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M. Hadjipanayiotou and A. Louca*

ABSTRACT

Twenty-four Chios ewes at the declining stage of lactation were used in a 3x3 balanced latin square design to test whether urea can partially replace natural protein sources. Supplemental urea-N furnished 0, 13 or 25 percent of the total nitrogen intake. Acceptability of the urea-containing diets was comparable to the diet containing no urea. No significant differences were found in either milk yield or its fat content. Dry matter (DM), metabolizable energy (ME) and crude protein (CP) consumed per kg of milk produced increased only slightly with urea supplementation. The rate of decline of milk yield during the 28-day experimental period was similar for all three diets.

INTRODUCTION

The digestive system of the ruminant permits extensive fermentation of ingested feed prior to any host enzyme attack. The breakdown of food in the reticulo-rumen, which acts as fermentation vat, is brought about by microbial enzymes (Hungate, 1966). The intervention of microbes provides ruminants with the unique capacity to utilize efficiently non-protein nitrogen (NPN), and thereby upgrade low quality dietary protein nitrogen to high quality microbial protein.

Urea is the most widely used NPN compound in ruminant diets. Research on the use of NPN as an alternative source of natural protein in diets of beef cattle, dairy cattle, sheep and goats has yielded contradictory results with regard to NPN utilization (National Research Council, 1976 ; Roy *et al.*, 1977). Earlier work carried out at this Institute, has shown that urea-containing diets can be fed to Friesian dairy cows (Louca, Papas and Hadjipanayiotou, unpublished), fattening calves (Louca and Papas, 1970), fattening lambs (Economides, unpublished) and young growing heifers (Georgiades *et al.*, 1979) without any adverse effect on their health and production. The present work was undertaken to study whether urea could be used in diets of lactating ewes as a substitute for more expensive feeds of high protein content.

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MATERIALS AND METHODS

Twenty-four Chios ewes at the declining stage of lactation (average days in milk 73±2) were used in a 3x3 balanced latin square design to test the effects of three rations on milk production. The columns of each square represented individual ewes to which the treatments were randomly assigned, and the rows represented periods of four weeks. Upon randomization and allocation of treatments to the animals all ewes receiving the same ration were housed in the same pen. At the end of each 4-week experimental period the ewes were reallocated to pens according to their new ration, following a 10-day adaptation period.

Group daily allowances of concentrates and lucerne and cereal hay were given in separate feed containers. The percentage composition of the concentrates is shown in Table 1 and the protein and energy content of lucerne and cereal hay in Table 2. The diets were isocaloric and isonitrogenous differing only in their natural crude protein content. Ewes were fed to main-

TABLE 1. Percentage composition of the three concentrate diets.

Ingredient	Diet		
	A	B	C
Barley	62	68	75
Corn	5	5	5
Soyabean meal	7	—	—
Cotton seed cake	8	8	—
Wheat bran	10	10	10
Carob meal	4	4	4
Urea	—	1	2
Minerals*	3	3	3
Vitamins**	1	1	1
Crude protein (g/kg)	140.3	140.4	141.3
Crude fibre (g/kg)	6.03	5.94	5.44
Metabolizable energy (Mcal/kg)	2.61	2.58	2.58

* Composition of mineral mixture (%): CaO 31.0; NaCl 30.0; P_2O_5 8.0; Fe_2O_3 1.3; MgO 2.5; KI 0.03; $MnSO_4$ 0.08; $CuSO_4$ 0.09; $CoSO_4$ 0.03.

** Vitamin activity per kg of finished feed was 5,000 IU for vitamin A and 500 IU for vitamin D_3.

tenance plus milk production as suggested by the National Research Council (1968). Food allowance was kept constant throughout each experimental period. Feed residues were collected and weighed daily and fresh feed was offered every morning. Milk yield was recorded daily. Representative milk samples were obtained from morning and afternoon milkings for fat determination once every fortnight. Ewes were weighed to the nearest 0.5kg at the commencement and at the end of each experimental period. All animals had free access to water and mineral licks. Since the rows of the latin squares represented the successive periods, and carry-over effects were suspected, the data were analyzed using the appropriate method for the estimation of residual effects (Cochran and Cox, 1957).

RESULTS

Three animals had health problems, which, however, did not appear to be associated with any diet. One animal on treatment C, replicate 7, suffered from hypoglycaemia and another two, replicate 8, one on treatment C and one on B, suffered from mastitis. As a result both replicates were discarded from the analyses.

No differences were found in the intake of concentrates, lucerne and cereal hay, CP and ME (Table 2). ME, and total and natural CP content of the finished feed were also calculated (Table 2.) Unlike ME and total CP

TABLE 2. Mean daily intake and nutrient content of three diets fed to Chios ewes.

	Diet		
	A	B	C
Intake (kg) :			
Concentrate	1.175	1.152	1.151
Luncerne hay +	0.435	0.429	0.443
Cereal hay ++	0.468	0.491	0.484
Crude protein	0.272	0.270	0.272
Metabolizable energy (Mcal)	4.52	4.45	4.47
Total CP content (g/kg finished feed)	131	130	131
Natural CP content (g/kg finished food)	131	115	100
Metabolizable energy content (Mcal/kg finished feed)	2.17	2.15	2.15

+ contained 160g CP and 1.7 Mcal ME per kg FMB
++ contained 80g CP and 1.5 Mcal ME per kg FMB

content, which were similar for the three diets, natural CP content decreased with each level of urea supplementation. Neither the differences in absolute milk yield, fat-corrected milk (FCM) and fat content of milk among treatments nor the differences in body weight changes were significant (Table 3).

TABLE 3. The effect of diet on milk yield, milk composition and liveweight changes of Chios ewes fed three diets.

	Diet			SD
	A	B	C	
Yield (kg/ewe/day)				
Absolute milk	0.914	0.878	0.859	0.104
Fat corrected milk*	1.268	1.254	1.188	0.109
Fat	0.059	0.059	0.057	0.006
Fat content (g/kg)	65	67	66	1.0
Initial body weight (kg)	52.7	52.7	52.5	2.83
Final body weight (kg)	53.5	53.2	53.0	2.94

* FCM (4% fat) = 0.4W + 15F

Where W = actual daily milk yield in kg

and F = fat produced daily in kg

Figure 1 shows the yield of milk produced by ewes during the experimental period. The rate of milk decline was the same throughout the 4-week experimental period for all three rations.

The amount of food and crude protein consumed per unit of milk and FCM produced was essentially the same (Table 4). Conversion efficiencies related to natural protein favoured the urea-containing diets.

TABLE 4. Conversion efficiencies of the three diets*.

	Diet		
	A	B	C
kg food/kg milk	2.27	2.36	2.42
kg food/kg FCM	1.64	1.65	1.75
kg CP/kg milk	0.298	0.308	0.317
kg CP/kg FCM	0.215	0.215	0.229
kg natural protein/kg milk	0.298	0.271	0.242
kg natural protein/kg FCM	0.215	0.190	0.175

* Maintenance allowance is also included.

DISCUSSION

The palatability of the diets containing urea was similar to that of the control diet, since no differences were found among diets in concentrate refusals. Similar findings were found by Van Horn *et al.* (1967), who reported that the palatability of the diets was not reduced when they contained between 1.5 and 2% urea. In the present study the concentration of urea was 0, 1 or 2% of the concentrate mixture or 0, 0.56 and 1.11% of the finished feed. Such values have been considered safe for lactating cows (National Research Council, 1976).

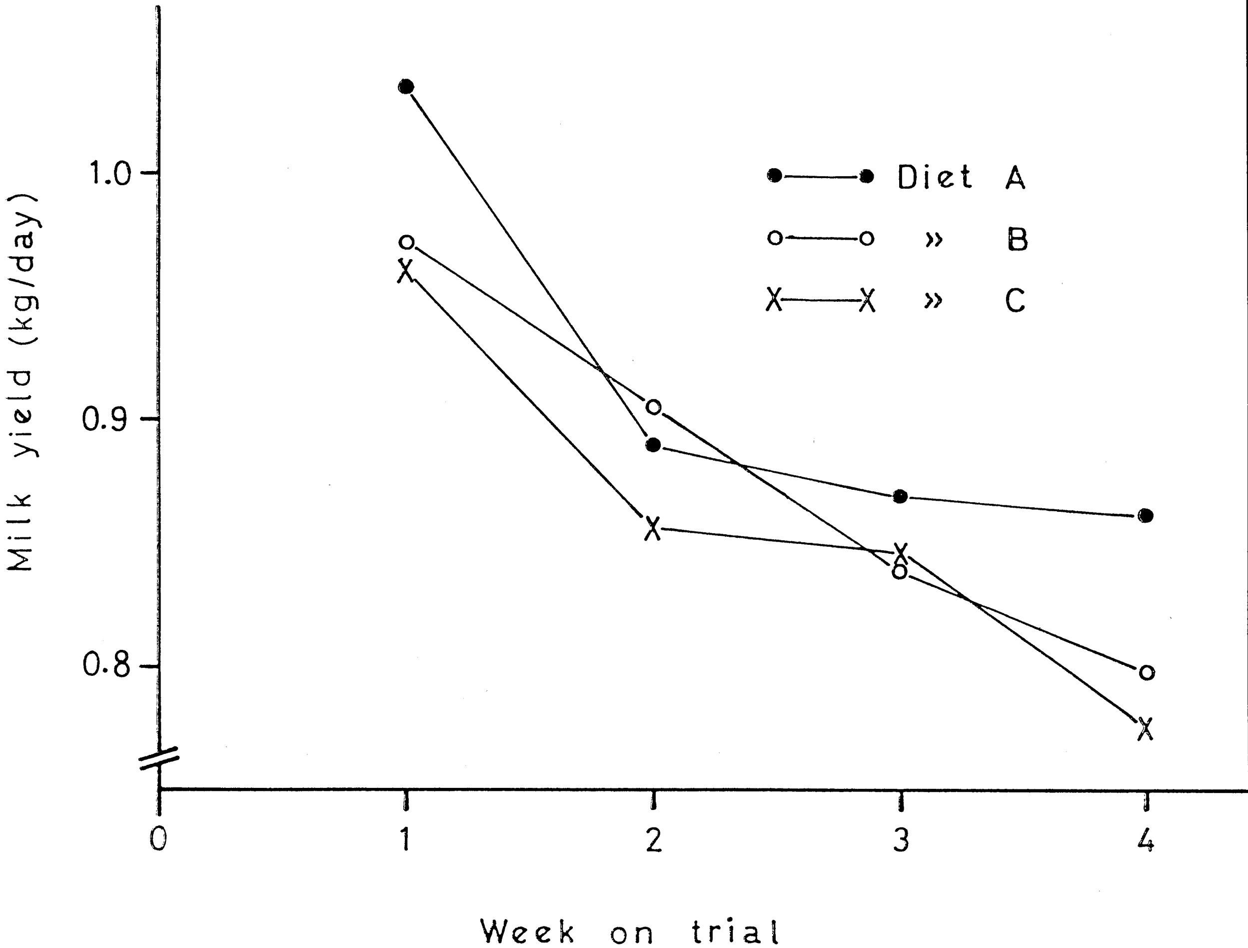

FIG. 1. Yield of milk produced by ewes during the 4-week experimental period.

Supplemental urea-N raised total CP content by 16 and 31g/kg of finished feed in diets B and C respectively. Chalupa (1973) postulated that NPN can be used to increase the CP content upto a level of 140g/kg, because some dietary protein normally escapes rumen degradation and does not contribute to the rumen NH_3-N. The daily crude protein and energy intake of ewes on the control diet were similar to the values suggested by the Agricultural Research Council (1965) lending support to the hypothesis that the crude protein content of the control diet was not in excess of requirements. Further support comes from the data of Papas (1977), who reported that a low level of CP (11.6%) in the ration depressed milk yield of Chios sheep at the declining stage of lactation.

Satter and Roffler (1975) divided dietary protein and energy combinations into three groups, i.e. those where added NPN would be utilized efficiently, partially or would not be utilized at all. The energy content of the diets used in this study was greater than 60% Total Digestible Nutrients implying that NPN would be only partially utilized. However, a somewhat higher degree of utilization was obtained since no significant differences among diets were detected for milk yield or fat content (Table 3). This is in agreement with the data of Knott *et al.* (1967), who reported that substituting urea for soyabean meal in concentrates fed to dairy cows did not significantly reduce milk production. On the other hand, Huber and Sandy (1965) reported an adverse effect of urea-N spplementation on milk yield, but not on milk composition. Assuming that the CP content of milk was the same for all three diets, the data presented in Table 4 show that supplemental urea-N was utilized with an efficiency of 0.85 compared to the control.

Rys' (1967) pointed out that the efficiency of urea utilization by low to average yielding dairy cows was higher than that of high yielding cows. High producing dairy animals are offered large quantities of feed of high dietary CP content. Such diets give rise to ruminal NH_3-N levels sufficient for maximal microbial growth. Any additional NPN in the diets of such animals is converted to NH_3-N. Excessive NH_3-N, however, cannot be utilized by the rumen microflora and is excreted via the kidney, representing a real nitrogen loss to the animal. Analysis of individual ewe responses to urea, showed that high producing ewes responded similarly to urea-N supplementation as lower producing animals contrary to the finding of Huber *et al.* (1972) with dairy cows. Overall, the rate of milk decline was the same during the 28-day experimental period for all three diets suggesting that the effect of urea was not significantly altered with time. This is in agreement with the data of Johnson and McClure (1964) and Georgiades *et al.* (1979), but is at variance with the data of King *et al.* (1965), who reported that urea utilization improved with time. The incorporation of urea in the concentrate mixture had no adverse effect on feed conversion efficiencies.

It may be concluded that urea can be used to furnish part of the total N in the diets of lactating Chios ewes at the declining stage of lactation. Without further experimental evidence, however, it would be hazardous to extrapolate from these findings to dairy sheep in early lactation, probably because of a much higher demand for specific amino acids, particularly sulphur amino acids, and higher CP content in their diets. At any rate, the feeding of urea may be justified only if it reduces costs.

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