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Effect of duodenal infusion of methionine on milk yield and composition in ewes at late lactation fed hay-based diet

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ABSTRACT

Four multiparous ewes of the 05 synthetic milking line, in the late lactation with T-shaped duodenal cannulas were assigned to a 4 x 4 Latin square design. Animals were fed a total mixed ration with hay and concentrate (50:50,% DM).Treatments consisted of duodenal infusions of 0, 2, 4, and 6 g/d DL-methionine.

Average milk yield was low. Duodenal infusion of 2 g methionine non-significantly increased milk production and non-significantly milk protein and fat yield as well as milk protein, fat and casein content. No effect of methionine treatment on the amino acid composition of milk protein was observed.

KEY WORDS : lactating ewes, methionine, milk yield, milk composition

INTRODUCTION

Methionine (Met) has been suggested as a limiting amino acid (AA) for milk yield and milk protein synthesis in ruminants (Colin-Shoellen et al., 1995; Bequette et al., 1998). Different levels of this AA given postruminally or intravenously may result in the increase in milk yield, improvement of AA utilization in the mammary gland of cows and goats as well as in the increase of protein content in milk (Colin-Schoellen et al., 1995; Sloan, 1997; Bequette et al., 1998).

In the available literature there are few studies concerning Met requirement by lactating ewes (Lynch et al.,1991; Baldwin et al., 1993).Therefore the objective of this investigation was to determine the effect of different levels of DL-methionine infused to the duodenum on milk production and composition in ewes at late lactation fed hay-based diet.

MATERIAL AND METHODS

Four ewes of the 05 synthetic milking line, of mean liveweight of 70 kg (SE ± 4 kg) in their third lactation, fitted with T-shaped duodenal cannulas were assigned to the trial 90 to 96 day postlambing. The experiment was conducted to a 4 x 4 Latin square design with 5-d consecutive periods. Treatments consisted of duodenal infusions of increasing amounts of DL-methionine: 0, 2, 4 and 6 g/d (Ajinomoto Co. IN., Tokyo, Japan).

Throughout the study ewes were housed and fed individually according to the INRA system (INRA, 1989). The diet was offered as a total mixed ration (TMR) consisting of meadow hay and concentrate (50:50%, DM basis), in which the main source of protein was soyabean meal. Hay was chopped into 2 cm pieces, mixed with the concentrate and in this form offered to animals. The daily ration of 1180 g TMR was split into two equal parts and fed to animals at 7.30 and 16.30. The composition of the concentrate, TMR chemical composition and nutritive value are given in Table 1. In an experiment carried out earlier (Urbaniak at al., 2001) the effect of the above mentioned TMR on AA profile and AA flow into the small intestine of sheep was determined.

TABLE 1

Concentrate composition, nutrients content and nutritive value of feeds

Concentrate composition %		Chemical composition, g/kg DM of total mixed ration (TMR)		Nutritive value of TMR	
Soyabean meal	31.0	Dry matter	884.1	UFL/ kg DM	0.91
Wheat	32.2	Crude protein	158.3	PDI (E), g/kg DM	110
Wheat brans	31.3	Ether extract	30.0	PDI (N), g/kg DM	120
Rape seed oil	3.0	Crude fibre	159.5	Met DI,% PDI[2]	1.67
Limestone	1.6	N-free extractives	573.1	Lys DI,% PDI[2]	6.88
Premix [1]	0.9	Crude ash	79.1		
		Acid detergent fibre	212.9		
		Neutral detergent fibre	454.0		

[1] contains in 1 kg: vit. A 160 000 IU, vit. D_3 130 000 IU, vit. E 2000 mg, vit. B_1 500 mg, Fe 2000 mg, Cu 1600 mg, Mn 8000 mg, Zn 9000 mg, I 80 mg, Co 20 mg, Se 30 mg, Mg 40 mg

[2] Urbaniak et al., 2001

Daily amounts of DL-methionine were disolved in 240 ml of physiological salt solution, and infused into the duodenum *via* a peristaltic pomp for 6 h at a rate of 40 ml/h. Ewes were milked at 07.00 and 16.00 h. For the last two days of each experimental period the feed intake and refusals as well as lactational performance were recordered. Samples from morning and afternoon milkings were pooled according to yield and analysed for protein, fat and lactose contents by infrared analysis (Milkoscan 133B, Foss Electric, Denmark) and for amino acids using an automatic amino acid analyser (T-339, Microtechna, Czech Republic) according to methods given by Urbaniak et al. (2001). Casein was determined according to the method given by Jurczak (1999). Standard methods were used to determine the basic chemical composition of feeds (AOAC, 1990). Acid detergent fibre (ADF) and neutral detergent fibre (NDF) were determined by the method of Van Soest et al. (1991).

Data were analysed by ANOVA using the general linear models procedure of SAS (1985). The main model effects were: ewe, period and treatment. Results were expressed as least square means. The significance of differences was accepted at $P<0.05$.

RESULTS

Average milk yield was low in all treatments (Table 2) because the ewes were approaching end of their lactation. However, duodenal infusion of 2 g Met led to a non-significant increase of milk production. Milk protein and fat yield and milk protein, fat and casein contents did not differ significantly among treatments, but

TABLE 2

The effect of methionine infusion on milk yield and composition

Indices	DL-methionine, g d^{-1}					
	0	2	4	6	SE[a]	P
Yield, g/d						
milk	81.0	93.8	78.8	77.2	9.7	NS
protein	5.2	6.9	5.7	4.7	0.9	NS
fat	5.1	6.7	5.6	5.4	0.8	NS
Composition, g/100 g						
protein	6.44	7.34	7.21	6.14	0.50	NS
fat	6.25	7.20	7.15	7.04	0.40	NS
casein	4.28	4.42	3.52	3.62	0.40	NS
lactose	4.44	3.02	2.49	2.67	0.76	NS

[a] standard error

NS – non-significant

the highest value of these parameters were observed when 2 g of this AA was added. Lactose concentration was not affected by Met supplementation. There were no treatment effects on the AA composition of milk protein (Table 3).

TABLE 3

The effect of methionine infusion on amino acid (AA) composition of milk protein, g AA/100 g protein

Amino acid	DL-methionine, g d[-1] 0	2	4	6	SE[a]	P
EAA*						
Lys	6.6	6.7	6.7	6.7	0.1	NS
His	2.9	2.8	2.7	3.2	0.2	NS
Thr	3.6	3.9	3.8	3.8	0.1	NS
Arg	2.8	2.4	2.7	2.6	0.1	NS
Val	4.2	5.1	4.7	5.0	0.4	NS
Met	2.4	2.7	1.9	2.4	0.5	NS
Cys	0.8	1.2	0.9	1.1	0.2	NS
Ile	3.9	4.0	4.0	3.9	0.1	NS
Leu	7.9	8.2	8.1	7.9	0.1	NS
Phe	4.9	4.9	4.4	5.2	0.2	NS
NEAA**						
Tyr	5.6	5.0	5.0	4.7	0.3	NS
Asp	7.1	7.3	7.4	7.4	0.2	NS
Glu	20.3	19.8	20.6	19.9	0.4	NS
Ser	4.6	4.6	4.8	4.7	0.1	NS
Gly	1.6	1.7	1.7	1.7	0.1	NS
Ala	3.4	3.6	3.6	3.5	0.1	NS
Pro	10.8	10.4	10.7	11.4	0.4	NS
Total EAA	40.0	41.9	39..9	41.8	0.7	NS
Total NEAA	53.4	52.4	53.8	53.3	0.5	NS
Total AA***	93.4	94.3	93.7	95.1	0.3	NS

*EAA – essential amino acids, **NEAA – non- essential amino acids, ***TAA – total amino acids
[a] standard error, NS – non- significant

DISCUSSION

The effectiveness of AA supplementation for lactating ruminants depends mainly on the lactation stage and the type of roughage in the ration. In the experiment on lactating dairy cows it was shown that the addition of Met can effect milk protein yield and content, especially in early lactation in animals fed diets based on maize silage and soyabean meal (Rulquin et al., 1993; Bequette et al., 1998). On the other hand, the effect of Met supplementation can be lower when it is associated with hay-based diets and late lactation (La Henaff et. al., 1990; Pacheco-Rios et al., 1997).

Relatively few experiments in this field were carried out on milking ewes. In a study in which a hay-based diet in early lactation was supplemented with rumen protected methionine (RPM), no significant changes in milk yield and composition were found (Baldwin et al., 1993). On the other hand, positive, albeit non-significant effect of rumen protected methionine and lysine were observed in other studies (Lynch et al., 1991) in which more favourable values of parameters referring to the assessment of nitrogen metabolism and milk yield in ewes were obtained. In addition, both AA were also found higher in milk protein. However, in experiments of both of the above-mentioned authors, Met supplementation was higher than in our studies.

In an earlier study (Urbaniak et al., 2001) in which this experimental diet was tested, it was found that Met and Lys concentration in total AA passing to the small intestine of sheep amounted to, 1.67 and 6.88%, respectively. Duodenal infusion of 2, 4 and 6 g/d of Met resulted in an increase of absorbable Met concentration which amounted to 3.15, 4.60 and 6.00%, respectively. In studies on lactating cows it was shown that optimal Met concentration in total AA absorbable in small intestine should be 2.5% (Rulquin et al., 1993). In the case of milking ewes, there is no data on this subject. Sheep milk, however, contains almost twice the amount of protein as cow milk as well as more Met (Lynch et al., 1991). Wool produced simultaneously contains approximately 18% cystine (Urbaniak et al., 1999) which derives in nearly 70% from metabolic changes of Met in the animal organism (Pisulewski and Buttery, 1985). It can, therefore, be assumed that the requirement of milking ewes for Met in protein absorbable in the small intestine may be higher than in the case of lactating cows. In addition, the above facts can also explain the non-significant increase in milk and milk protein yield achieved in our experiment when basal diet was supplemented with 2 g Met despite late stage of ewes lactation.

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STRESZCZENIE

Wpływ infuzji metioniny do dwunastnicy na wydajność i skład mleka maciorek w końcowym okresie laktacji żywionych dawką z udziałem siana

Badania wykonano w układzie kwadratu łacińskiego, 4 x 4, na czterech maciorkach syntetycznej lini mlecznej 05, w końcowym okresie laktacji, z prostymi kaniulami w dwunastnicy. Zwierzęta żywiono dawką skladającą się z siana łąkowego i paszy treściwej (50:50,% s.m.) Maciorki otrzymywały na drodze infuzji do dwunastnicy odpowiednio 0, 2, 4 i 6 g/d DL-metioniny.

Dzienna wydajność mleka była stosunkowo niska. Infuzja do dwunastnicy 2 g metioniny wpłynęła na nieistotny wzrost produkcji mleka oraz wydajności białka i tłuszczu, a także zawartości białka, tłuszczu i kazeiny w mleku. Nie stwierdzono wpływu dodatku metioniny na skład aminokwasowy białka mleka.