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Effect of Feeding Frequency of a Total Mixed Ration on the Performance of High-Yielding Dairy Cows

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ABSTRACT

Forty Finnish Ayrshire cows, 16 primiparous and 24 multiparous, were randomly assigned to 1 of 2 treatments (FF1 or FF5). Total mixed ration (TMR) was fed once a day on the FF1 treatment and 5 times a day on the FF5 treatment. The experiment began at calving and continued to wk 28 of lactation. The TMR consisted of a grass silage and concentrate mix. The amount of concentrate in the TMR was 51% on a DM basis. The feeding frequency had no effect on milk or energy-corrected milk yields or on milk composition. The average energy-corrected milk yield was 32.8 kg/d on the FF1 treatment and 32.5 kg/d on the FF5 treatment. The less frequent feeding increased the dry matter intake (DMI) of cows. The average DMI during the experiment was 20.9 kg/d on the FF1 treatment and 19.9 kg/d on the FF5 treatment. The difference in DMI was due to the differences in DMI of the mature cows. Energy and protein conversion tended to be lower with feeding once a day compared with feeding 5 times a day. The cows' feeding behavior was also observed. Cows fed 5 times a day tended to eat quite evenly after each delivery, whereas on the FF1 treatment there were 2 clear feeding peaks in the evening after the feed delivery. The time spent eating during the observation period was longer on FF5 than on FF1. The cows fed once a day spent more time lying than the cows fed 5 times a day. Based on the observations of feeding behavior, feeding a TMR 5 times a day seemed to be too frequent based on the increased restlessness and decreased lying time of the cows.
Key words: feeding frequency, dairy cow, total mixed ration, milk production

INTRODUCTION

In Finland it is common practice to feed dairy cows a TMR once or twice a day to keep the labor cost to a minimum. However, feeding robots are available, allowing more frequent feeding with a limited labor requirement. These robots are quite an expensive investment, although the building cost of new cow barns can be reduced, because robots require less room than a tractor-pulled mixer wagon. The effect of feeding frequency on the performance of dairy cows has been examined in many studies. In a review of 35 experiments, Gibson (1984) concluded that increasing the feeding frequency of dairy cows to 4 or more times a day, compared with once or twice a day, increased the milk fat percentage by an average of 7.3% and increased milk production by 2.7%. In the studies reviewed, however, the feeding strategies varied from feeding concentrates separate from forages to feeding complete diets, so the results are not directly applicable to today's high-producing cows fed TMR.

More recent results with TMR feeding have been variable. In the studies by Shabi et al. (1999) and Le Liboux and Peyraud (1999), increasing the number of feedings from 1 to 2, to 4 to 6 increased the DMI of the TMR, but had no effect on milk production. Contrary to these results, in the study by Phillips and Rind (2001), the DMI and milk yield were higher with feeding once a day compared with 4 times a day. Phillips and Rind (2001) concluded that frequent feeding disturbed the cows and reduced milk production. In their study the cows were housed in a free-stall barn, whereas in the studies by Shabi et al. (1999) and Le Liboux and Peyraud (1999), the cows were stanchioned. The housing type can change the feeding behavior (Albright and Arave, 1997) and therefore alter the effect of feeding frequency on the cows' performance. The feeding behavior of high-yielding cows has also been shown to differ from the behavior of low producers (Grant and Albright, 1995). Thus, the milk-producing capacity of the cow can influence its response to different feeding frequencies. This experiment was conducted during the indoor period to examine how feeding frequency of a TMR might affect the feed intake, milk production, and feeding behavior of high-yielding cows housed in a free-stall barn.

MATERIALS AND METHODS

Animals and Experimental Design

Forty Finnish Ayrshire cows, 16 primiparous and 24 multiparous, were blocked by projected date of parturi-

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Table 1. The chemical composition and estimated feed values of the ingredients and TMR (mean ± SD)

Item	Grass silage	Concentrate mix[1]	TMR
Chemical composition			
DM, %	25.2 ± 2.6	88.3 ± 0.6	39.6 ± 3.4
In DM, %			
Ash	7.5 ± 0.6	6.8 ± 0.4	7.1 ± 0.3
CP	14.8 ± 0.6	19.1 ± 0.7	17.0 ± 0.4
Ether extract	ND[2]	5.3 ± 0.4	4.7 ± 0.1
NDF	51.2 ± 4.4	22.7 ± 1.6	36.9 ± 2.1
Starch	ND	35.2 ± 3.3	18.3 ± 1.7
Digestible OM	70.6 ± 1.7	ND	ND
Water-soluble carbohydrates	5.7 ± 1.9		
Lactic acid	7.3 ± 1.3		
Acetic acid	2.2 ± 0.5		
Butyric acid	0.02 ± 0.02		
pH	3.97 ± 0.15		
Ammonia-N, g/kg of N	73 ± 6.7		
Soluble N, g/kg of N	571 ± 70.6		
Feed values in DM			
ME,[3] MJ/kg	11.3 ± 0.3	12.5 ± 0.06	11.9 ± 0.09
AAT,[4] g/kg	86 ± 1.6	116 ± 1.1	101 ± 0.9
PBV,[5] g/kg	1 ± 6.3	6 ± 5.6	4 ± 3.3

[1]A mix (% in DM) of barley (60.6), rapeseed meal (27.0), molassed sugar beet pulp (10.0), and mineral and vitamin mix (2.4).

[2]Not determined.

[3]Metabolizable energy (MAFF, 1975, 1984).

[4]Amino acids absorbed from the small intestine (MTT, 2004).

[5]Protein balance in the rumen (MTT, 2004).

tion and parity (primiparous or multiparous) and randomly assigned to 1 of 2 treatments (**FF1 or FF5**) differing in feeding frequency. In the FF1 treatment the TMR was fed once a day, and in the FF5 treatment it was fed 5 times a day. The experiment began at calving and continued to wk 28 of lactation. The average age and weight after calving were 24.5 mo and 586 kg for the primiparous cows, and 47.9 mo and 636 kg for the multiparous cows.

Feeds, Feeding, and Housing

All cows were fed the same TMR, which consisted of a grass silage and concentrate mix (Table 1). The amount of concentrate in the TMR was 51% on a DM basis. The grass silage used was prepared from primary-cut timothy (*Phleum pratense*) and meadow fescue (*Festuca pratensis*) sward wilted for 1 to 2 h. A formic acid–based additive (5 L/t) was used at ensiling. The concentrate mix contained, in DM (%), barley (60.6), rapeseed meal (27.0), molassed sugar beet pulp (10.0), and mineral and vitamin mix (2.4). The mineral and vitamin mix (Suomen Rehu Ltd., Helsinki, Finland) contained (g/kg) calcium (210), phosphorus (2), magnesium (100), sodium (100), selenium (0.02), vitamin A (13,000 IU/kg), vitamin D (81,000 IU/kg), and vitamin E (470 mg/kg).

The cows were housed in a 2-compartment free-stall barn. Cows on different treatments were placed in different compartments, which were separated by a milking parlor. Cows in different compartments were not able to see each other; therefore, the more frequent feeding of the FF5 group did not disturb the cows in the FF1 group. The cows were fitted with transponder collars that allowed identification in the milking parlor and feeding place. Each cow had an individual feeding place with free access to the TMR through computerized gates (RIC Access Doors; Insentec, Marknesse, The Netherlands). The TMR was mixed in a mixer wagon (Junkkari Ltd., Ylihärmä, Finland), and the feeding was carried out by a feeding robot (TR Feeding Robot; Pellonpaja Ltd., Ylihärmä, Finland). In the FF1 treatment, feeding took place at 1600 h and in the FF5 treatment at 0800, 1320, 1430, 1800, and 1940 h. The gaps between feedings on the FF5 treatment were not uniform because of the feeding schedule of the other animals. To ensure ad libitum feeding, at least 5% daily refusals were required.

Measurements, Sampling, and Analysis

The amount of TMR offered was recorded automatically each day and TMR intakes were measured by recording the orts with an accuracy of 0.5 kg (fresh weight). A sample of the grass silage was taken twice a week. The subsamples were combined to give a 2-wk sample for analysis. Samples were stored at –20°C. Thawed samples were analyzed for DM, ash, CP, NDF,