

# EATING AND RUMINATION BEHAVIOUR IN SHEEP FED A HAY DIET WITH AN ORAL SUPPLEMENT OF UREA

T. Fujihara<sup>1</sup>, T. Ichinobe and T. Harumoto

Faculty of Agriculture Shimane University  
Matsue-shi 690, Japan

## Summary

The effect of orally supplemented urea on eating and rumination behaviour of sheep fed a low quality hay was investigated in this study. Daily time spent eating was not influenced by ruminal addition of urea, thus the eating rate (g DM/min) also did not change with urea supplementation. The rumination appearance (the lag time after eating) tended to be shorter with urea supplement than without supplement, but not significantly ( $p > 0.05$ ). Daily time spent ruminating was in the range of 600-630 min/d, and rumination index (ruminating time/100 g DM ingested) was 85 min on the average for all the treatments, but there were no significant differences among the values in each treatment. Daily number of rumination periods tended to be smaller with urea supplement than with no urea, but not significantly ( $p > 0.05$ ), and cyclic rate was almost constant in all the treatments. From these results, it may be concluded that an administration of urea in sheep receiving hay diet could have little effect on eating and rumination behaviour, when it was given at two times a day.

**(Key Words:** Hay Diet, Urea Supplement, Eating and Rumination Behaviour, Sheep)

## Introduction

It has been shown in ruminants that chewing during eating and rumination is closely associated with reducing the particle size of feed eaten and this obviously stimulates the microbial degradation in the rumen (Gordon, 1958; Welch and Smith, 1969). There are therefore many works which indicate a close relationship between the eating and rumination behaviour and roughage utilization in ruminants (Welch and Smith, 1969; Sudweeks et al., 1975; Fujihara, 1981a).

It is also well recognized that the chemical composition of ingested feed as well as its physical characteristics, such as a bulk, coarseness and/or fineness, clearly causes a change in chewing behaviour during eating and rumination. Formerly, Freer et al. (1962) have shown a reduced time spent eating and on rumination in cows when urea was supplemented to an oat straw hay, and then, suggested an important interaction between the chewing behaviour and microbial degradation which will be responsible for reducing the particle size of feed in the rumen. Hemsley and Moir (1963) have also reported a similar result in sheep.

According to Fujihara (1980), it has been suggested that an efficient rumination might induce an efficient utilization of dietary nitrogen in sheep offered roughage diet alone. Fujihara and Nakao (1984) have also shown that an oral casein supplement to sheep receiving hay diet could serve to reduce the time spent eating, although chewing during rumination is not directly affected. In the present study, the effect of oral urea supplement on eating and ruminating behaviour was investigated in sheep receiving a low quality hay alone, and the results obtained were compared with that of the previous experiment (Fujihara and Nakao, 1984). A part of the results obtained in this study was reported previously (Fujihara, 1993).

## Materials and Methods

Three Japanese Corriedale rams, each weighing 35-37 kg, were kept in metabolism cages throughout the experimental period, and fed a mixed hay composed of Italian ryegrass, cocksfoot and ladino clover, at a level of 1% (dry matter: DM) of body weight in each feeding at 09:00 and 17:00 hr. The chemical composition (as % DM) of mixed hay, determined by the AOAC method (1960), was as follows: organic matter, 93.9; crude protein, 8.2; crude fat, 2.0; crude fibre, 39.1; nitrogen free extract (NFE), 44.6; crude ash, 6.1. Three sheep were allotted to a 3 × 3 Latin square

<sup>1</sup>Address reprint requests to Dr T. Fujihara, Laboratory of Animal Science, Faculty of Agriculture, Shimane University, Matsue-shi 690, Japan.

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design to examine the effect of 3 levels of urea administration, i.e., 0, 15 and 30% of dietary nitrogen from hay. Half the daily dose of urea was orally given by drenching just after finishing each feed while water and salt licks containing trace minerals were accessible at all times. The 5-day sampling periods were preceded by 8-day preliminary periods. During the 5-day sampling periods the time spent chewing during eating and rumination was measured daily by the method of Fujihara (1980) using a wire strain gauge on the lower jaw (Harumoto and Kato, 1979). The terms used for indicating rumination behaviour were the same as in the previous report of Fujihara et al. (1989) based on the work of Gordon (1955).

### Results and Discussion

As shown in table 1, the daily time spent eating hay did not change with urea supplement, and consequently, the rate of eating hay was also similar in all the dietary treatments. The figures on time spent eating in table 1 were larger than those reported earlier with sheep fed Italian ryegrass (Fujihara, 1980) or cocksfoot hay (Fujihara, 1981a), and were very similar to that for timothy hay (Fujihara and Nakao, 1982). The difference in time spent eating hay diet has been thought to be due to a difference in forage species and/or quality in fresh or dried form as described previously (Fujihara and Nakao, 1982; Fujihara, 1981b,

1982). The previous result in sheep (Fujihara and Nakao, 1984) has shown that the time spent eating a mixed hay decreased with an increase in casein supplemented orally, and the rate of eating hay obviously increased with casein supplement, but not significantly ( $p > 0.05$ ). A similar observation has been made by Freer et al. (1962), in which cows were fed oat straw hay with an intraruminal infusion of urea. These findings suggest that the supplementation of casein or urea could be clearly used to stimulate the fermentation of ingesta in the rumen, and consequently, the energy cost of eating hay would be saved with the supplementation of some nitrogen sources. Although the energy cost of eating has been thought to be high per unit of DM ingested at a slow eating rate (Osuji et al., 1975), in the present experiment, the supplemented urea had little effect on the time spent eating hay and the rate of eating, i.e., added urea did not stimulate the ruminal fermentation of ingesta. A possible reason for non-positive effect of supplemented urea on reducing the time spent eating hay might be due to an inefficient utilization of urea as nitrogen source in the rumen, so that the effect of added urea nitrogen on the stimulation of microbial activity to reduce the food particles was very weak, i.e., a rapid degradation of added urea, and absorption of ammonia elaborated through the rumen wall, synthesis to urea in the liver, and finally excreted into urine (McDonald, 1948). Actually, the level of ruminal ammonia rapidly

TABLE 1. EATING AND RUMINATION BEHAVIOUR IN SHEEP FED HAY DIET AND ORALLY SUPPLEMENTED WITH UREA

Supplemented urea level (%) <sup>a</sup>	0	15	30
Time spent eating (min/day)	184.6 ± 23.0 <sup>b</sup>	173.2 ± 5.2	186.0 ± 9.5
Rate of eating (g DM/min)	4.0 ± 0.4	4.3 ± 0.2	3.9 ± 0.2
Rumination appearance (min) <sup>c</sup>	209.5 ± 48.3	175.7 ± 20.6	183.8 ± 21.6
Ruminating time (min/day)	600.4 ± 32.6	629.7 ± 26.1	602.5 ± 41.9
No. of boli regurgitated/day	552.8 ± 19.1	578.1 ± 3.8	555.6 ± 27.3
No. of rumination periods/day	29.4 ± 3.4	25.8 ± 3.6	26.5 ± 2.1
Cyclic rate (sec)*	65.1 ± 1.4	65.4 ± 2.8	66.4 ± 3.9
Length of rumination period (min)	21.1 ± 3.3	25.2 ± 3.1	23.0 ± 2.2
No. of boli per rumination period	19.3 ± 2.6	23.2 ± 2.8	21.1 ± 1.2
Rumination index (min)**	84.5 ± 3.3	85.5 ± 3.8	84.3 ± 6.4

<sup>a</sup> % of urea nitrogen to the dietary nitrogen from hay.

<sup>b</sup> Mean ± S.E. of 3 sheep.

<sup>c</sup> Lag time after eating.

\* Total rumination time (sec)/no. of boli regurgitated.

\*\* Time spent ruminating per 100 g DM eaten.

## EATING AND RUMINATION BEHAVIOUR IN SHEEP

increased after urea supplementation, and the urinary excretion also increased clearly with oral urea supplement in this study (Fujihara, 1993).

Rumination appearance (the lag time after eating) tended to be shortened with urea supplement compared with control, but not significantly ( $p > 0.05$ ) because quite big variations in the values among individuals was observed in control. In a previous paper (Fujihara et al., 1989), it was suggested that the bulk of feed ingested, as some physiological load, i.e., as a certain stimulus to a mechano-receptor on the rumen wall, could have an obvious effect on the lag time after eating, and then rumination after eating will be initiated more quickly by some mechanical stimuli than that by chemical stimulation in response to a chemo-receptor on the rumen wall (Fujihara and Nakao, 1990). In the present study, the same hay was used as a sole diet, and daily hay intake by sheep was similar, and then, it could be considered that as a certain stimulus to a mechano-receptor, which was mostly the same in both feedings of hay diet with or without urea supplement. Therefore, the difference in the lag time after eating hay alone and hay with urea supplement could be slightly due to some differences of chemical stimulation in response to a chemo-receptor on the rumen wall. From this observation, it could be suggested that when the mechanical stimuli, such as volume (or bulk) of feed ingested, does not differ largely, the response of the chemo-receptor on the rumen wall may be accelerated by an accumulation of chemical stimuli i.e., fermentation products (such as ammonia) in the rumen. In the present study, ruminal ammonia concentration was markedly increased after feeding hay with urea.

The daily time spent ruminating and daily number of boli regurgitated tended to increase slightly with oral supplementation of 15% urea nitrogen compared with those in control or 30% urea N supplement, but not significantly ( $p > 0.05$ ). The time spent ruminating was similar to that reported earlier, when the sheep were fed a low-quality hay (Fujihara, 1982) or a fibrous residue silage of broad bean with timothy hay (1:1, DM) (Fujihara and Nakao, 1982), and was fairly longer than for Italian ryegrass hay (Fujihara, 1980), timothy hay (Fujihara and Nakao, 1982) or cocksfoot hay (Fujihara, 1981a). According to Fujihara and Nakao (1984), the daily time spent ruminating increased slightly with an increase in the oral

supplement of casein, although the daily number of boli regurgitated did not change. Freer et al. (1962) reported, however, that the time spent ruminating decreased fairly in cows, when the intake of oat straw hay was restricted during the ruminal infusion of urea. In the present experiment, the time spent ruminating has not decreased with oral urea supplement, although the daily amount of hay intake by sheep was almost constant during urea treatment. As a result, it is clear that urea added had no effect on the time spent chewing during eating and rumination to comminute the ingested hay in the present study. The microbial degradation and the chewing activity during eating and rumination seems to be the main factors in reducing the food particles to a suitable size for passage from the reticulo-rumen (Freer et al., 1962). A possible reason for the uneffectiveness of administered urea on reducing the particle size of hay eaten may be a rapid degradation of urea added in the rumen, so that there will be little stimulation of microbial activity to reduce the feed particle as described above, because urea was given by drenching (as single dose) just after each feeding of hay in the present study. In these circumstances, it may be assumed that there will be a rapid degradation of urea, and ammonia production will be much more and at a faster rate than that microbes would be able to use for their body protein synthesis in the rumen, and accordingly, most of the ammonia would be absorbed directly through the rumen wall, and then will be excreted into urine as urea resynthesized in the liver (McDonald, 1948). As mentioned above, ruminal ammonia level and urinary nitrogen excretion was fairly high after feeding hay with urea supplement in the present study. It seems, therefore, that the utilization of urea supplemented could be much better when supplied in small quantities than when supplied in bulk as in this study.

The number of rumination periods per day tended to decrease a little with urea supplement, but not significantly ( $p > 0.05$ ). This will support in principle the suggestion that, the difference in daily number of rumination period could be clearly due to a difference of dietary treatment (Fujihara and Nakao, 1990). The cyclic rate, which was defined by Gordon (1955) as total rumination time (in seconds) per number of boli regurgitated, did not change with urea supplements, and the values are within a range reported earlier (Fujihara,

1982; Fujihara and Nakao, 1982) in sheep fed various hay diets. The rumination index also did not change with an addition of urea, and the figures were in a range reported for hay diets in the previous works (Fujihara, 1981a; Fujihara, 1982; Fujihara and Nakao, 1982).

From the results presented in this study, it could be concluded that an oral urea administered by drenching to sheep fed a hay diet could not save the time spent eating hay and on chewing during rumination, i.e., to stimulate the microbial activity in the rumen, when it was given at one time.

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