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Effect of methionine and fishmeal added to the diet of cows with different beta-lactoglobulin genotypes on the composition and physical properties of milk

Tadeusz Szulc *, Magdalena Pawelska-Góral [1]

Institute of Animal Breeding, Wrocław University of Environmental and Life Sciences, ul. Chełmońskiego 38C, 51-630 Wrocław, Poland

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Abstract

The effect of protected methionine (20 mg/head/day) and fishmeal (300 g of crude protein/head/day) on milk yield, composition and physical properties, as well as the proportion of individual casein fractions, was analysed for 41 Black-and-White cows with different milk beta-lactoglobulin genotypes (AA, AB and BB). A significant increase in the content and production of beta-casein in milk was observed in all groups of cows examined. The addition of protected methionine to the diet of cows with the BB beta-lactoglobulin genotype resulted in a significant ($P \leq 0.01$) increase in the content of crude protein and production of beta-casein, and a significant ($P \leq 0.05$) increase in the content of casein and beta-casein in milk. The addition of fishmeal to the diet of AB beta-lactoglobulin genotype cows resulted in a significant decrease in the content of urea together with an increase in the content of crude protein and casein, including alpha- and beta-caseins, in milk.

Keywords: Nutri-genomics; Methionine; Fishmeal; Milk properties

1. Introduction

The expression of milk protein genes may vary according to cows' feeding, keeping, care and performance. Understanding this variability may allow regulation of the composition and physical properties of cows' milk and affect its biological and technological value, milk processing efficiency and the quality of products for consumers. It may also be of assistance in the selection of feeds for animals. From the technological point of view milk with elevated content of BB kappa-casein is the most desirable, due to higher cheese-making efficiency and better technological parameters in processing. No prior studies on gene expression in cows with different milk beta-lactoglobulin genotypes, receiving feed supplemented with protected methionine and fishmeal, measured by changes in the composition and quality of the milk produced, were found in the published literature.

The present study was designed to determine changes in the composition and physical properties of milk produced by cows with different milk beta-globulin genotypes receiving feed supplemented with protected methionine or fishmeal. It was assumed that such cows may utilise the supplements received for the production of individual milk components, including caseins, differently.

* Corresponding author. Tel.: +48 71 32 05 762; fax: +48 71 32 05 764.
E-mail address: szulc@ozi.ar.wroc.pl (T. Szulc).
[1] Tel.: +48 71 32 05 762; fax: +48 71 32 05 764.

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2. Materials and methods

The study was conducted on Black-and-White cows in a herd with a mean annual yield of 8500 kg of milk per cow, with a fat content of 3.99% and crude protein content of 3.40%. All the cows in the herd were examined for beta-lactoglobulin (blg) genotype using PCR method as described by Ziemiński et al. (2002). On the basis of the results obtained, 41 cows were selected with specific genotypes for milk proteins (12 cows with the AA genotype, 15 with the AB genotype and 14 with the BB genotype). Within the genotypes the cows qualified for the experiment on the basis of analogues, taking into consideration their milk yield, subsequent lactation and month of lactation. Cows in 2–5 lactation were qualified for the experiment on the basis of their similar milk yield in the last sample milking. Cows in a period of 30–100 days of lactation took part in the first experiment, while in the second one cows in a period of 60–120 days of lactation.

All the year cows in the herd were fed using the same fodder set of the total mixed ration (TMR) system. The mean daily content of particular fodders in TMR mixture per cow consisted of: corn silage — 21 kg, alfalfa silage — 9 kg, beet pulp silage — 12 kg, hay — 1 kg, and solvent-extracted rapeseed oil meal — 1 kg. The feed offered contained 45.52% of dry matter (DM). The TMR mixture contained: 12.43% ash, 15.75% crude protein, and 18.28% crude fibre in 1 kg of DM. Amino acids content was not determined in TMR mixture. Their level as calculated using INRAtion software points that the demand for lysine was fulfilled in 80%, while for methionine in 90%. The quality of the silage, according to Flieg's score, amounted to 77. The basic ration was calculated for production of 18 kg of milk. Cows with a daily milk yield exceeding 18 kg received 1 kg of concentrate B, containing 7.5 MJ of net energy for lactation (NEL) and 185 g of crude protein for each 2 kg of additional milk. During the experimental period the cows additionally received on top of the TMR (of the same composition during the whole experimental period):

- experiment I — 20 g of protected methionine per head per day;
- experiment II — 420 g of fishmeal per head per day (300 g of crude protein).

Test milkings were performed two weeks before the beginning and after the end of the experimental period. The milk samples were analysed for: crude protein, fat, lactose and dry matter content using the Milko-Scan 133B apparatus (ASN FOSS-Electric); casein content by Walker's method (PN-68/A-86122); active acidity using a pH meter; potential acidity according to the method of Soxhlet–Henkel (Budsławski, 1973); thermostability by the alcohol test (PN-68/A-86122); somatic cell count (SCC) using the Somacount 150 apparatus (Bentley); total number of micro-organisms (TBC) using the Bactocount 80 apparatus (Bentley); urea content using the AA II analyser (Bran+Lubbe); coagulability according to the method of Scharb (Budsławski, 1973); electrical resistance using the Dramiński apparatus; and the relative proportion of casein protein fractions (alpha-casein, beta-casein and kappa-casein) according to the electrophoretic method described by Laemmil (1970).

The results obtained were statistically analysed using analysis of variance with Duncan's test to discriminate the significance of the differences between groups (using Statistica 6.1 software).

Table 1
The yield and chemical composition of milk and content of casein proteins in milk from cows of different beta-lactoglobulin genotypes before and after administration of protected methionine

Specification	Analysis	Beta-lactoglobulin genotype					
		AA		AB		BB	
		x	SD	x	SD	x	SD
Daily yield, kg	*	28.3	3.7	29.6	3.5	28.5	3.8
	**	28.0	3.5	29.3	3.5	28.1	3.6
Fat, %	*	4.42	0.79	4.25	0.46	4.28	0.69
	**	4.57	1.03	4.00	0.68	4.15	0.98
Protein, %	*	3.87	0.42	3.64	0.29	3.62 A	0.42
	**	3.96	0.41	3.71	0.42	3.74 B	0.42
Casein, %	*	2.96	0.32	2.79	0.22	2.77 a	0.32
	**	3.01	0.30	2.84	0.32	2.86 b	0.32
Alpha-casein, %	*	57.4	3.3	55.6	3.6	57.5	3.6
	**	56.5	2.7	54.7	2.6	55.9	4.6
Alpha-casein, g/l	*	17.1	2.6	15.5	1.7	15.9	2.1
	**	17.0	1.9	15.5	1.8	16.0	2.0
Beta-casein, %	*	26.7 a	3.1	27.5	3.1	27.3 a	2.8
	**	27.6 b	2.6	28.1	2.7	28.2 b	2.7
Beta-casein, g/l	*	7.90 a	1.0	7.70 a	1.0	7.50 A	1.0
	**	8.30 b	1.2	8.00 b	1.2	8.00 B	0.1
Kappa-casein, %	*	15.9	2.9	17.0	1.9	15.2	2.9
	**	15.9	3.2	17.2	2.0	15.9	4.8
Kappa-casein, g/l	*	4.7	0.8	4.7	0.6	4.2	1.0
	**	4.8	1.1	4.9	0.8	4.6	1.7
Lactose, %	*	4.51	0.22	4.54	0.19	4.42	0.41
	**	4.51	0.15	4.48	0.19	4.25	0.81
Dry matter, %	*	13.5	1.02	13.1 a	0.60	13.0	0.94
	**	13.6	1.25	12.7 b	0.74	12.7	1.44
Urea, mg/l	*	232	81.5	217	84.0	201 a	63.2
	**	221	82.8	227	41.2	251 b	81.7

*Before administration of protected methionine, **after administration of protected methionine; statistical comparison before and after administration (in columns): A, B — $P \leq 0.01$; a, b — $P \leq 0.05$.

3. Results

The slightly lower milk yield observed in the second test milking at the end of the experiment resulted from