Effect of dietary supplementation with methionine on cheese-making properties

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RIASSUNTO – Effetto dell'integrazione della dieta con metionina sulle caratteristiche casearie del latte. *Sono stati messi a confronto due gruppi omogenei di bovine in lattazione che hanno ricevuto diete ipoproteiche (13% S.S.) integrate o meno con DL-metionina ruminoprotetta. I risultati dimostrano che bassi tenori proteici ottenuti con diete prive di soia sono compatibili con elevate produzioni. Nel latte l'urea si mantiene bassa (20 mg/100 ml) e la qualità dello stesso risulta buona. L'integrazione delle diete ipoproteiche con metionina stimola la produzione ma, verosimilmente per un effetto "diluizione", ne riduce significativamente il contenuto di proteine e di lattosio. Le caratteristiche casearie non risultano influenzate (eccezion fatta per l'acidità) dalla metionina ma le rese in formaggio sono inferiori nel gruppo trattato. In ogni caso la quantità stimata di formaggio prodotto dalle vacche trattate è leggermente superiore in relazione alla produzione media giornaliera più elevata.*

Key words: low protein diets, protected methionine, cheese-making, milk production.

INTRODUCTION – The present research is part of a larger project aimed to investigate the effects of diets low in protein, devoid of soybean and supplemented with industrially-produced amino acids on milk production and cheese-making properties. These objectives aim, through an increased utilization of alfalfa, to reduce environmental pollution and to eliminate soybean, often GM, from the diets of animals used in the dairy production.

Providing that an intake of raw protein equal to 16% (dry weight) is fair to meet the protein requirements of milking cows of large size (650-700 kg of weight) producing 30-35 kg/day of high quality milk (NRC, 2001), a reduction of the protein content to 13% (dry weight) can be viewed as an interesting objective, but may cause problems as to the critical aminoacids in a ruminant species, especially for methionine.

MATERIAL AND METHODS – The research was carried out in a dairy farm with more than 300 Holstein heads (150 milking cows), with an annexed cheese factory for the production of Parmigiano-Reggiano cheese and a drying system for hay production. 122 milking cows were involved in the research, randomly subdivided into two homogeneous groups paired according to milk yield and quality, age and lactation number.

The experimental design adopted in the 112 days has been as follows. All animals were fed with TMR (Total Mixed Ratio) rations which included: mixed hay (5 kg); alfalfa hay (11 kg); concentrates (13.5 kg). The composition of TMR used was the same in two groups. The concentrate, produced in the farm, included: 26% corn, 26% barley, 26% sorghum, 18% bran, 1% linseed, 2.2% major minerals, 0.8% trace elements and vitamins.

The "treatments" were as follows: Group A (Control). TMR base diet with a supplement of 25 g/cow/day of the triglycerides utilized for methionine protection; Group B (Treated), TMR base diet with a supplement of 50 g/cow/day including 25 g of DL-methionine "protected" (microencapsulated with 25 g of a triglycerides film).

Both diets were administrated *ad libitum* and daily consumption was calculated subtracting the daily leftover from the total given.
On the vat milk the cheese-making trials were carried out at regular intervals (8-9 days): four samples of bulk milk (2 controls and 2 treated, evening and morning) and four samples of vat milk (2 vats controls and 2 treated, utilized to obtain eight "twin cheeses"), were collected and analyzed (AOAC, 2000).
The data were subjected to the analysis of variance (ANOVA) and means compared by the t test.

RESULTS AND CONCLUSIONS – The effects of supplementing a low protein diet with "rumen-protected" methionine on the production and quality of milk, particularly its cheese-making properties, are briefly summarized.

Production – Despite the low protein content of the diets (13% crude protein of D.M. basis), high levels of milk production (30-33 kg/day) were reached in both groups with low milk concentration of urea (20 mg/dl); this result should be related to the high dry matter intake (25-26 kg of D.M./cow/day). The methionine addition significantly increased (P<0.05) milk yield (+810 g/cow/day) which compensated, from a standpoint of daily production, a significant decrease (P<0.01) in the protein content of the milk (Table 1 and 2).

Table 1. Average daily milk and cheese production of the cows.

Groups		Control	Treated	Significance
Observations (n.)		13	13	-
Milk production (kg/cow/day)		31.02 ± 0.83	31.83 ± 0.78	P<0.05
Protein production (g/cow/day)		1048.45 ± 45.21	1056.36 ± 26.63	n.s.
Casein production (g/cow/day) (*)		807.49 ± 34.74	813.11 ± 20.56	n.s.
Observations (n.)		13	13	-
Estimated amount of cheese produced (g/cow/day)	32 hours	2703.41 ± 108.79	2748.43 ± 75.35	n.s.
	6 months	2478.18 ± 91.22	2511.72 ± 62.74	n.s.

(*) computed as% of protein x 0.77.

Table 2. Vat milk composition.

Vat milk	Control	Treated	Significance
Observations (n.)	13 (x 2 replicates)	13 (x 2 replicates)	-
Fat (%)	2.61 ± 0.07	2.69 ± 0.20	n.s.
Protein (%)	3.41 ± 0.06	3.35 ± 0.05	P< 0.01
Casein (*) (%)	2.63 ± 0.05	2.58 ± 0.04	P< 0.01
Fat/casein	1.00 ± 0.03	1.03 ± 0.03	P< 0.01
Lactose (%)	5.12 ± 0.03	5.09 ± 0.03	P< 0.01
Urea (**) (mg/100ml)	19.89 ± 3.76	21.72 ± 3.34	n.s.

(*) estimated as% protein x 0.77.
(**) measured with CL 10 Plus, Diffchamb-Eurochem, Roma, Italy.

Cheese-making properties of milk – The lactodynamographic analysis (LDG; CRM Polo Trade, Cavarzere, VE, Italy) of the milk indicate no significant differences between the two groups (data not shown), however the milk produced by the control presents a higher acidity (control 3.52±0.07 *vs.* treated 3.42±0.11 °SH/50ml; P<0.05), likely due to a different protein content.

Cheese-making production – The quantity of seasoned cheese (6-month-old) produced from 100 kg of vat milk (Table 3) was significantly higher in the control group, mainly owing to the higher protein content of the milk.

Table 3. Cheese yield of bulk and vat milk at 32 hours and after 6 months seasoning.

	Unit	Control	Treated	Significance
Observations	n.	13 (x 2 replicates)	13 (x 2 replicates)	-
Bulk milk				
Yield at 32 hours	kg cheese / 100 kg milk	8.71 ± 0.16	8.63 ± 0.14	n.s.
Yield at 6 months	kg cheese / 100 kg milk	7.99 ± 0.13	7.89 ± 0.14	P<0.05
Vat milk				
Yield at 32 hours	kg cheese / 100 kg milk	8.84 ± 0.17	8.76 ± 0.15	n.s.
Yield at 6 months	kg cheese / 100 kg milk	8.11 ± 0.14	8.01 ± 0.14	P<0.05

Cheese production per cow – As a function of production and characteristics of milk with particular reference to cheese yield, the quantity of cheese produced at 32 hours and after 6 months (Table 1) by each cow in both groups was estimated: the cows whose feed was supplemented with methionine produced, on a daily basis, 34 g of additional seasoned cheese when compared to the controls.

Based on the results reported, the following can be stated:

- the use of low protein diets with and without an integration of rumen-protected methionine, in the presence of a good feed intake (≥25 kg D.M./cow/day), is compatible with a high production of good quality milk; methionine increases (P<0.05) the daily milk production although decreasing protein and lactose contents;
- the treatment with methionine does not change the main cheese-making characteristics of milk but reduces (P<0.05) yields after 6 months of seasoning (Table 3), likely as a consequence of a "dilution" effect of the milk itself;
- the larger quantity of daily milk produced by each cow, promotes a slightly higher cheese production in the "treated" group.

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