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The effect of addition of methionine and lysine in the form of rumen protected tablets on the milk protein yield in high-producing lactating dairy cows

J. Třináctý[1], M. Richter[1], P. Homolka[2]

[1]*Research Institute for Cattle Breeding, Ltd., Dept. Pohořelice, Vídeňská 699, 691 23 Pohořelice, Czech Republic, e-mail:* trinacty@vuvz.cz
[2]*Research Institute of Animal Production, Praha-Uhříněves, 104 01, Czech Republic*

Abstract

The aim of the study was to confirm the possibility of compensation of deficiency of Lys and Met in diets of high-producing dairy cows based on corn silage by addition of these amino acids in the form of rumen protected tablets. The diameter of the experimental tablets was 6 mm, protective layer was on the copolymer vinyl-pyridine-styrene basis. The tablets were applied orally after mixing into a part of the feeding mixture before each feeding. The experiment in the form of Latin square design (4x4) was carried out on 4 lactating dairy cows in four 14 d intervals with four levels of factor (control, Lys, Met, Met+Lys). The milk samples were collected for the last 4 days of each period. The group of cows supplemented with Lys+Met showed the significantly higher ($P<0.05$, n=16) milk yield (34.2 kg/d, SEM=1.41) in comparison with group Lys (32.5 kg/d, SEM= 1.54) or Met (32.2 kg/d, SEM=1.77). Daily milk protein yield was significantly higher ($P<0.05$, n=16) in the group Lys+Met (1054 g/d, SEM=48.2) in comparison with control (990 g/d, SEM=43.7), Lys (998 g/d, SEM= 44.6) and Met (968 g/d, SEM=54.0).

This study was supported by MSM 2678846201

Introduction

In order to get new knowledge in the field of amino acid nutrition of lactating dairy cows the rumen-protected tablets containing protein, individual amino acids or their mixtures were developed. Thanks to modest technology it was possible to realize a small batch production of tablets and thereby ensure the modification of the tablets content according to requirements of experiments. Usage of the tablets containing soya protein enriched with essential amino acids in the experiment carried out on the lactating dairy cows was already described in the article of Třináctý et al. (2006).

The aim of the experiment was to confirm the possibility of compensation of deficiency of Lys and Met in diets of high-producing dairy cows based on corn silage by addition of these amino acids in the form of rumen protected tablets.

Material and Methods

Tablet core is composed of the mixture of active substance (amino acids) and tablet additives (binding materials, modifiers of specific gravity etc.). Manufacturing procedures of the tablets is common (like in pharmaceutical industry, it is homogenization, granulation, tableting process). As a protective layer a biologically active mixture based on the vinyl-pyridine-styrene copolymer according to patent (Ardaillon et al., 1989) was used. This protective layer is stable at pH > 5 and is dissolved at pH < 3.5. Lenticular shape of tablets is cca 6.5 mm and specific gravity approximately 1.2 g/cm^3.

The experiment was carried out on 4 lactating dairy cows with average live weigth of 580 kg (SEM = 31) and yield of 33,0 kg/d (SEM = 0.5). The experiment was arranged in the form of Latin square design (4x4) in four 14 d intervals with four levels of factor (control, Lys, Met, Met+Lys).

The nutrient requirement for the individual lactating dairy cows was calculated according to Sommer et al. (1994) which is based on the INRA (1989). The values of AADI balancing the Met and Lys requirement (2.5 a 7.3 %, resp.) were adapted from Rulquin et al. (1993). The animals were fed individually twice daily (7.00 and 16.35 h) on the diet based on corn silage and soybean meal (see Table 1) which is supposed to be defficient especially in Met. Diets were formulated to meet the 100% requirement of PDI and NEL. Values of MetDI and LysDI were based on the Rulquin et al., 2001). The tablets containig the supplemented amino acids Met or Lys were applied orally after mixing into a part of the feeding mixture before each feeding.

Cows were milked twice daily at 7.15 and 17.15 h. Milk yield was recorded and samples were taken at each milking during the experimental period (the last 4 days of each period). The samples of milk were conserved by 2-bromo-2-nitropropane-1.3-diol (Bronopol) and cooled to the 6°C and the basic compositions of milk were analysed by infrared analyser (Bentley Instruments 2000, Bentley Instruments Inc., USA). Casein isolation was carried out following the conditions described by López-Fandiño et al. (1993).

Results

The intake of DM and other nutrients in dependence of treatment is given in Table 2. The DM intake was significantly higher ($P<0.05$) for cows supplemented with Met and Lys+Met than for control cows (C) or cows with Lys supplement. Differences in DMI resulted in different consumption of other nutrient. Values of LysDI and Met DI varied according to used experimental treatment (Table 2).

Milk yield and composition is presented in the Table 3. The group of cows supplemented with Lys+Met showed the significantly higher ($P<0.05$) milk yield (34.2 kg/d) in comparison with group Lys (32.5 kg/d) or Met (32.2 kg/d). Daily milk protein yield was significantly higher ($P<0.05$) in the group Lys+Met (1054 g/d) in comparison with control (990 g/d), Lys (998 g/d) and Met (968 g/d). Increased milk protein yield was followed closely by increases in casein content and yield in the T group ($P<0,05$). The proportion of individual casein fractions was not affected by the treatment. With regards to differences in DMI, the yield and composition of milk was expressed in dry matter intake as given in Table 4.

Conclusions

The most limiting amino acids for synthesis of milk and milk protein have been reported to be Met and Lys. In the present study we found out that the lactating dairy cows supplemented with Lys+Met showed the significantly higher ($P<0.05$) milk yield and protein yield in comparison with cows supplemented with either Lys or Met. Obtained results suggest that the possibility that Met and Lys were co-limiting in the presented experiment.

Table 1. Composition of diet and nutrient content

Item	Unit	Value
Maize silage	% DM	34.6
Lucerne hay	% DM	8.6
Concentrate[1]	% DM	57.0
DM	g/kg DM	672.0
OM	g/kg DM	912.7
CP	g/kg DM	144.7
Fat	g/kg DM	35.9
CF	g/kg DM	138.3
NDF	g/kg DM	189.9
ADF	g/kg DM	353.4
PDIN	g/kg DM	94.9
PDIE	g/kg DM	94.8
NEL	MJ/kg DM	7.1

[1] concentrate contains (%): barley 35.0, oat 25.0, wheat 8.0, sugar beet chippings 15.0, linseed 5.0, soyabean meal 7.0, sodium chloride 0.5, dicalcium phosphate 1.5, limestone 1.5, sodium bicarbonate 0.1, monosodium phosphate 0.2, magnesium phosphate 0.2, trace elements and vitamin mixture 1.0

Table 2. Influence of rumen protected Lys and Met on nutrients intake.

Nutrient	**Unit**	**Control**		**Lys**		**Met**		**Met+Lys**	
		Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
DMI	kg/day	**20.83** [a]	0.35	**20.73** [a]	0.69	**21.39** [b]	0.48	**21.64** [b]	0.44
OM	kg/day	**19.01** [a]	0.32	**18.91** [a]	0.63	**19.52** [b]	0.43	**19.77** [b]	0.43
CP	kg/day	**3.00** [a]	0.05	**2.99** [a]	0.12	**3.09** [b]	0.06	**3.16** [c]	0.10
Fat	kg/day	**0.75** [a]	0.01	**0.75** [a]	0.04	**0.77** [b]	0.02	**0.78** [b]	0.02
NDF	kg/day	**3.93** [a]	0.04	**3.96** [a]	0.10	**4.10** [b]	0.10	**4.08** [b]	0.10
ADF	kg/day	**7.35** [a]	0.10	**7.37** [a]	0.20	**7.56** [b]	0.13	**7.61** [b]	0.15
PDIN	kg/day	**1.96** [a]	0.04	**1.96** [a]	0.08	**2.03** [b]	0.04	**2.08** [c]	0.07
PDIE	kg/day	**1.96** [a]	0.04	**1.96** [a]	0.07	**2.02** [b]	0.04	**2.07** [c]	0.06
NEL	MJ/day	**148.6** [a]	2.74	**147.5** [a]	5.52	**152.4** [b]	3.65	**155.1** [c]	3.44
LysDI	% PDIE	**6.96** [a]	0.00	**7.46** [b]	0.02	**6.93** [c]	0.00	**7.25** [d]	0.01
MetDI	% PDIE	**1.85** [a]	0.00	**1.84** [a]	0.00	**2.25** [b]	0.01	**2.39** [c]	0.02

[a,b] means in the same row followed by the different superscripts differ ($P<0.05$)

Table 3. Influence of rumen protected Lys and Met on yield and composition of milk.

Component	Unit	Control		Lys		Met		Met+Lys	
		Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
Milk yield	kg	**33.33** [ab]	1.50	**32.46** [a]	1.54	**32.13** [a]	1.77	**34.18** [b]	1.41
4% FCM	kg	**30.76** [a]	0.97	**27.43** [b]	0.87	**27.32** [b]	0.70	**30.32** [a]	0.69
Laktose	%	**5.03**	0.03	**5.00**	0.03	**5.00**	0.04	**4.99**	0.04
Fat	%	**3.59** [a]	0.21	**3.07** [bc]	0.19	**3.19** [bc]	0.26	**3.37** [ac]	0.24
Protein	%	**2.97** [a]	0.03	**3.08** [b]	0.02	**3.01** [ac]	0.04	**3.08** [bc]	0.03
Casein	%	**2.48** [a]	0.02	**2.55** [bc]	0.02	**2.52** [ac]	0.02	**2.54** [bc]	0.02
α casein	%	**57.38**	0.64	**57.69**	0.80	**56.91**	0.52	**57.03**	0.83
β casein	%	**35.75**	0.55	**35.50**	0.58	**36.81**	0.58	**36.47**	0.62
κ casein	%	**6.88**	0.44	**6.81**	0.47	**6.28**	0.31	**6.50**	0.39
Urea	mg/100g	**23.30**	0.79	**22.91**	0.88	**23.05**	0.76	**23.46**	1.00

[a,b] means in the same row followed by the different superscripts differ (P<0.05)

Table 4. Influence of rumen protected Lys and Met on daily yield of milk and its components corrected for DMI.

		Control		Lys		Met		Met+Lys	
		Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
Milk yield	kg/kg	**1.59** [a]	0.05	**1.56** [a]	0.03	**1.49** [b]	0.06	**1.57** [a]	0.04
Laktose	g/kg	**79.9** [a]	2.2	**77.9** [a]	1.6	**74.3** [b]	2.7	**78.3** [a]	1.8
Fat	g/kg	**56.2** [a]	3.0	**47.4** [bc]	2.8	**45.7** [b]	2.7	**52.0** [ac]	2.8
Protein	g/kg	**47.3** [a]	1.5	**47.9** [a]	0.8	**44.9** [b]	1.9	**48.4** [a]	1.4
Casein	g/kg	**39.5** [a]	1.3	**39.6** [a]	0.8	**37.4** [b]	1.4	**39.9** [a]	1.0
α casein	g/kg	**82.7**	1.2	**83.0**	1.4	**82.3**	0.8	**83.0**	1.6
β casein	g/kg	**51.5**	0.7	**51.1**	1.1	**53.3**	1.0	**53.0**	1.0
κ casein	g/kg	**9.91**	0.65	**9.78**	0.67	**9.07**	0.42	**9.49**	0.63

[a,b] means in the same row followed by the different superscripts differ (P<0.05)

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