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Effect of Source of Nitrogen Supplementation on Straw Utilization and Nitrogen Balance of Mature Male Goats

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ABSTRACT. *The effect of sources of protein on total and straw dry matter intake (DMI), nutrient digestibility and nitrogen balance was studied with 12 mature male goats in a randomized complete block design with three replications per treatment. Animals were housed in individual metabolism cages and fed 2% urea supplemented rice straw with and without 200 g isonitrogenous concentrate mixture, isogenous. in N content. Experiment consisted of 10 day preliminary, 10 day adaptation and 10 day total collection period. Provision of concentrate did not improve the nutrient digestibility nor did it increase total or straw DMI significantly. Instead, straw DMI was reduced by concentrate. Source of N also did not affect these parameters. Supplementation of rice straw with 2% urea containing 5% crude protein (CP) was sufficient to maintain adult goats on positive N balance. Although concentrate supplementation of adult goats fed urea supplemented straw improved ($p<0.05$) N intake, but N status was not improved significantly. Treatments did not significantly affect the rumen pH, Total Volatile Fatty Acids and Blood Urea Nitrogen.*

INTRODUCTION

Only a fraction of world crop by-products are utilized effectively. Rice straw is the most important in terms of its availability and quantity and the present production in Sri Lanka is 2.6 million metric tons (Central Bank Annual Report, 1995). As a result, different aspects of feeding rice straw to ruminants have been dealt with in some detail. Most of the research that have been carried out are on large ruminants and sheep. Dietary nitrogen plays an

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important role in roughage utilization and microbial protein synthesis (Perera *et al.*, 1992). Feeding straw alone will not meet the required rumen nitrogen concentration of 80-200 mg/l of rumen fluid (Hoover, 1986) and supplementation becomes essential (Perera and Perera, 1995). Sources of dietary nitrogen for supplementation are expensive and therefore, cheaper sources and economical methods of feeding must be evaluated (Sahama *et al.*, 1993). The effect of different sources of N on total and straw DMI, digestibility of different nutrients, N balance and performance by goats at various physiological stages has not been studied in detail. This experiment was conducted to study the effects of different sources of N on straw DMI, nutrient digestibility and N balance of mature male goats.

MATERIALS AND METHODS

A feeding and metabolism trial was conducted at the Department of Animal Science, University of Peradeniya using 12 mature male goats in a randomized complete block design with three replicates using total collection method. Animals were blocked according to their body weight, housed in individual metabolism cages and fed 2% urea supplemented rice straw with and without 200 g per day of isonitrogenous (Table 1) concentrate mixture made with different feed ingredients isogenous in N but with different sources of protein. All animals were assigned to one of the following treatments at random as shown below;

T_0: 2% urea supplemented rice straw alone, control.

T_1: T_0 + concentrate I (Rice bran 37.5%+Coconut poonac-expeller 62.5%)

T_2: T_0 + concentrate II (Rice bran 61.5%+Coconut poonac-extractor 38.5%)

T_3: T_0+concentrate III (Rice bran 87.5%+Fish meal 12.5%)

100 g of molasses was given by adding to the concentrate feed in two equal portions on top of the concentrate mixtures. Mineral mixture of 50 g and common salt was also provided to all animals. In control animals, molasses was mixed with the mineral mixture. Rice straw was chopped to 8-10 cm length, supplemented with 2% urea solution (20 g of urea in 1 l of water per kg of chopped rice straw) by sprinkling over the chopped straw on a cemented floor. Urea supplemented straw was offered at 1000 and 1600 hrs and provided *ad libitum*. Amount of urea supplemented straw offered was such that 10% would be left in the feed trough. Goats in all treatments except in the control,

Table 1. **Proximate and detergent fibre composition of straw, concentrate mixtures and test ingredients of the concentrates (% dry matter basis).**

	DM	OM	CP	NDF	ADF	Hcel	Cel	ADL
Straw	94.84	88.67	10.84	51.29	75.90	24.61	44.37	6.92
Concentrate I	88.89	81.38	18.89	29.63	46.32	16.69	23.23	6.40
Concentrate II	91.72	82.58	18.48	31.76	47.80	16.04	24.81	6.95
Concentrate III	89.92	82.62	18.64	28.59	44.16	15.57	22.60	5.99
Rice bran	92.59	84.95	12.20	38.04	53.74	15.70	30.63	7.41
Coconut poonac I	90.16	94.03	24.45	30.72	54.64	23.92	23.75	6.97
Coconut poonac II	90.16	94.02	20.77	28.63	49.26	20.63	21.90	6.74
Fish meal	77.40	86.63	71.41	-	-	-	-	-
Molasses	77.51	91.66	4.81	-	-	-	-	-

* After 2% Urea supplementation.

DM = Dry Matter; OM = Organic Matter; CP = Crude Protein
NDF = Neutral Detergent Fibre; ADF = Acid Detergent Fibre; Cel = Cellulose
Hcel = Hemicellulose; ADL = Acid Detergent Lignin

were offered with 200 g concentrate mixture containing different sources of protein; one half at 0800 and the other half at 1400 hrs before new straw was added. Refusals of the concentrates, if any, were collected and weighed before offering the straw. Water was made available at all times.

Feeds offered and refused were measured and sampled daily for chemical analysis. Oats were collected 2 h post feeding. Dry matter intake was measured by taking the difference between the amount offered and refused. Digestibility of different nutrients and N balance were determined by measuring the intake and output of the respective nutrients.

During the collection period faeces and urine were collected daily in the morning at 0700 hrs. Urine was collected in acidified (25 ml of 10% HCl) buckets and the amount was measured daily. Collected urine was diluted with water to a constant weight depending on the amount of urine output. About

10% of this diluted urine was sampled and refrigerated for N determination. Faecal samples were collected and DM was determined daily. Faecal and urine samples were composited for individual animal during the whole collection period for chemical analysis. Rumen fluid and blood samples were collected at the end of total collection period 2 h post feeding of concentrates. In the case of T_0 where no concentrate was given, blood and rumen fluid samples were collected 2 h post feeding of straw but the time was adjusted to be the same as for others. Rumen fluid was drawn using a stomach tube. Samples of rumen fluid were collected after straining with double layer cheese cloth, pH was measured immediately and stored in pre-acidified culture tubes and deep frozen until analysis. Blood samples were collected from the jugular vein in vacutainers, centrifuged and the separated serum was deep frozen until analysis.

Chemical analysis for proximate composition of straw, concentrates and individual components of concentrates were determined using AOAC (1980), detergent fibre according to Van Soest (1963) and Van Soest and Wine (1967). Urinary N was determined as per AOAC (1980). Rumen pH (electrometrically), TVFA (AOAC, 1980) and BUN (Coulombe and Favreau, 1963) were determined. Samples of straw offered, refused and faeces were also subjected to the same chemical analysis as for diets.

Data obtained were statistically analyzed using analysis of variance and means were separated by DMRT using SAS package (1985).

RESULTS AND DISCUSSION

Proximate and detergent fibre composition of straw, concentrate mixtures and feed ingredients of the concentrate mixtures are given in Table 1. Dry matter intake of goats are given in Table 2. It appears that the concentrate mixture had a substitution effect on the DMI of mature goats in all treatments as indicated by the reduction in basal DMI. All animals irrespective of the source of protein supplement exhibited a satisfactory DMI (> 2.5% of the body weight) indicating less influence of good quality protein. Straw DMI in terms of g/kg BW, g/kg $W^{0.75}$ and kg/100 kg BW, though not significant, decreased in all the animals given different sources of protein. However, a non-significant increase in total DMI of goats given extra protein source in terms of g/kg BW, g/kg $W^{0.75}$ and kg/100 kg BW was observed. Substitution rate may go even to >1.0 when roughage intake decreases by an amount equal to or greater that the concentrate given (Dixon, 1986). Similar result was found by Ibrahim (1987). This can be due to two reasons, i. goats require more protein when given in the form of protein rich concentrates than in the form of urea and

Table 2. Effect of source of protein on dry matter intake of mature male goats fed 2% urea supplemented straw, with or without concentrates.

		T_0	T_1	T_2	T_3	SE ±
1.	Straw DMI:					
	g/kgBW/d	26.0	23.8	23.1	22.1	1.36
	g/kg$W^{.75}$/d	53.4	45.6	48.1	50.4	2.40
	kg/100BW/d	2.60	2.21	2.31	2.33	0.13
2.	Total DMI:					
	g/kgBW/d	26.0	32.1	32.9	30.1	2.40
	g/kg$W^{.75}$/d	53.4	66.0	68.5	63.4	5.80
	kg/100kgBW/d	2.60	3.21	3.29	3.01	0.30

DMI = Dry Mater Intake BW = Body Weight
SE ± = Standard Error $W^{.75}$ = Metallic Body Weight

urea is more efficiently utilized by goats than the N in protein rich concentrates (Mba *et al.*, 1974), ii. protein rich concentrates may not increase the intake of long-chopped roughage in addition to the intake response achieved by provision of adequate amounts of rumen degradable protein (Hunter, 1988). Saadullah (1986) could not find any effect of fish meal supplementation on straw DMI in growing calves over a 120 day period.

The effect of source of N on digestibility of different nutrients is shown in Table 3. Supplementation of straw with concentrates increased CP digestibility significantly ($p<0.01$). This may be due to the higher quality of added protein than the protein in straw itself. Thus this increment may not be in straw CP digestibility per se. Among the different sources of N, there was no significant difference in CP digestibility. Although an overall increase in DM digestibility is expected when concentrates are supplemented, it was not observed in this experiment. This may be due to the negative associative

Table 3. Effect of source of protein on digestibility of nutrients in mature male goats fed 2% urea supplemented rice straw, with or without concentrates.

Digestibility (%)	T_0	T_1	T_2	T_3	SE ±
Dry Matter	50.7	56.0	54.5	47.3	2.80
Organic Matter	53.1	59.3	58.3	51.6	2.38
Crude Protein	44.6^b	60.5^a	63.2^a	58.1^a	2.68
Neutral Detergent Fibre	55.8	55.5	54.2	47.0	2.84
Acid Detergent Fibre	53.1	50.6	50.1	48.8	1.51
Cellulose	54.6	53.4	52.1	50.0	1.37
Hemicellulose	61.3	65.2	62.3	57.8	2.34

Figures in the same row with different superscripts are significantly different ($P < 0.01$).

effects between the digestion of concentrates and cell wall constituents of the roughage (which comprises most of the roughage DM) where the rate of digestion of roughage in the rumen is decreased by the ingestion of concentrates (Dixon, 1986). Thus the reduced digestibility of cell wall components may override the expected increase in digestibility due to protein supplements. There is also a likelihood of increased number of saccharolytic microbes which digest and utilize readily fermentable carbohydrates and a decrease in the number of cellulolytic microbes (Dixon, 1986).

With regard to N balance (Table 4) all the animals were in positive N balance. But there was no significant effect of concentrate supplement on N balance over that of 2% urea supplemented straw. Neither was their a significant difference among different sources of N on its balance. Although, N intake was significantly improved by concentrate, it also increased N loss in the faeces and urine. Thus, the significant difference in N balance as would be expected when protein supplements are given was not observed in this experiment. This suggests that such sources of N which are relatively expensive would be of no use to the non-producing animals. Apparently these animals are not able to take advantage of good quality protein or they simply do not require it. None of the animals lost their body weight. This suggests

Table 4. Effect of source of protein on nitrogen balance of mature goats fed 2% urea supplemented rice straw, with or without concentrates.

		T_0	T_1	T_2	T_3	SE ±
1.	Nitrogen Intake (g/d)					
	Total	8.13^b	12.45^a	13.01^a	11.83^a	0.73
	Straw	8.13	6.86	7.59	7.88	0.43
2.	Nitrogen Out Put (g/d)					
	Faecal	3.58^c	5.75^a	4.86^{ab}	4.94^{ab}	0.42
	Urinary	1.93^{bc}	2.44^{ab}	3.22^a	3.76^a	0.30
	Total	5.50^b	8.21^a	8.61^a	8.16^a	0.62
3.	Nitrogen Balance (g/d)	2.62	4.24	4.36	3.67	0.58
4.	Nitrogen Retention as % Nitrogen Intake (%)*	32.23	34.06	33.51	31.02	.

* No statistical analysis was done.

Figures in the same row with different superscripts are significantly different ($P<0.05$).

Table 5. Effect of source of protein on pH, Total Volatile Fatty Acids and Blood Urea Nitrogen content of mature male goats fed 2% urea supplemented rice straw, with or without concentrates.

Parameter	T_0	T_1	T_2	T_3	SE ±
pH	7.3	7.3	7.1	7.1	0.07
Total Volatile Fatty Acids (μmol/ml)	49.3	51.7	39.4	45.1	3.85
Blood Urea Nitrogen (mg/dl)	7.00	6.97	7.53	8.2	0.42

that 2% urea supplementation of straw alone can meet the maintenance requirement of the animals, at least during a short period. Insignificant increase in N balance of the animal irrespective of its source might be that 2% urea supplementation gave a minimum NH_3-N concentration in the rumen necessary for microbial biomass production. Additional source of protein had thus no effect on overall N economy of the animal, instead it would increase the feed cost for maintenance.

The effect of source of protein on pH, TVFA and BUN were also not significant (Table 5). Neither it was among the different sources of N. For technical reason it was not possible to analyze the NH_3-N concentration in the rumen fluid. pH and TVFA of T_0 and T_1 was slightly higher than T_3 and T_4 whereas that of BUN was slightly lower than T_3 and T_4. Slightly higher values of BUN in T_3 and T_4 might have led to relatively higher excretion of N in the urine of those animals. This indicates a small proportion of ammonia being lost from the rumen when concentrates are given to non-producing animals. However, BUN content of all animals was within the normal range. The pH of the rumen fluid in all treatments was optimum for fibre digestion.

CONCLUSION

Supplementation of rice straw containing about 5% CP with 2% urea is sufficient to bring the adult goats to positive N balance. Provision of concentrates to the adult goats fed urea supplemented straw does not necessarily improve N status of the animal, at least during short term, nor did improve straw intake and the digestibility of different nutrients in it. Instead, straw dry matter intake was reduced.

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