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The effect of by-pass methionine supplement served before and after calving on milk yield and physiological parameters in dairy cows

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Introduction

At the beginning of lactation, the milk production of high-yielding dairy cows increases faster than their intake of nutrients. Nutritional imbalance and particularly energy deficiency occur and negatively affect the synthesis of microbial protein and amino acid supply (Schwab et al., 1992; Pisulewski et al., 1996).

Methionine and lysine are considered as first limiting amino acids in nutrition of dairy cows. As for methionine, its presence is limiting especially when a diet contains only a small amount of maize silage and a higher proportion of fodder crops or when undegradable protein originates mainly from soybean products. With respect to rumen fermentation it is necessary to use such forms of amino acids that are not subject to rumen degradation and at the same time are easily digested in the small intestine.

One of possible solutions is to use specially protected amino acids. In addition to positive effects on milk production, it was suggested that these products also positively influence other physiological functions which may result in a desirably reduced stress of liver metabolism and improved fertility. High rumen concentrations of protected methionine and lysine fed at the beginning of lactation may reduce the risk of metabolic disorders (Xu et al., 1998). Mentioned problems mostly arise in the process of body fat utilisation and subsequent degradation of ketone compounds during which the liver tissue is extremely overloaded.

Material and methods

Totally 36 high yielding Holstein and Czech Fleckvieh dairy cows were involved in the group experiment. The trial was initiated 21 days before calving. The cows were allotted to two groups (18 cows in each group) fed diets differing in the supplement of by-pass methionine. Whereas the group "M" received 18.2 g of methionine in concentrates, no supplement was fed to animals of the group "0".

After calving, each group was subdivided into two sub-groups (9 cows in each sub-group) either with or without methionine supplementation.

The experimental design was following:

Groups before calving	M*		0**	
Groups after calving	MM	M0	0M	00

*M = addition of by-pass methionine
**0 = no by-pass methionine added

The production ration has been fed *ad libitum* since the 8th day after calving as TMR and consisted of maize silage, sugar beet silage, alfalfa hay, fresh bewery grain, LKS (ground corn cobs+bracteas mixture silage) and concentrates with fat and mineral supplements.

The ration has been provided using electronically controlled feeding troughs. TMR intakes by individual cows as well as the amounts of different feed components entering the mobile feed mixer were automatically recorded.

Starting approximately three weeks and subsequently every week before the expected term of calving, samples of blood from *vena jugularis* and samples of rumen liquid with use of probang were collected from six cows approx. 2.5 hours after morning feeding. Blood and rumen liquid were also collected on days 1, 2-3, 4-6 after calving and then in three weeks intervals. At the times of collections the live weights of cows were also recorded.

Milk yields were recorded for each milking. Milk samples for the analysis of milk components were collected once a week. The experiment was terminated after 90 days in milk.

Objective

The objective of the study was to determine the effect of by-pass methionine fed during the late dry period and early lactation on milk production, physiological functions, health status and reproduction parameters of high yielding dairy cows.

Results and discussion

Dry matter intake before calving was not positively influenced by additional methionine (12,444 and 10,680 g for groups 0 and M, respectively). Similarly, feed intake was not higher in cows receiving methionine in any of the experimental periods after calving. In contrast, the highest average dry matter intake for 90 days of lactation was observed in 00 cows with no added methionine in the diet (20,650 g). The lowest intake before calving (10,410 g) and after calving (17,396 g) was found in MM cows receiving methionine both before and after calving. The average dry matter intake of M0 and 0M after calving was 18,623 and 18,947 g, respectively.

Milk production adjusted to FCM (Table 1) was higher in sub-groups receiving methionine. The highest average FCM production was observed in cows receiving methionine both before and after calving. The MM cows produced on average 2.28 kg FCM (32.42 kg/head/day) more than 00 cows and were followed by the 0M cows receiving methionine after calving (31.29 kg/head/day) and the M0 cows (30.89 kg/head/day). The 00 group (without methionine) only produced 30.14 kg FCM/head/day due to a low fat content in milk (3.32 %). The rank of different groups according to milk fat yield was MM, M0, 0M and 00. The average daily milk production of the MM cows (34.84 kg) was by 1.29 kg higher than in the 00 animals (33.55 kg) and by 2.52 kg higher than in the M0 (32.32 kg). The 0M cows ranked second with the average milk production 33.62 kg. Milk yield and FCM of animals receiving methionine after calving were significantly higher ($P<0.01$) than in cows with no supplemented methionine.

Table 1: Average milk production

TRAIT		**Group**			
		MM	**M0**	**00**	**0M**
Milk yield	***kg/head/day***	34.84	32.32	33.55	33.62
Fat content	***%***	3.54	3.70	3.32	3.54
Fat yield	***kg/head/day***	1.23	1.20	1.11	1.19
FCM yield	***kg/head/day***	32.42	30.89	30.14	31.29
Protein content	***%***	3.11	3.22	3.04	3.12
Protein yield	***kg/head/day***	1.08	1.04	1.02	1.05
Lactose content	***%***	4.90	4.95	4.93	4.97
Lactose yield	***kg/head/day***	1.71	1.60	1.66	1.67
Urea concentration	***mmol/l***	4.8	4.4	4.6	4.9

Milk protein content was lowest (3.04 %) in the 00 group without methionine. The addition of methionine in any of the experimental periods resulted in an increased concentration of milk protein. Similarly, significantly enhanced content and yield of milk protein as well as increased concentrations of methionine in milk due feeding protected methionine were reported by Robert and al. (1996) and Robinson et al. (1996). With respect to increase of fat yield, feeding methionine both before and after calving (MM) was found as the most efficient (1.08 kg). Fat yields in the M0 and 0M groups were intermediate and the lowest content of fat was observed in the 00 cows (1.02 kg). Fat content was also higher in the animals receiving methionine. Sloan (1995) reported 0.12 % increase of fat content when TMR was supplemented with 13 g/head/day of Smartamine M. Milk urea concentrations were similar in different groups. They were only slightly higher in MM and 0M animals (4.8 and 4.9 mmol/l, respectively) and ranged slightly above the physiological optimum. Glucose concentrations (Table 2) in blood serum before calving were increased more in M than in 0 cows (by 0.26 and 0.09 mmol/l, respectively). After calving (Table 3), the concentration of glucose was markedly higher until the day 3 after calving in the MM cows. It may be associated with their higher milk production but also with the addition of methionine to the diet. Methionine as well as other amino acids can be converted to oxalacetate as the starting substrate for gluconeogenesis. It was reported that as much as 10 % (and even more) glucose can be formed from deaminated amino acids. While in animals receiving methionine (M) the protein concentrations in blood slightly increased, these concentrations were considerably reduced in 0 cows. The concentration of urea increased before calving in both groups but this increase was higher in 0 than in M animals (by 0.52 and 0.31 mmol/l, respectively). After calving, most urea concentrations were above the reference values and only the average of the M0 group (4.86 mmol/l) was within the optimum physiological levels. The highest values were observed in groups 0M and MM receiving methionine after calving (6.59 and 5.89 mmol/l, respectively). Both before and after calving, the highest cholesterol concentrations were exhibited when methionine supplemented diets were fed.

Table 2: Average values of blood parameters in cows before calving

TRAIT	**Group**	**Period of sample collections**		
		during 3rd weeks	**during 2nd weeks**	**during 1st week**
Glucose (mmol/l)	***M***	3.81	4.06	4.07
	0	3.95	3.92	4.04
Proteins (g/l)	***M***	64.16	68.78	66.23
	0	66.07	59.88	51.79
Urea (mmol/l)	***M***	4.71	4.88	5.02
	0	4.59	4.81	5.11
Cholesterol (mmol/l)	***M***	1.76	1.81	1.49
	0	2.07	2.03	1.63
Lipids (g/l)	***M***	1.75	1.71	1.66
	0	1.78	1.78	1.68
Calcium (mmol/l)	***M***	2.73	2.65	2.49
	0	2.59	2.72	2.68
Magnesium (mmol/l)	***M***	0.87	0.82	0.82
	0	0.83	0.81	0.86
Phosphorus (mmol/l)	***M***	1.84	1.88	1.86
	0	1.99	1.88	1.86

Concentrations of NEFA (non-esterified fatty acids) in blood serum of cows in late pregnancy were low and the values were within the physiological range. Forthcoming calving, however, resulted in their increasing. The average values were higher in cows receiving methionine before calving. Although the average value 1 week before calving in the M group was almost twofold in comparison with the 0 group, the difference was not significant. At the day of calving and in the early lactation stage, the observed concentrations of NEFA were high in all animals. Relatively high concentrations of this metabolite indicating the process of lipomobilisation persisted for two weeks and afterwards they were considerably reduced in all groups.

Concentrations of BHB in blood serum in the third and second weeks before calving were low and within the physiological range. They were increased with forthcoming calvings particularly in the cows with no methionine supplementation. The observed average value 0.752 mmol/l was beyond the physiological range. Such a value may indicate the initiation of sub-clinic ketosis. In the period *post partum* the concentration of BHB was gradually increased and in most cases exceeded the physiological range in the first week after calving. Subsequently the concentration was again reduced and the values reached the physiological range in the third or fourth week of lactation. These findings suggest that the period of negative energy balance was only short and was accompanied by steatosis of liver and sub-clinic ketosis. The used diet relatively quickly prevented further development of ketosis in the early *post partum* period.

Table 3: Average values of blood parameters in cows after calving

TRAIT	**Group**	**Time of sample collections**					
		1st day	**2nd–3rd day**	**4 -6th day**	**2nd week**	**3rd week**	**4th week**
Glucose (mmol/l)	*MM*	4.62	5.00	3.48	3.19	3.43	3.55
	M0	4.15	0.00	3.63	3.43	3.65	3.34
	0M	4.13	4.24	3.43	3.28	3.67	3.59
	00	3.73	4.33	3.51	3.39	3.37	3.50
Proteins (g/l)	*MM*	63.30	74.40	71.26	66.95	72.82	74.43
	M0	59.02	0.00	70.48	58.41	66.11	55.49
	0M	68.87	70.05	70.76	81.34	75.33	76.42
	00	82.45	49.91	70.71	76.18	86.75	72.27
Urea (mmol/l)	*MM*	5.01	5.97	4.34	6.03	6.90	7.11
	M0	4.54	0.00	4.48	5.12	4.77	5.41
	0M	6.06	5.39	5.86	5.62	8.38	8.25
	00	6.13	3.98	5.07	6.55	5.39	5.56
Cholesterol (mmol/l)	*MM*	1.26	1.42	1.22	1.26	1.98	2.59
	M0	2.16	0.00	1.29	2.66	3.09	2.49
	0M	1.66	1.41	1.81	1.84	2.27	2.39
	00	2.29	3.49	2.18	2.57	1.40	4.63
Lipids (g/l)	MM	1.35	1.49	1.48	1.86	2.02	2.57
	M0	1.91	0.00	1.51	1.78	2.00	2.49
	0M	1.61	1.54	1.86	1.69	232	2.80
	00	1.78	2.51	1.87	2.30	2.25	2.58
Calcium (mmol/l)	MM	2.11	2.00	2.45	2.60	2.58	2.66
	M0	2.67	0.00	2.29	2.20	2.56	2.49
	0M	2.25	2.00	2.78	2.57	2.62	2.61
	00	2.29	2.45	2.61	2.61	2.21	2.84
Magnesium (mmol/l)	MM	0.82	0.90	0.70	0.79	0.91	1.00
	M0	0.74	0.00	0.69	0.76	0.82	1.02
	0M	0.94	0.80	0.73	0.82	0.91	0.95
	00	0.90	0.84	0.77	0.86	0.80	0.74
Phosphorus (mmol/l)	MM	1.59	1.13	1.67	1.64	1.81	1.91
	M0	1.72	0.00	1.62	1.65	1.88	1.62
	0M	1.60	1.59	1.70	1.47	1.85	1.92
	00	1.93	1.74	1.95	2.16	1.68	2.04

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