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Urea as a Source of Non-protein Nitrogen for Ruminants

I. Effect of Urea as a non-protein source on digestibility by sheep, fed artificially dried Pusa Giant Napier harvested at an extended cutting interval of 90 days.

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Abstract: Pusa Giant Napier fertilized with 300 lb nitrogen per acre per year and harvested at monthly intervals can yield 40,000 lb dry matter having 16% crude protein. Extending this cutting interval will increase the dry matter production but result in a lower crude protein content. Since urea in ruminant diets low in nitrogen has often resulted in increased digestibilities, an experiment was conducted to investigate the effect of urea supplementation on the apparent digestibility of Pusa Giant Napier harvested at 90 day intervals from a field previously fertilized with poultry manure.

The effect of six levels of urea were studied in a 4 × 4 latin square layout of treatments, using sheep fed at maintenance level. The fodder had an average crude protein content of 9.6% on a dry matter basis and contributed 80% of the total diet.

Results indicated that supplementary nitrogen in the form of urea had no significant effect on the apparent digestibility of fodder organic matter. Increased levels of supplementation appeared to depress the digestibility further.

It was concluded that high nitrogen application was not necessary for Pusa Giant Napier if it is to be fed to low yielding cows, since a grass with 10% crude protein can be expected to meet the nutritional requirements of low yielding tropical cows. If fertilized with 300 lb nitrogen per acre per year, it would be more desirable to extend the cutting frequency to 90 days.

1. Introduction

THE usefulness of non-protein nitrogen (NPN) compounds in the nutrition of ruminants has been well established. [3,8,17,18] Of the various NPN compounds investigated urea is probably the commonest compound of choice as a protein replacer for practical feeding.[14]

Inclusion of urea in rations containing poor quality roughages has often resulted in increased digestibilities. [6,9,11,13] Increased digestibilities would result in higher voluntary intakes and greater energy retentions, leading to increased production.[4,5]

Pusa Giant Napier (a hybrid resulting from a cross between *Pennisetum purpureum shumac* and *Pennisetum typhoideum* Riche) is a recommended fodder species for Sri Lanka, capable of producing 40,000 lb dry matter per acre (44,000 kg per hectare) when fertilized with 300 lb nitrogen per acre per year (336 kg per hectare) and

harvested at monthly intervals.[2] This material is known to have around 16 per cent crude protein on a dry matter basis.[12] Extending this cutting interval will no doubt result in an increased dry matter yield but will also lower the crude protein content. Hence if this protein deficiency can be successfully corrected, extending the cutting interval will invariably result in a greater carrying capacity and increased animal production per acre of land.

This paper reports the results of an investigation carried out to study the effect of urea supplementation on the apparent digestibility of Pusa Giant Napier harvested at an extended cutting interval of 90 days from a field that had been previously fertilized with poultry manure (six months before the commencement of the experiment). The work was carried out at the Department of Animal Husbandry, University of Sri Lanka, Peradeniya Campus.

2. Experimental

2.1 Experiment 1.

The apparent digestibility of four diets were determined in a 4×4 latin square lay-out of treatments using four growing Bikaneri X Jaffna crossbred ewes of average live weight 19.6 kg (range 19.0 kg to 20.4 kg).

The diets, given at maintenance level[1] consisted of 400g chopped and oven-dried Pusa Giant Napier, harvested from a field previously fertilized with poultry manure, 90 days after the previous harvest and 100g ground maize with or without urea per animal per day, in two equal feeds. Pusa Giant Napier contributed 80 per cent of the total ration.

Treatment A which consisted of the control diet had no urea added in it, but contained 9.9 per cent crude protein on a dry matter basis. The other three diets (treatments B, C and D), supplemented with urea had 10.5, 11.0 and 11.5 per cent crude protein respectively, on a dry matter basis. When preparing these three diets urea was added to the ground maize in amounts of 1, 2 and 3g per 100g maize and thoroughly mixed by hand.

The animals were housed individually in metabolism craters constructed according to the design of Lowman.[16] These cages facilitated the separate collection of faeces and urine.

During the last eight days of each 18 day period the daily output of faeces and urine were recorded. *Ad libitum* intakes of water and any feed refusals were also measured. Animals were weighed at the beginning and end of each period.

Samples of concentrates and grass fed during each of the four periods were stored for subsequent analysis for moisture, ash and crude protein. Chemical analysis were done in duplicate using conventional methods.

2.2 Experiment 2.

The same four animals as in Experiment 1 were used in a 4 × 4 latin square layout of treatments to determine the apparent digestibility of four diets. The diets consisted of 100g ground maize with or without urea and 400g chopped, oven dried Pusa Giant Napier, harvested from the same field which provided fodder for Experiment 1, after allowing 90 days for regrowth. The diets were given in two equal feeds daily at maintenance level.[1] Pusa Giant Napier contributed 80 per cent of the total ration.

Of the four diets the control (treatment A) had no urea but the crude protein content of the ration was 9.8 per cent on a dry matter basis. The other three diets (treatments B, C and D) in which urea was incorporated in ground maize at the rates of 5.0, 10.0 and 15.0g per 100g respectively, contained 12.3, 14.9 and 16.7 per cent crude protein on a dry matter basis. Housing of animals, collection of faeces and the sampling of food for chemical analysis were similar to that in Experiment 1. The amount of urine excreted and the voluntary intake of water were not measured in this experiment. Animals were weighed at the beginning and end of each period.

3. Results

The mean chemical composition of dried Pusa Giant Napier and ground maize used in the two experiments is given in Table 1.

TABLE 1. Mean chemical composition of dried Pusa Giant Napier and ground maize used in Experiments 1 and 2.

Experiment number	*component*	*dry matter*	*ash*	*crude protein (% in dry matter)*
Experiment 1.	Dried Pusa Giant Napier	92.3	11.7	9.7
	Ground maize	88.6	1.9	10.6
Experiment 2.	Dried Pusa Giant Napier	89.5	13.4	9.6
	Ground maize	88.3	1.7	10.8

In both experiments the addition of urea to the diets did not show any apparent effect upon the health of the animals. Animals were able to maintain live weight over the duration of the trials.

3.1 Experiment 1.

Urea supplementation of Pusa Giant Napier harvested 90 days after the previous cut showed no significant effect on the apparent digestibility of organic matter of the total diet. Neither did it affect the faeces moisture content, voluntary intake of water and urine output (Table 2).

3.2 Experiment 2.

Even with the higher rates of supplementation, urea appeared to have no effect on the apparent digestibility of organic matter of the diets. The digestibilities of urea supplemented diets in the present experiment were in fact lower than those obtained in Experiment 1. Addition of urea had no effect on the faeces moisture content (Table 2).

TABLE 2. The effect of urea supplementation on the apparent digestibility of organic matter of total diet, faeces moisture content, voluntary intake of water and urine output in Experiment 1 and 2.

Diet *80% dried Pusa Giant Napier* *20% ground maize with or without urea*	*% crude protein content of total diet (% in dry matter)*	*apparent digestibility of O.M. (%)*	*moisture in faeces (%)*	*voluntary intake of water (l/day)*	*output of urine (l/day)*
EXPERIMENT 1.					
Treatment A—dried fodder + concentrate without urea	9.9	64.2	49.4	1.527	1.128
Treatment B—dried fodder + 1% urea in concentrate	10.5	64.9	50·5	1.897	0.958
Treatment C—dried fodder + 2% urea in concentrate	11.0	65.8	51.6	1·987	1.000
Treatment D—dried fodder + 3% urea in concentrate	11.5	66.2	52.8	1.869	1.286
S. E. of difference for comparing any pair of treatment means	—	±2.21	±2.22	±0.24	±0.62
Significance difference (P = 0.05)	—	4.7	4.7	0.509	1.316
EXPERIMENT 2.					
Treatment A—dried fodder + concentrate without urea.	9.8	64.0	43.2	—	—
Treatment B—dried fodder + 5% urea in concentrate	12.3	62.6	45.5	—	—
Treatment C—dried fodder + 10% urea in concentrate	14.9	63.6	45.5	—	—
Treatment D— dried fodder + 15% urea in concentrate	16.9	63.2	43.8	—	—
S.E. of difference for comparing any pair of treatment means	—	±0.96	±1.33	—	—
Significance difference (P = 0.05)	—	2.1	2.9	—	—

TABLE 3.Derived apparent digestibility of fodder O.M. in Experiments 1 and 2 (assuming 85% for digestibility of concentrate O.M.) and intake of fodder and concentrate dry matter.

Diet 80% *dried Pusa Giant Napier* 20% *ground maize with or without urea*	*% crude protein content of diet (% in dry matter)*	*derived apparent digestibility of fodder O. M. (%)*	*intake of fodder dry matter (g./KgW.$^{0.75}$/ day)*	*intake of concentrate dry matter (g./KgW$^{0.75}$/ day)*
EXPERIMENT 1.				
Treatment A—dried fodder + concentrate without urea	9.9	57.9	39.6	9.5
Treatment B—dried fodder + 1% urea in concentrate	10.5	58.9	39.6	9.5
Treatment C—dried fodder + 2% urea in concentrate	11.0	60.1	39.6	9.5
Treatment D—dried fodder + 3% urea in concentrate	11.5	60.6	39.6	9.5
EXPERIMENT 2.				
Treatment A—dried fodder + concentrate without urea	9.8	57.1	36.9	9.2
Treatment B—dried fodder + 5% urea in concentrate	12.3	55.4	36.9	9.2
Treatment C—dried fodder + 10% urea in concentrate	14.9	56.7	36.9	9.2
Treatment D—dried fodder + 15% urea in concentrate	16.9	56.2	36.9	9.2

4. Discussion

The results of the present series of experiments suggest that supplementary nitrogen in the form of urea does not enhance the apparent digestibility of organic matter (O.M.) of a fodder containing 9.6 per cent crude protein on a dry matter basis, when fed to sheep to satisfy their maintenance requirements. Although the addition of urea has been shown to increase the digestibility of many poor quality roughages,[7,13] with Pusa Giant Napier harvested at 90 day intervals, it appears that the nitrogen in the fodder at this stage of growth is sufficient for its effective utilization by rumen microorganisms. This is in good agreement with the findings of Head [15] who suggested that cellulolytic microorganisms do not require supplementary nitrogen if the food substrate contained over 1 per cent nitrogen, but contradictory to the view of Reid.[18] According to Reid, a non-protein nitrogen source is best utilized when added to a feed stuff containing 9—12 per cent crude protein to raise the level of crude protein equivalent up to 16—18 per cent.

As indicated in Table 3 the maximum digestibility of fodder O.M. can be achieved if the ration contains 11.5 per cent crude protein. Levels of crude protein higher than this in fact appeared to depress the digestibility of fodder O.M. as recorded in the work of Ellis and Pfander.[10] The stimulating effect of nitrogen therefore appears to be most evident when the diet contains less than 12 per cent crude protein (2 per cent nitrogen).

Since a grass with 10 per cent crude protein in dry matter can be expected to meet the nutritional requirements of tropical cows yielding 8 pints of milk per day,[19] it appears that Pusa Giant Napier containing 9.6 per cent crude protein could be successfully utilized for feeding low yielding cows. It also seems reasonable to suggest that land established with Pusa Giant Napier need not be fertilized with high rates of nitrogen, if the fodder from such land is to be utilized for feeding low yielders and dry cows.

When harvested at 60 day cutting intervals, Pusa Giant Napier fertilized with 300 lb nitrogen per acre per year can produce around 98,000 lb dry matter per acre (110,000 kg per hectare) having 12.2 per cent crude protein on a dry matter basis.[12] Increasing the cutting frequency to 90 days can be expected to increase the dry matter further but with a lowering of crude protein content to around 9—10 per cent.[12] Thus it appears that if fertilized at 300 lb nitrogen per acre, it could be more beneficial to extend the cutting frequency to 90 days even at the expense of crude protein, if the fodder is to be fed to tropical cows, since this could mean an increased carrying capacity and better utilization of available land.

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