

Effect of Rumen Protected Methionine on Lactational Performance of Dairy Cows

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ABSTRACT : Thirty-six Holstein dairy cows were used to evaluate the effect of a rumen protected methionine supplement (RPMet). The cows were divided into two groups of 18 each (control/experimental). The experimental group was given 15 g/d of RPMet (Mepron[®]M85, Degussa) from the 4th to the 26th week postpartum. All cows were fed a similar amount of forage including alfalfa silage, corn silage and timothy silage. Concentrate mixture was offered in proportion to the milk yield of each cow. Sufficiency of major metabolizable AAs was checked. Milk yield and milk composition was monitored for each individual cow. A metabolic profile test (MPT) was carried out at the 7th, 11th and 21st week postpartum. Without supplement, both methionine and leucine fell short of the daily requirement. Supplementation with 15 g/d RPMet was calculated to be within a sufficient margin of safety. Milk yield tended to remain higher in the supplemented group than in the controls during supplementation with RPMet. The differences in weekly milk production at the 17th, 18th, 19th and 22nd weeks postpartum were significantly high in the RPMet group ($p < 0.05$). The average 305-d milk yield and the percentages of milk fat, milk protein and solids-not-fat were not affected by the treatment. No differences were observed in either the somatic cell count in the milk or the reproductive status. Judging from MPT, all the cows were in good health during lactation. (*Asian-Aus. J. Anim. Sci.* 2000. Vol. 13, No. 9 : 1235-1238)

Key Words : Rumen Protected Methionine, Milk Production, Metabolic Profile Test, Dairy Cows

INTRODUCTION

The milk yield of dairy cows has been increasing year by year, and satisfying the nutrient requirement for such high performing cows has become a matter of importance. Recently, amino acids (AA) have drawn attention in the formulation of feed for lactating cows. In ruminants, because proteins and AAs are degraded and resynthesized as microbial protein in the rumen, the ratio of AA in the diet will be considerably changed. Although it is difficult to estimate the ratio of metabolizable AA in the small intestine, methionine has been identified as one of the first limiting AA in popular diets for lactating dairy cows (Schwab et al., 1976; Pisulewski et al., 1996). Therefore, rumen protected methionine (RPMet) has attracted attention in improving the balance of AA in the diet.

Many researchers have noted the effects of RPMet supplement. Supplemental RPMet enhanced production of milk protein (Casper and Schingoethe, 1988; Pisulewski et al., 1996; Armentano et al., 1997; Dinn et al., 1998), milk yield and milk protein content (Illg et al., 1987) and yield of 3.5% fat corrected milk and milk fat (Overton et al., 1996). On the other hand, supplementation with RPMet has also been reported to have had no effect (Papaz et al., 1984; Overton et al., 1998). The results of these studies differ, and the value of RPMet is not yet clear.

The purpose of this experiment was to evaluate the

effect of supplementing RPMet on the milking performance, reproductive ability and metabolic and nutritional status of dairy cows through a metabolic profile test.

MATERIALS AND METHODS

Thirty-six Holstein dairy cows kept in the research farm of Rakuno Gakuen University were used in this study. All cows were fed a similar amount of forage comprising alfalfa silage (CP 16.9%, NDF 48.5%, DM basis), corn silage (CP 7.4%, NDF 48.7%) and timothy silage (CP 10.2%, NDF 64.9%). Five kg of each forage was supplied each day. A commercial concentrate mixture for dairy cow (CP>16.0%, TDN>73.0%) was offered 1 kg per 3 kg of the milk yield (an average of 7 kg DM). The average proportion of roughage in the diet was around 70%. The composition of CP in the total diet was 16.2% DM, with undegradable protein in the CP at 28.3% (calculated by Degussa). The intake of individual cow could not be measured because the design of the bank was inadequately for collecting leftovers. The cows were allocated into one of two groups (18 each) over a three-week period according to volume of milk production. The experimental group was then given a methionine supplementation of 15 g/d. Topdressing with methionine supplement (RPMet; Mepron[®]M85, Degussa) was carried out once daily from the 4th through the 26th week postpartum. Analysis of AA composition in the ration, amount of AA supplied to the small intestine and requirement and sufficiency of major metabolizable AA was checked using the

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Degussa system (The Degussa Metabolizable Amino Acid Program for Dairy Cow Nutrition. Ver. July 1994, Degussa). To calculate the requirement for AA, milk yield and milk protein concentration were set at 36 kg/d and 3.30%, respectively. The amount of AA supplied from the diet was based on a combination of 15 kg DM/d of roughage and 7 kg DM/d of concentrate. Milk yield was recorded every day. Milk composition was analyzed every month for each individual cow entrusting the Hokkaido Dairy cattle Milk Recording Association. Blood samples collected from the jugular vein were taken from all cows at the 7th, 11th and 21st week postpartum, and a metabolic profile test (MPT) was carried out according to the method recommended by The Federation of Hokkaido Agricultural Mutual Aid Associations.

The differences in mean values between the control and experimental groups were compared using a t-test.

RESULTS AND DISCUSSION

Without the RPMet supplement, it was calculated that methionine and leucine in the total ration fell short of the lactational requirement by 15 and 5%, respectively (table 1). Many researchers (Illg et al., 1987; Pisulewski et al., 1996; Armentano et al., 1997) have indicated that methionine was the first limiting AA in milk production, and the same result was predicted in this study. The RPMet in this experiment was expected to compose of 85% DL-methionine, and have an 85% probability of escaping from the rumen (analyzed by Degussa). Therefore, we calculated that about 10.8 g/d of methionine from 15 g/d of RPMet would reach the small intestine and be metabolized. Accordingly, 15 g/d of RPMet should be expected to provide 100% of methionine requirement when added to the dietary methionine (table 1).

Weekly milk production in the two groups is presented in figure 1. There was no difference in milk yield between the two groups during the first 3 weeks postpartum (pretreatment). However, milk yield tended to remain higher in the supplemented group than in the control group after commencement of supplementation with RPMet. The differences in weekly milk yield between the two groups at the 17th, 18th, 19th and 21st week postpartum were statistically significant ($p < 0.05$). Terminating supplementation with RPMet depressed milk yield to the level of the control group within a few weeks. The lactation curve indicates that milk yield in the supplemented group did not fall as rapidly as in the control group in the weeks postpartum. This results supports past studies (Illg et al., 1987; No et al., 1988; Han et al., 1996). Illg et al. (1987) offered RPMet to dairy cows from the 4th week postpartum and reported a response in milk yield in the supplemented group, which stayed higher than

Table 1. The requirement¹ for and supply² of metabolizable amino acids and their sufficiency

Amino acid	g/kg of milk	Requirement (g)	Supply (g)	Sufficiency (%)
Met	1.27	53	45	84.9
Lys	3.82	161	161	100.0
Leu	4.62	190	180	94.7
Ile	2.55	105	118	112.4
Thr	2.22	94	109	116.0
Val	2.97	122	125	102.5

¹ For milk yield of 36.0 kg/d and 3.30% milk protein.

² Predicted value in case of 15 kg DM roughage with 7 kg DM concentrate.

that of the control group throughout the experimental period. Likewise, No et al. (1988) found that rumen-bypass methionine prevented a decline in milk yield. Illg et al. (1987) concluded that a lack of absorbed methionine limited milk production, and that when methionine supplement was offered, milk yield increased.

Milk production and reproductive characteristics are shown in table 2. The total milk yield during both dose period and 305-d in the supplemented group tended to increase without statistical significance. Milk fat, milk protein and solids-not-fat content were not

Table 2. Milk yield, milk composition, somatic cell count and reproductive characteristics for the controls and the supplemented group (Met)¹

	Control	Met	SEM ⁴
Milk yield, kg			
Dose period ²	5021.4	5267.8	137.0
305-d	8622.9	9135.9	263.7
Fat ³			
%	3.93	3.98	0.06
kg	197.4	203.5	4.9
Protein ³			
%	3.26	3.26	0.04
kg	163.5	150.2	6.5
Solids-not-fat ³			
%	8.83	8.82	0.05
kg	443.5	414.2	11.9
Somatic cell count ³ , 10000/ml of milk	13.0	10.9	3.3
Days open	117.6	117.9	7.2
No. of Artificial insemination	2.2	2.2	0.2

¹ Supplied with 15 g/d of rumen protected methionine.

² Means of samples taken from the 4th to the 26th week postpartum.

³ The data of dose period.

⁴ Standard error of the mean.

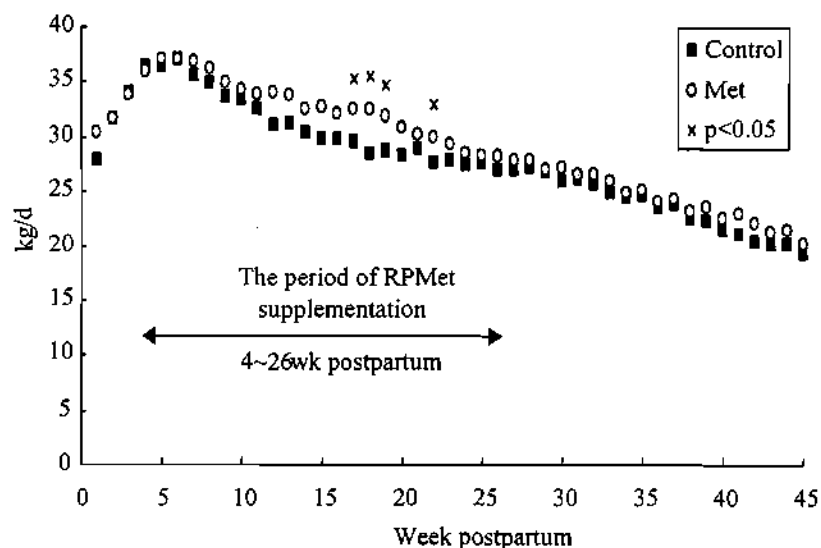


Figure 1. Milk yield of cows supplied either 0 g/d (control) or 15 g/d of rumen protected methionine (Met)

affected by the treatment. Production of these milk components tended to be higher in the supplemented group, but the difference was not significant. The RPMet supplement had a short-term effect on milk yield, and there was no significant effect on total milk production through the experimental period. Other researchers (Papas et al., 1984; Yang et al., 1986) have indicated that RPMet has no effect on milk production. Papas et al. (1984) offered RPMet (0, 157, 315, 472 and 630 mg/kg) to Holstein cows in early lactation for 3 weeks, and found no change in on milk production. They suggested that methionine may be co-limiting along with another AA, or that short-term trials may not be accurate predictors of long-term effects on dairy cows. This suggests that other AAs, especially lysine, might be more limiting than methionine on milk production in Holstein (Yang et al., 1986; Illg et al., 1987) or Jersey cows (Bertrand et al., 1998). Because RPMet was supplemented over 22 weeks in our experiment, the influence of feeding time would probably have been negligible. Calculated lysine requirement was sufficient in this study (table 1), but leucine tended to be slightly deficient. It might be possible that a lack of leucine also is limiting milk production along with methionine. Similarly, in another study, methionine supplementation improved methionine status in the blood, but milk production did not increase (Yang et al., 1986). Wu et al. (1997) interpreted these results as indicating a reduction in the efficiency of utilization of supplemental AA in the mammary gland in milk production. When discussing a factor in the variability published responses, it should be added that the effective protection of commercial rumen protected AAs will be the various level.

No differences were observed in either somatic cell

counts in the milk or reproductive status (table 2). The reason why RPMet supplement showed no improvement in this study may have been that the values in the controls were higher than those found in cows on the average dairy farm in Hokkaido. In any case, the relation between supplemental AA and milk quality or reproductive status is very important for field application. However, only several investigations have been found any effect from AA supplementation on these factors (Donkin et al., 1989; King et al., 1991; Han et al., 1996).

Table 3 gives the metabolic profile for each group. There are no abnormal values for any parameter (Payne et al., 1970; Ohgi et al., 1989), although some parameters show a difference ($p < 0.05$) between the control group and the experimental group. MPT clearly shows that the treatment had no excessive influence on metabolism, and the nutritional and physiological status of both groups was good. Nonesterified fatty acid concentration was higher in the supplemented group than the controls at the second MPT (the 11th week postpartum, $p < 0.05$). This result reflects in the active lipolysis because of the increase in milk yield in the supplemented group during the experimental period. No difference was found in concentration of blood urea nitrogen in either group, although total AA intake increased in the supplemented group compared with the control group. It is suggests that RPMet little degraded in the rumen and it might result in higher efficiency of use of other AAs.

CONCLUSION

Supplementation with rumen protected methionine resulted in a significant but a temporary effect on the continuity of milk yield from the peak to middle

Table 3. Metabolic profiles of blood samples taken from both groups at the 1st, 2nd and 3rd samplings

	1st ¹			2nd ²			3rd ³		
	Control	Met	SEM ⁴	Control	Met	SEM	Control	Met	SEM
Hematocrit, %	27.1	27.1	0.4	30.8	30.6	0.9	31.0 ^a	29.4 ^b	0.4
Total protein, g/dl	8.0	8.2	0.1	8.2	8.4	0.1	8.1	8.2	0.1
Blood urea nitrogen, mg/dl	14.1	13.9	0.4	14.7	15.4	0.3	15.9	16.5	0.4
Glucose, mg/dl	61.3	62.2	1.0	66.1	67.8	0.8	68.1	66.5	0.7
Nonesterified fatty acid, μ Eq/l	92.3	95.9	5.1	84.2 ^a	102.6 ^b	4.4	96.9 ^a	80.7 ^b	2.6
Ca, mg/dl	9.9	9.9	0.1	10.1	10.1	0.05	10.1	10.2	0.1
Inorganic phosphorus, mg/dl	5.6 ^a	4.9 ^b	0.1	5.3	5.3	0.1	5.2	4.8	0.1
Mg, mg/dl	2.54	2.62	0.04	2.62	2.75	0.04	2.7 ^a	2.6 ^b	0.03
γ -glutamyltranspeptidase, IU/l	21.0	19.7	1.1	20.3	21.0	0.8	20.5	21.9	0.8
Glutamic-oxaloacetic transaminase, IU/l	86.6	82.4	2.0	82.6	82.3	1.5	83.3	81.6	1.9
Total cholesterol, mg/dl	200.8	202.9	6.6	206.9	223.7	7.0	211.3	225.5	7.0
Free cholesterol, mg/dl	43.9	44.4	1.5	45.3	48.7	1.6	45.9	49.3	1.6

^{a,b} Significantly different ($p < 0.05$).¹ The 7th week postpartum, ² The 11th week postpartum, ³ The 21st week postpartum.⁴ Standard error of the mean.

lactation period under the feeding regime in this experiment. However, over the total lactation period, although there was a slight increase in yield of milk, milk fat, milk protein and solids-not-fat, the effect of supplementation was not significant.

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