTAKE, DIGESTIBILITY, RUMEN AND BLOOD PARAMETERS

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Summary

In two separate experiments with crossbred bulls (Sahiwal × indigenous) the effect of access to a urea-molasses lickblock (MOL-U-MIN) on straw diets was studied. The animals were given either untreated (US) or urea treated (TS) rice straw with or without lickblock supplementation. In experiment 1, individual dry matter intake (DMI) and dry matter digestibility (DMD) were measured, while in experiment 2 in addition to the above rumen (pH, ammonia, minerals) and blood (protein, minerals and haemotological) parameters were also measured. With both experiments urea treatment did not effect DMI, but lickblock supplementation significantly ($p < 0.05$) increased DMI. The DMD values obtained in both experiments for TS were significantly ($p < 0.05$) higher than for US, but lickblock supplementation did not effect the DMD of either US or TS fed animals. Both urea treatment (6.97 vs 6.93) and lickblock supplementation (6.98 vs 6.92) significantly ($p < 0.001$) reduced the rumen pH. Urea treatment and lickblock supplementation increased the rumen NH_3-N concentration (mg/100 ml) from 8.7 to 11.9 and 9.2 to 11.4, respectively. Both US and TS diets fed with or without lickblock increased the molar ratio of Na : K in saliva. Phosphorus content in blood plasma was significantly ($p < 0.01$) increased due to lickblock supplementation, whereas the Fe content in blood was significantly increased ($p < 0.01$) by urea treatment. Haemoglobin content in blood ranged from 11.3 to 11.7 g/dl, and was not influenced by urea treatment or lickblock supplementation. Lickblock significantly reduced the number of red blood cells, but increased the mean corpuscular volume. It is concluded that feeding urea treated straw with proper mineral supplementation could be a more economical alternative to lickblock supplementation.
(**Key Words**: Rice Straw, Cattle, Urea Treatment, Lickblock)

Introduction

It is widely recognised that major limitations to the utilization of fibrous crop residues as a feedstuff for ruminants are associated with their low digestibility, low intake and low content of essential nutrients such as nitrogen and minerals. As such manipulation of the rumen environment to maintain a maximal rate of digestion of cell wall constituents is likely to result in increased digestion and/or intake of low quality fibrous residues. On the other hand to improve the nutrition of an animal it is obviously important to identify the sequence of limiting factors such as N, minerals and readily fermentable carbohydrates in diets as either a substrate for rumen microorganisms or as amino acid N absorbed from the small intestine.

Evidence from literature indicate that supplementation with urea molasses either in the liquid form or block form has yielded variable results (Dixon, 1984; Neric et al., 1985; Schiere et al., 1989). Kunju (1986) reported that supplementation of untreated straw with urea molasses lick (MOL-U-MIN) improved its digestibility to the level of urea ammonia treated straw. This was attributed to the provision of minerals, easily fermentable carbohydrates and a better rumen environment for microbial fermentation. He also reported that in India the use of urea molasses lick at both research and farm level has shown beneficial response, easy to adopt and is also economically accepted. Supplementation of straw based ration with these lickblocks had increased intake, milk production and live weight gain. Use

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Received October 20, 1993
Accepted March 17, 1994

of this product at farmers level in villages has also shown beneficial results and is claimed that farmers could make considerable savings by cutting down on the use of concentrates. However, some hesitation arises from the fact that the use of same or similar products in Sri Lanka (Schiere et al., 1989) and in other countries (Chicco et al., 1972; Church and Santos, 1981) has resulted in less encouraging results.

Manipulation of rumen environment towards optimum rumen fermentation (rumen pH, rumen ammonia) would result in improved digestibility and/or intake of rice straw with lickblock than without lickblock. Furthermore, provision of by-pass protein and minerals via lickblock should reflect in optimum concentration of protein and mineral elements in blood plasma. Hence the objectives of the studies reported in this paper were

– to evaluate the effect of urea molasses lick-block supplementation on intake and digestibility of untreated and urea treated rice straw

to document the changes in rumen pH, rumen ammonia concentration, mineral status (in rumen and blood plasma) and in blood parameters of animals fed the above diets.

Materials and Methods

Treatments

The treatments tested in both experiments consisted of 4 diets, namely; untreated rice straw (US), untreated straw supplemented with urea molasses lick (MOL-U-MIN), urea ammonia treated rice straw (TS) and urea ammonia treated rice straw supplemented with MOL-U-MIN.

The urea ammonia treated straw was prepared by mixing urea solution (4 kg urea disolved in 100 litres water per 100 kg air dry straw) with dry straw. Straw sprayed with urea solution was mixed thoroughly and stored under air-tight condition in a cement pit for 7 days. Continuous supply of treated straw was made available by using 2 pit × 7 day system of urea treatment. After 7 days the treated straw was directly offered to the animals.

The urea molasses lick was imported from India, and according to the manufacturers it constituted of 45% molasses, 15% urea, 15% mineral mixture, 8% salt, 4% calcite powder, 3% bentonite and 10% cotton seed meal.

In both experiments, the animals had free choice to straw and urea molasses lick, and free access to clean drinking water. The lick was offered in especially made wooden boxes.

Animals and experimental design

Experiment 1

Twelve cross-bred (Sahiwal × indigenous) bull calves (mean body weight 173 ± 23 kg) were assigned to three groups of 4 animals in each according to body weight. The animals were kept in metabolism crates until the completion of the experiment.

The four diets were randomly allocated to the animals in each group. This experiment consisted of 2 periods, at the end of the first period the animals were regrouped and randomly allotted to the 4 diets. Each period was of 7 weeks durations, which consisted of 3 weeks adaptation period, 2 weeks preliminary period and 2 weeks collection period.

Experiment 2

Four cross bred (Sahiwal × indigenous) bulls with an average body weight of 280 ± 59 kg were fitted with rumen canula (internal diameter 4 cm) and housed in metabolism cages.

In order to subject all the animals to all treatments, the experiment was repeated over 4 periods to form a 4 × 4 balanced latin square. Each period consisted of 25 days of adaptation and 21 days of pre experimental period followed by a collection period of 15 days. The animals were fed *ad libitum* at hourly intervals throughout day and night.

Measurements and laboratory analyses

Experiments 1 and 2

During the collection period, the amount of feed offered, refused and the faecal output was recorded daily. The dry matter content of straw offered, refused and the faeces was determined by drying in a forced draft oven at 100℃ for 24 h. Dry matter content of MOL-U-MIN was determined by drying a representative sample in a vacuum oven at 80℃ for 24 h.

Sub samples of feed offered and faecal output were collected daily and stored at −4℃. At the end of the collection period the samples were thoroughly mixed and representative samples were oven dried at 70℃ for 48 h. The dried samples were ground to pass through a 1 mm sieve and used

for laboratory analyses.

The organic matter content of the straw, lick-block and faeces was determined by ashing at 550°C for 6 h. The straw and lickblock was also analysed for crude protein (AOAC, 1981), Na, K, P, Mg, Cu, Zu, Fe and Mn. In addition, the lick-block was analysed for NH_3-N, Ca and Co.

Experiment 2

In experiment 2, in addition to the above parameters, samples of rumen fluid, blood and saliva were collected and subjected to the analyses described below.

During the last 3 days of the collection period, about 30 ml of rumen fluid was withdrawn using a 50 ml glass syringe through the canula. Rumen fluid samples were collected from 08:00 to 14:00 h at 30 min intervals. Immediately after collection 5 ml sample was put into small bottles (in duplicate) containing 1-3 drops of concentrated sulphuric acid. These samples were kept under refrigeration and later analysed for rumen ammonia. Rest of the sample was used for rumen pH determination. On the last day of each period blood sample was taken from the jugular vein into a vacutainer. On the same day, samples of saliva were collected 3 times from the mouth. Saliva sampling was done by inserting a clean sponge roll into the mouth of the animals and the saliva from the sponge was squeezed into small bottles. The blood samples were analysed for packed cell volume (PCV) by micro hemacrit, red blood cell count by Neubourer Hemacytometer, concentration of haemoglobin by cyanomethaemoglobin method and serum protein level by the serum protein meter method. Blood samples were also analysed for Ca, P, Mg, Zn, Cu and Fe by the Atomic absorption spectrophotometer. Saliva samples were analysed for Na and K by using the Flame photometer method. In order to avoid effects due to dilution, the molar ratio of Na and K was used for comparison.

Statistical analyses

In experiment 1

At first the intake and digestibility data from each period were analyzed separately using two-way analysis of variance (Snedecor and Cochran, 1980). As both periods I and II gave similar results, final analysis was performed using the three-way analysis of variance procedure.

In experiment 2

Intake, digestibility, mineral contents and other blood, rumen and saliva parameters measured were analysed using the 4 × 4 Latin square design (Snedecor and Cochran, 1980).

Results

The chemical composition of the urea molasses lick and the untreated and urea treated straw used in both experiments are given in table 1. Except for differences in dry matter and crude protein contents, the other parameters measured are similar for both untreated and treated straw.

TABLE 1. INGREDIENTS USED FOR THE MANUFACTURE OF LICKBLOCK AND THE CHEMICAL COMPOSITION OF LICKBLOCK AND STRAW DIETS USED IN EXPERIMENTS 1 AND 2

	Lick-block	Untreated straw	Urea treated straw
Ingredients (%):			
Molasses	45		
Urea	15		
Mineral mixture	15		
Salt	8		
Binders			
Calcite powder	4		
Bentonite	3		
Cottonseed meal	10		
Chemical composition:			
Dry matter (%)	93.2	89.9	56.7
Ash (% DM)	28.2	17.6	17.8
Crude protein (% DM)	56.1	5.6	10.8
Ammonia (%)	8.97	–	–
Sodium (mg/g)	39.26	0.50	0.49
Potassium (mg/g)	17.46	9.42	10.01
Phosphorus (mg/g)	7.07	0.81	0.76
Magnesium (mg/g)	1.30	1.20	1.19
Calcium (mg/g)	40.97	–	–
Cabalt (mg/g)	9.95	–	–
Copper (mg/g)	71.29	2.01	2.21
Zinc (mg/g)	206.1	35.0	34.0
Iron (mg/g)	25.6	280.0	275.0
Manganese (mg/g)	177.6	100.0	101.0

Experiment 1

The effect of lickblock supplementation and

urea treatment on intake and digestibility of straw is presented in table 2. With both US and TS groups, animals consumed higher quantities of lick in period I. The increased intake of lick with untreated straw was marked by the presence of period X treatment interaction ($p < 0.05$). The mean lickblock intake (g/100 kg LW/d) for the group of animals receiving treated straw was 71.4 and that for animals receiving untreated straw was 226.3. No clear effect of period was shown for intake (DMI), digestibility (DMD) and digestible dry matter intake (DDMI). Urea treatment significantly increased ($p < 0.01$) the DMD of straw from 40.7 to 48.4%. The effect due to lickblock supplementation on DMD was not significant (45.1 vs 44%). Supplementation with licks resulted in significantly higher ($p < 0.05$) DMI (2.53 vs 2.30 kg/100 kg LW), but the effects due to urea treatment was not significant (2.41 vs 2.42 kg/100 kg LW). DDMI (kg/100 kg LW/d) for TS was significantly higher ($p < 0.05$) than for US (1.19 vs 0.98). The effect due to lickblock on DDMI was not significant (1.11 vs 1.03 kg/100 kg LW).

TABLE 2. EFFECT OF UREA AMMONIA TREATMENT AND LICKBLOCK SUPPLEMENTATION ON DIGESTIBILITY AND INTAKE OF RICE STRAW (EXPERIMENT 1)

	Untreated straw (US)		Urea treated straw (TS)		Means	
	Without lick	With lick	Without lick	With lick	US vs. TS	Without lick vs. With lick
Dry matter digestibility (%)	42.4 (0.18)	39.0 (1.73)	47.8 (1.29)	49.0 (0.56)	**	NS
Intake :						
Lickblock (g/100 kg LW)						
Period I		334.6[a]		108.4[b]		
Period II		118.0[b]		34.5[a]		
Straw dry matter (kg/100 kg LW)	2.29 (0.24)	2.53 (0.08)	2.31 (0.09)	2.54 (0.07)	NS	*
Digestible dry matter (kg/100 kg LW)	0.97 (0.10)	0.99 (0.04)	1.10 (0.09)	1.24 (0.11)	**	NS

Within rows and columns means with dissimilar superscripts are significantly different ($p < 0.005$).
Values within parentheses are standard errors.
NS = not significant; * = $p < 0.05$; ** = $p < 0.01$.

Experiment 2

The DMD, DMI and DDMI of straw and intake of lickblock are presented in table 3. The DMD values obtained for TS were significantly higher ($p < 0.05$) than for US (47.3 vs 42.4%), but lickblock supplementation did not affect the DMD of *either* US or TS fed animals (45.9 vs 43.7%). Urea treatment did not affect DMI, but lickblock supplementation significantly ($p < 0.05$) increased DMI from 2.09 to 2.42 kg/100 kg LW. TS supplemented with lickblock gave the highest DDMI (1.16 kg/100 kg LW) as compared to other treatment groups ($p < 0.05$).

The effect of urea treatment and lickblock supplementation on rumen pH, rumen ammonia concentration and concentration of mineral elements in rumen fluid is given in table 4. Both urea treatment (6.97 vs 6.93) and lickblock supplementation (6.98 vs 6.92) significantly ($p < 0.001$) reduced the rumen pH. Urea treatment significantly increased ($p < 0.01$) the rumen NH_3-N concentration (mg/100 ml) from 8.66 to 11.94, while the increase achieved by lickblock supplementation (9.18 vs 11.42) was not significant ($p > 0.05$). Among the mineral elements analysed, only the potential availability of Ca and Fe increased significantly due to urea treatment ($p < 0.01$). None of the minerals were affected by lickblock supplementation.

The mineral content in blood plasma and the molar ratio of Na and K in saliva of animals fed (un) treated straw without or with lickblock is

Table 3. EFFECT OF UREA AMMONIA TREATMENT AND LICKBLOCK SUPPLEMENTATION ON DIGESTIBILITY AND INTAKE OF RICE STRAW (EXPERIMENT 2)

	Untreated straw (US)		Urea treated straw (TS)		Means	
	Without lick	With lick	Without lick	With lick	US vs. TS	Without lick vs. With lick
Dry matter digestibility (%)	44.7 (1.04)	40.1 (1.18)	47.2 (1.04)	47.4 (1.22)	**	NS
Intake:						
Lickblock (g/100 kg LW)	–	154.8[a]		82.3[b]		
Straw dry matter (kg/100 kg LW)	2.08 (0.19)	2.39 (0.10)	2.09 (0.18)	2.40 (0.05)	NS	*
Digestible dry matter (kg/100 kg LW)	0.93 (0.12)	0.95 (0.04)	0.99 (0.09)	1.14 (0.11)	**	NS

Within rows means with dissimilar superscripts are significantly different ($p < 0.005$).
Values within parentheses are standard errors.
NS = not significant; * = $p < 0.05$; ** = $p < 0.01$.

TABLE 4. EFFECT OF UREA AMMONIA TREATMENT AND LICKBLOCK SUPPLEMENTATION OF RICE STRAW ON RUMEN pH, RUMEN AMMONIA (NH_3-N), AND ON THE MINERAL CONTENT OF RUMEN FLUID (EXPERIMENT 2)

	Untreated straw (US)		Urea treated straw (TS)		Means	
	Without lick	With lick	Without lick	With lick	US vs. TS	Without lick vs. With lick
Rumen pH	7.00[d] (0.11)	6.94[b] (0.02)	6.96[c] (0.06)	6.90[a] (0.09)	***	***
Rumen NH_3 N (mg/100 ml)	7.06[a] (1.43)	10.26[ab] (1.08)	11.30[b] (1.39)	12.58[b] (2.73)	**	NS
Mineral content in rumen fluid:						
Calcium (mg/l)	64.0[a] (5.8)	71.7[ab] (5.4)	84.0[b] (2.8)	82.7[b] (2.6)	**	NS
Magnesium (mg/l)	34.0 (5.2)	40.3 (7.0)	35.3 (3.0)	36.5 (3.0)	NS	NS
Iron (ug/ml)	6.17 (0.58)	6.99 (1.22)	9.84 (1.27)	9.86 (2.12)	*	NS
Zinc (ug/ml)	0.49 (0.06)	0.58 (0.13)	0.73 (0.45)	0.69 (0.17)	NS	NS
Copper (ug/ml)	0.01 (0.01)	0.12 (0.02)	0.13 (0.02)	0.13 (0.02)	NS	NS

Within rows means with dissimilar superscripts are significantly different ($p < 0.01$).
Values within parentheses are standard errors.
NS = not significant; * = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.001$.

given in table 5. Supplementation with lickblock significantly ($p < 0.01$) increased the P content in plasma, whereas urea treatment significantly ($p < 0.01$) increased the Fe content in plasma. Feeding

(un) treated rice straw without or with lickblock did not significantly influence the Ca, Mg, Zn and Cu contents in blood plasma. Both urea treatment and lickblock supplementation increased the molar ratio of Na:K in saliva, but these difference were not significant. Nevertheless, the ratio was higher with lickblock supplementation.

As regards the haematological parameters (table 6), lickblock supplementation showed no effect on serum protein, while urea treatment significantly ($p < 0.05$) decreased its level from 8.05 to 7.49 g/dl. The haemoglobin content in blood was not significantly influenced by either urea treatment or lickblock supplementation. Supplementation with lickblock significantly ($p < 0.05$) reduced the number of red blood cells ($10^6/mm^3$) from 8.03 to 6.76, and significantly ($p < 0.05$) increased the mean corpuscular volume (fl) from 48.5 to 57.1. The mean corpuscular haemoglobin concentration was not significantly influenced by any of the treatments.

Discussion

The mean lickblock intakes (g/100 kg BW per day) of 226 (experiment 1) and 155 (experiment 2) observed when animals were offered untreated straw is within the range of values reported in Sri Lanka (156 g/100 kg BW per day; Schiere et al., 1989) and in India (151 187 g/100 kg BW per day; Kunju, 1986). As in the studies reported here, these authors also used the same commercially available lickblock (MOL-U-MIN). In both experiments 1 and 2, animals fed TS diet consumed significantly lower amount of lickblock as compared to those fed US diet. For example, the percent reduction in lickblock consumption in experiments 1 and 2 was 68 and 46%, respectively. In a similar trial in Sri Lanka reductions up to 40% has been reported (Schiere et al., 1989). In general it is accepted that the amount of supplement consumed depends on the quality of the basal roughage.

With both US and TS diets lickblock supplementation showed no significant effect on digestibility, but significantly increased straw intake. Several other workers have also found increased intakes of basal ration as a result of urea/molasses or lickblock supplementation (Ernst et al., 1975; Losada et al., 1979; Sudana, 1985; Kunju, 1986), whereas other found no increased intakes of basal ration (Church and Santos, 1981; Dixon, 1984; Schiere et al., 1989). Kunju (1986) reported an increase in intake of straw from 4.4 to 5.7 kg per day, when he replaced 1 kg concentrate with 560 g lickblock, while intake of straw marginally increased from 6.4 to 6.8 kg per day when lickblock was added to a ration including 1 kg concentrates. These effects could not be explained due to confounding of possible stimulation of straw intake by lickblock and substitution of straw by concentrate. In experiments where the roughage has consisted of cereal straw or low quality hay, stimulation in roughage intake by supplements can be usually attributed to addition of nitrogen. Crabtree and Williams (1971a) found that a concentrate containing 19.1% crude protein stimulated intake by sheep of oat straw containing 3.9% crude protein. The same authors (Crabtree and Williams, 1971b) in a subsequent trial found that the increased intake was due to the addition of N to the diet rather than readily fermentable carbohydrates. McLennan et al. (1981) showed that urea supplementation increased intake by 14%, whereas additional molasses, sodium sulphate or both had no effect on intake.

Urea treatment can improve the feeding value of rice straw by increasing its digestibility (Saadullah et al., 1981; Wanapat et al., 1984), by increasing feed intake (Jaiswal et al., 1983) or by a combination of these effects (Wanapat et al., 1982; Schiere et al., 1989). In both our studies the effect due to urea treatment was on digestibility, consequently the intake of digestible dry matter (DDMI) of animals fed urea treated straw with or without lickblock was up to 17% higher. In terms of animals production DDMI gives a clear indication of the responses one could expect. As such the justification of using lickblock as a supplement should be weighed against other benefits that could be achieved (rumen pH, rumen ammonia concentration, mineral status, haematological parameters).

Providing a suitable environment for rumen microbes to efficiently degrade fibre is one of the primary objectives of supplementation. The indicators to this effect are the rumen pH and rumen ammonia concentration. In general the rumen pH of an animal consuming only long roughage of low quality is in the range of 6.4-7.0, and consequently is sufficiently high not to reduce the rate of fibre digestion (Dixon, 1986). In our study, the

TABLE 5. EFFECT OF UREA AMMONIA TREATMENT AND LICKBLOCK SUPPLEMENTATION OF RICE STRAW ON MINERAL CONTENT OF BLOOD PLASMA AND ON MOLAR RATIO OF SODIUM AND POTASSIUM IN SALIVA (EXPERIMENT 2)

	Untreated straw (US)		Urea treated straw (TS)		Means	
	Without lick	With lick	Without lick	With lick	US vs. TS	Without lick vs. With lick
Mineral content in blood :						
Calcium (mg/l)	85.7	93.6	88.6	86.0	NS	NS
	(1.1)	(4.0)	(1.6)	(0.7)		
Magnesium (mg/l)	17.6	19.5	19.7	19.3	NS	NS
	(1.3)	(1.0)	(0.3)	(0.7)		
Phosphorus (mg/l)	38.4	49.6	37.4	39.6	NS	**
	(3.5)	(1.9)	(4.1)	(4.1)		
Iron (mg/l)	1.0	1.1	1.3	1.2	**	NS
	(0.2)	(0.1)	(0.2)	(0.1)		
Zinc (mg/l)	1.2	1.2	1.1	1.2	NS	NS
	(0.1)	(0.2)	(0.1)	(0.1)		
Copper (mg/l)	0.7	0.8	0.7	0.7	NS	NS
	(0.1)	(0.1)	(0.1)	(0.1)		
Molar ratio of Na : K of saliva	1.59 (0.41)	3.19 (0.33)	2.19 (0.93)	2.66 (0.79)	NS	NS

Values within parentheses are standard errors.
NS = not significant; ** = $p < 0.01$.

TABLE 6. EFFECT OF UREA AMMONIA TREATMENT AND LICKBLOCK SUPPLEMENTATION OF RICE STRAW ON HAEMATOLOGICAL PARAMETERS (EXPERIMENT 2)

	Untreated straw (US)		Urea treated straw (TS)		Means	
	Without lick	With lick	Without lick	With lick	US vs. TS	Without lick vs. With lick
Serum protein (g/dl)	8.05	8.05	7.58	7.40	*	NS
	(0.34)	(0.07)	(0.19)	(0.33)		
Haemoglobin (g/dl)	11.70	11.49	11.32	11.53	NS	NS
	(0.42)	(0.26)	(0.51)	(1.12)		
Red blood cell count (10^6/mm^3)	7.97^a	6.81^b	8.09^a	6.72^b	NS	*
	(0.21)	(0.28)	(0.95)	(0.08)		
PVC (%)	39.13	37.69	38.75	39.61	NS	NS
	(0.82)	(0.42)	(2.32)	(1.96)		
Mean corpuscular volume (fl)	49.09	55.35	47.89	58.94	NS	*
	(0.32)	(0.27)	(0.73)	(0.60)		
Mean corpuscular haemoglobin concentration (g/dl)	29.90	30.49	29.21	29.11	NS	NS

Within rows means with dissimilar superscripts are significantly different ($p < 0.05$).
Values within parentheses are standard errors.
NS = not significant; * = $p < 0.05$.

mean pH of 7.0 recorded for feeding a ration consisting of untreated straw only seems to be on the high side of the above range. While with both urea treatment and lickblock supplementation the rumen pH was within the acceptable range, and hence conducive for fibre degradation. A number of studies have emphasized the need for a continuous supply of ammonia in the rumen in order to maintain a high intake and digestibility of a fibrous diet (Romero et al., 1976). In our study the mean ammonia concentration in the rumen of animals fed untreated straw alone was 7.1 mg/100 ml as compared to 11.3 mg/100 ml in animals fed only urea treated straw. Increase achieved by providing lickblock to animals fed on urea treated straw was numerically small (increase of 0.3 mg/100 ml), nevertheless statistically signi ficant. Kunju (1986) reported rumen ammonia concentrations of 11.2-19.5 mg/100 ml with rations containing untreated rice straw, lickblock and concentrates. The minimum rumen ammonia concentration for maximum efficiency of microbial N synthesis been estimated *in vitro* to be less than 5 mg/100 ml (Satter and Slyter, 1974) and *in vivo* to range from 2-8 mg/100 ml depending on the diet fed (Pisulewski et al., 1981). Evidence from literature indicate that the minimum rumen ammonia concentration required may vary depending on the type of fibrous material being digested (Dixon, 1987). In this same review, Dixon concluded that a deficiency of rumen ammonia led to much greater reductions in the microbial digestion of roughages of low N content (eg. straws) than those of higher N content (eg. grasses and legumes). Kennedy (1980) ascribed a large recycling of urea in sheep and cattle on forage diets to the presence of sugar which in some way apparently stimulated urea entry from blood via the rumen wall. If this is true, then continuous supply of small amounts of molasses (which contains sugars) may be beneficial as a means of increasing recycling of urea-N to the rumen thus ensuring a continuous of ammonia for the rumen microbes.

Mineral concentration in the rumen fluid would give an indication to the extent to which the minerals present in the feeds are solubilized, and thereby their potential availability to rumen microbes or to the host animal (Ibrahim et al., 1990). The latter is rather difficult to assess because of the possible interactions between mineral elements and their effect on absorption. On the other hand, mineral content in blood plasma gives a better indication of the mineral status of the animal and assists in the diagonis of certain mineral deficiencies.

Ca deficiency in ruminants is determined by analyzing the blood for Ca. Blood Ca levels of cattle in the United Kingdom have a mean value of 90 mg/liter (Topps and Thompson, 1984). In the present study the higher intake of lickblock with untreated rice straw increased the Ca level in blood up to 94 mg/liter. Ruminants attempt to maintain a constant concentration of Mg (18-30 mg/liter) in blood plasma (Grace, 1983). The absorption of Mg or its content in blood plasma appears to be influenzed by the level of crude protein (CP) in the diet. It has been demonstrated that the Mg content in blood decreased from 15 to 7 mg/liter when the CP of the forage diet increased from 172 to 234 g/kg (Minson, 1992). This deppression in blood Mg levels could be related to the concentration of ammonia in the rumen. Some of the earlier studies (Giduck and Fontenot, 1987) clearly indicate that inclusion of readily available carbohydrates in the diet drasticaly reduced the concentration of ammonia in the rumen and increased the Mg level in blood. In our study the possible effect of providing soluble sugars via molasses block supplementation failed to enhance the Mg content in blood. Some fluctuations in blood P are considered normal (Minson, 1992), but ruminants attempt to maintain a labile pool of 40 70 mg/liter inorganic P in the plasma (Whitten, 1971). In the present study, the blood P levels of animals fed on untreated or urea treated rice straw alone was below the above range, but supplementation with lickblock increased the P content in blood to the acceptable level. Moreover, the increase was related to amount of lick consumed as in the case with untreated straw diet. Liveweight gain in steers could be increased by 65 kg/year by increasing the P level in blood from 35 to 75 mg/liter (Van Schalkwyk and Lombard, 1969; cited by Minson, 1992). As regards Zn and Cu, the levels found in blood are well within the recommended critical levels of 0.65 mg/liter and 0.60 mg/liter, respectively (Spais and Papasteriadis, 1974; McDowell, 1985).

Both urea treatment and lickblock supplementation increased the molar ratio of Na : K in saliva, but these difference were not significant. Nevertheless, the ratio was higher with lickblock supple-

mentation. The fall in Na concentration is balanced by a rise in the K concentration and the analysis of parotid saliva for Na : K ratio provides a sensitive index of whether the animal is actively conserving Na (Morris, 1980). Results from several workers confirm that there is no response to feeding Na supplements when the Na : K ratio exceeds 2.0 (Minson, 1992). In our study, except for US diet where the ratio was 1.6, with the other 3 diets the ratio was above 2.0.

Both urea treatment and lickblock supplementation did not influence the haemoglobin content in blood and was above the critical value of 8 g/dl (Ranawana et al., 1992). The mean red blood cell (RBC) count in blood is 6.3 × 10^6/mm^3 (range 5-10; Banerjee, 1982), and the values found in our study is within this range. Nevetheless, RBC count significantly declined with lickblock supplementation. With all diets tested the packed cell volume (PVC %) was marginally below normal value of 40 found in cattle (Banerjee, 1982). The mean corpuscular volume and the mean corpuscular haemoglogin concentration was within the accepted range of 40-60 fl and 26-34 g/dl, respectively (Ranawana et al., 1992).

Conclusions

Supplementation of untreated straw with lickblock showed no positive response on the intake of digestible dry matter, whereas better performance could be achieved with feeding urea treated straw. Data from these experiments provide insufficient basis to conclude that expensive lickblocks would be beneficial. Inclusion of small quantity of green forage and/or cheap concentrate such as rice bran would not only provide some supplementary plant protein, readily fermentable carbohydrate and minerals (rice bran is rich in phosphorus), but also in many instances be a more economic alternative for the farmer.

Acknowledgements

The authors wish to thank the Sri Lankan and the Netherlands authorities who supported the Straw Utilization Project (SUP). Ms. Chandra Unawatune and Mr. H.G.D. Perera for assisting with the laboratory analyses. Especial thanks are due to Ir. J. B. Schiere for helping with the initial planning of the experiments. Mr. A. L. Badurdeen was a recipient of M. Phil. fellowship funded by the SUP Sri Lanka.

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