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Effect of timing to feed corn silage-based supplement for grazing dairy cows on intake, milk production and nitrogen utilization

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ABSTRACT

As herbage contains high ruminal degradable protein, the efficiency of nitrogen utilization is low in grazing dairy cows. Corn silage (CS) supplementation to grazing cows would be effective to reduce ruminal NH_3-N loss because its high content of easily digestible carbohydrate (NFC) will improve nitrogen capture by ruminal microbes. The timing to feed NFC supplement is important to maximize microbial growth. Four grazing Holstein cows were used to determine intake, milk production and nitrogen utilization when cows were fed CS-based ration 2 hours before grazing (Pre) or immediately after grazing (Post). Cows were grazed on pasture for 1700-1930 and 0530-0800. Herbage intake was estimated by the weighing technique. Total intake was not difference between Pre and Post as herbage intake was not different. Milk protein yield for Pre tended to be higher than that for Post, while milk yield did not differ between Pre and Post. Total nitrogen intake for Pre tended to be higher than that for Post. There was no difference in urinary nitrogen output between Pre and Post, while the ratio of urinary nitrogen output to total nitrogen intake for Pre was lower than that for Post. Milk nitrogen output and nitrogen retention for Pre were higher than that for Post ($P<0.06$). Therefore, the feeding CS-based supplement 2 hours before grazing would improve nitrogen utilization.

Keywords: timing of supplementation, CS, milk production, grazing cows

INTRODUCTION

For lactating dairy-cows, herbage from grazing is preferable feed which has high nutrient value with high protein and low fiber contents. On the other hand, as herbage has high degradation rate in the rumen, ingested nitrogen and energy is unbalanced in the rumen. When cows were fed herbage mainly, nitrogen utilization became low as high output of urinary nitrogen (Kolver, 2003). For grazing dairy-cows, improving nitrogen utilization leads high efficiency of milk production. In case of optimizing nitrogen and carbohydrate degradation rate in the rumen, nitrogen was more utilized by microbes in the rumen (Hoover and Stokes, 1991).

With conventional feeding procedure for grazing cows, a supplement is supplied separately herbage. Mcgilloway and Mayne (1996) pointed out the importance of manipulating the feeding time of supplement for grazing cows, which means synchronization of carbohydrate (CHO) degradation from supplement with protein degradation from herbage. Corn silage (CS) contains high non-fibrous carbohydrate (NFC), however a CHO degradation rate of corn grain contained in CS is slow (Nocek and Tamminga, 1991). It would be need a sufficient time for NFC degradation of CS to synchronize with protein degradation from herbage.

The objectives of the present study was to determine the effect of feeding CS-based supplement before grazing on intake, milk production and nitrogen utilization for grazing dairy-cows. Cows were fed the CS-based supplement 2 hours before grazing (Pre) or immediately after grazing (Post).

MATERIALS AND METHODS

The experiment was conducted as cross-over design. Cows were grazed twice a day (1700–1930 and 0530–0800) and were fed CS-based supplement 2 hours before grazing (Pre: 1500 and 0330) or immediately after grazing (Post: 1930 and 0800). Four multiparous Holstein dairy-cows were used for the experiment and the performances of cows were 30.1 ± 3.0 kg/day of milk yield, 646.3 ± 30.9 kg of live weight and 94.1 ± 64.1 days in milk at the beginning of the experiment.

A supplement was formulated every two weeks based on TDN requirement (Japanese Feeding Standards, 1999). An allowance of CS was subtracted TDN intake of herbage and concentrate from total TDN requirement. Expected herbage intake was calculated from herbage mass, and concentrate intake for each cow was 1 kg DM per 5 kg of milk yield. Chemical compositions of each diet is shown in Table 1.

Table 1. Chemical compositions of herbage, corn silage (CS) and concentrate (Conc.)

	Herbage	CS	Conc.
DM, %	23.4	26.9	85.9
Chemical compositions, % of DM			
CP	22.3	9.7	20.4
NDF	41.7	45.3	17.6
NFC*	18.3	29.7	49.7

*: NFC = OM - (CP + NDF + EE)

Herbage intake was measured by a weighing technique corrected with insensible weight loss (IWL: Penning and Hooper, 1985). Each cow was weighed immediately before (W_1) and after (W_2) grazing. Whole feces and urine were collected separately during grazing and weighed after grazing (feces: W_f, urine: W_u). IWL was measured by other two cows in similar to body weight and milk production as cows used in the experiment at the same time when the experimental cows were grazed. Two cows were weighed (W_3) and were turned out a bare paddock without accessing to feed and water. Then, two cows were weighed again 2.5 hours after turning out a paddock (W_4). The body weight loss was regard as IWL. Therefore, herbage intake was calculated as follows:

$$\text{Herbage intake (kg of fresh matter)} = W_2 - W_1 + W_f + W_u + (W_4 - W_3) \times T_1 / T_2$$

where T_1: duration of grazing for experimental cows (min), and T_2: duration of turning out a paddock for IWL cows (min).

Milk yields were recorded every each milking. Milk sample were collected and mixed consecutive p.m. and a.m. milking. Mixed milk samples were analyzed fat concentration with infrared spectrophotometer (Milko Scan C54A, Foss Electric, Denmark), and were measured milk protein content (nitrogen content x 6.38) according to Kjeldahl methods (AOAC, 1970).

Rumen fluids were collected with stomach tube on 1500, 2000, 0300 and 0800. Fluid samples were through two layers of cheese cloth. Samples were preserved at -20˚C before analysis. Frozen samples were thawed and determined NH_3-N and VFA by the indophenols reaction and the gas chromatography, respectively.

For calculating nitrogen utilization, whole feces and urine were collected with collection bags. Fresh feces sample were analyzed DM and nitrogen (AOAC, 1970). Urine samples were frozen and stored at -20˚C till analysis, then, were measured nitrogen (AOAC, 1970). Microbial-N flow to duodenum was predicted from purine derivatives excreted in urine (Chen and Gomes, 1992). The sum of allantoin and uric acid in urine were regarded as purine derivatives. Allantoin and uric acid in an acidify urine collected were measured by colorimetric methods (Chen and Gomes, 1992).

RESULTS AND DISCUSSION

Table 2 shows DM intake of each diet. DM intake of herbage did not differ with a change of the timing to feed supplement. There was no difference in CS intake between treatments. DM intake of concentrate for Pre was a little higher than that for Post. There was no difference in total DM intake between Pre and Post. Vaughan et al. (2002) reported that feeding partial mixed ration before grazing did not affect on herbage intake. The supplement did not almost affect herbage intake when time and/or herbage mass were restricted (Phillips, 1988, Bargo et al. 2002). In the present study, feeding CS-based supplement before grazing did not decrease herbage intake.

Table 2. Dry matter intake (kg/day)

	Pre	Post	P
Herbage	8.1	7.7	0.45
CS	5.9	5.4	0.62
Conc.	5.2	4.9	0.05
Total	19.3	18.1	0.23

Milk yield and milk composition are shown in Table 3. Milk yield and milk fat yield were no difference between Pre and Post. Milk protein yield for Pre tended to be higher than that for Post ($P = 0.08$). Milk fat content for Pre was lower than that for Post ($P < 0.01$). Milk protein content did not differ between treatments. The feeding supplement 2 hours before grazing did not make milk and milk fat yield increase but milk protein yield increase. In the other study (Moran and Jones, 1992; Kolver et al.

1998; Vaughan et al. 2002), there was no change in milk production with changing the feeding time of supplement for grazing cows as was the present study. For Pre group, cows may absorb amino acids much in the duodenum as milk protein production is affected by the amount of amino acids absorbed.

Table 3. Yields of milk and milk compositions

	Pre	Post	P
Yield, kg/day			
Milk	23.3	22.4	0.31
Fat	0.98	0.98	0.95
Protein	0.80	0.74	0.08
Milk composition, %			
Fat	4.2	4.5	<0.01
Protein	3.5	3.4	0.13

Figure 1 shows the variation of NH_3-N and VFA concentration in the rumen at four sampling time. NH_3-N concentration after grazing (2000 and 0800) were higher than that before feeding Pre supplement (1500 and 0300) ($P < 0.01$). However, the interaction of the feeding time to feed supplement (Treatment) and the sampling time (Time) was not significant in NH_3-N concentration. Similarly, the interaction of Treatment and Time was not significant in acetate and propionate concentrations. However, the interaction of Treatment and Time was significant in branched-fatty acids concentration ($P < 0.01$). A reaction of branched-fatty acids was differed between Pre and Post. The branched-fatty acids concentration for Pre was lower than that for Post at the sampling after grazing. Branched-fatty acids increase with an increase in degradation of protein in the rumen (Allison, 1970). For Pre, therefore, undegraded herbage protein passed from the rumen would increase as herbage degradation in the rumen delayed.

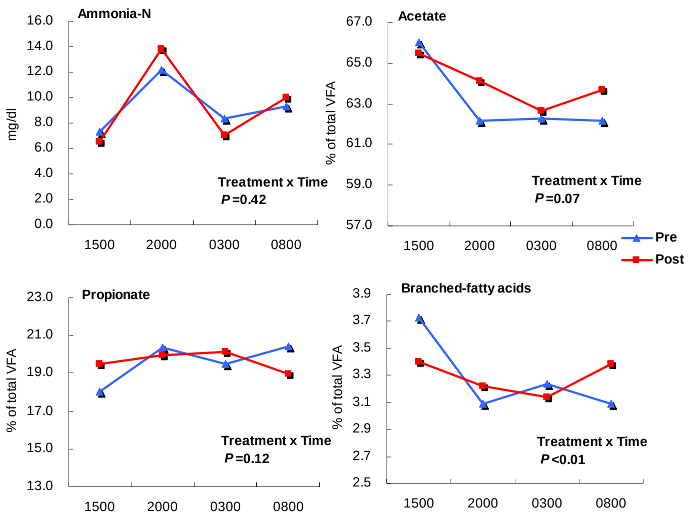

Figure 1. Ammonia-N and VFA concentration in the rumen at four sampling time

Nitrogen utilization and microbial-N flow to the duodenum are shown in Figure 2. Total nitrogen intake for Pre tended to be higher than that for Post. There were no difference in fecal and urinary nitrogen output between Pre and Post. Milk nitrogen output for Pre tended to be higher than that for Post. The ratio of urinary nitrogen output for Pre tended to be lower than that for Post. The ratio of utilizable nitrogen as milk nitrogen output plus nitrogen retention for Pre was higher than that for Post ($P < 0.01$). These results indicated that the efficiency of nitrogen utilization was improved by the feeding CS-based supplement before grazing. There was no difference in microbial-N flow between Pre and Post, while microbial-N flow for Pre was numerically higher than that for Post. Synchronizing carbohydrate degradation rate with protein degradation rate in the rumen increased microbial protein synthesis and decreased ruminal NH_3-N (Sinclair et al. 1993). Vaughan et al. (2002) suggested that a capture of ruminal-N increased by feeding a partial mixed ration before grazing, which was indicated by the low level of BUN.

As conclusion, the feeding CS-based supplement before grazing did not affect herbage intake and milk production, while increased milk protein yield. High microbial-N flow and/or high undegraded herbage protein passed from the rumen would lead to improve nitrogen utilization with the feeding CS-based supplement before grazing.

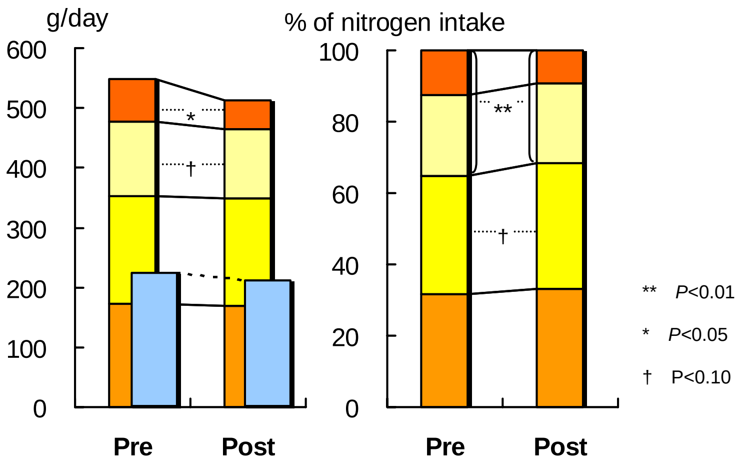

Figure 2. Nitrogen utilization and microbial-N flow to the duodenum (predicted by purine derivatives in urine)

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