Influence of the dietary protein level on the quality of cow milk

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Abstract

The experiment studied 18 multiparous dairy cows during the second half of lactation, assigned to three groups. Throughout the two experimental months the animals received isoenergetic diets based on corn silage and sunflower meal, so that groups had different dietary protein levels compared to the norm: 100% (C), 105% (E1) and 110% (E2). The control animals produced 18.5 kg milk per day, the E1 animals produced 0.6 kg/day more milk and the E2 animals produced 0.2 kg/day more milk compared to C. The difference are not significant statistically (p=0.95). The protein supplements produced an insignificant increase of milk protein level (p=0.09) (32.0 g in C, 32.8 g in E1 and 33.2 g in E2), but decreased significantly (p<0.05) the milk fat (40.7 g/kg in C, 38.4 g/kg in E1 and 37.6 g/kg in E2). The weight gain was not influenced by the dietary protein level.

Keywords*: cow, feeding, protein, milk, quality*

Introduction

The requirement of consumers for quality animal products caused an intensification of research in this field, including cow milk, which is essential for humans.

Among the multitude of factors affecting the chemical composition of milk, the nutritional factors play the most important role (Rulquin, 1995).

The purpose of this experiment was to monitor the influence of dietary protein level on milk chemical composition, particularly the protein and fat levels.

It is possible that higher dietary protein levels cause higher milk protein levels because thus a larger part of ingested protein escapes ruminal degradation increasing thus the supply of dietary amino acids for tissues and organs (Rulquin *et al*.1992; Maas, 1998; Mabjeesh, 1995).

An enhanced microbial activity in the rumen is important for increasing feeding efficiency (Jouany, 1994). This allows high amounts of microbial protein to be made available to the organism at the level of the small intestine, which may thus cut down on the supply of protein products, expensive many times. The energy supplied by the fermentescible sugars and the ammonia resulting from proteolysis are important for the synthesis of microbial protein.

Worldwide, the interest for milk quality prevails on the interest for milk quantity, focusing on the properties influencing cheese production and consumer’s health.

Ludden (1995a and 1995b), Khorasani (1996), Jones (1996), approached this subject concerning the influence of nutritional factors on the quality of cow milk.

The knowledge in this field is insufficient in our country, focusing on the milk fat content.

Material and methods

The experiment was conducted for 60 days on multiparous Holstein-Friesian dairy cows, with an average of 106 days of lactation in the beginning of the experiment and 500 kg average body weight. The cows were assigned to 3 groups of 5 cows each (plus two spare animals in each group), similar as milk yield, milk fat, milk protein, stage of lactation, body weight, etc.

The groups received diets with different protein levels, as follows:

- control group (C): 100% protein norm (Burlacu et al., 1996);
- experimental group 1 (E1): 105%
- experimental group 2 (E2): 110%

The diets consisting of alfalfa hay, corn silage and compound feed were administered restrictedly.

Table 1 shows the structure of compound feeds, determined on the basis of the nutrient supply of ingredients correlated with animals requirements, the purpose being to obtain isoenergetic diets.

Table 1 *Compound feed structure (%)*

	C	E1	E2
Corn	70.4	65.7	64.7
Sunflower meal	25.7	30.4	31.6
Feed grade limestone	0.8	0.8	0.7
Dicalcium phosphate	1.1	1.1	1.0
Salt	1	1	1
Vitamin-mineral premix	1	1	1

The nutritive value of the ingredients was determined by chemical analyses (two rounds).

Feed intake and milk yield were measured daily and individually and milk chemical composition was determined periodically by four sets of analyses.

Body weight was checked twice, in the beginning and the end of the experiment.

The animals were housed in confinement throughout the experiment.
To test the significance of differences in mil yield, milk composition and body weight we used a monofactorial experimental design (ANOVA) preceded by Grubbs test for data screening for gross errors.

Results and discussion

Nutritive value of the ingredients

Table 2 shows the nutritive value of ingredients resulting from the chemical analyses.

Table 2 *Nutritive value of ingredients (by kg DM)*

	milk FU	IDPN	IDPE	Ca	P
		g	g	g	g
Alfalfa hay	0.62	101	84	12.9	2.3
Corn silage	1.02	41	65	3.5	2.5
Corn	1.26	82	116	0.3	3.5
Sunflower meal	0.66	247	103	3.9	5.6

Feed intake and nutrient supply

Table 3 shows feed intake under the conditions of limited administration of both compound feeds (6.1 kg for C, 6.24 for E1 and 6.96 for E2) and forages.

Table 3 *Average feed intake (kg DM/day)*

	C	E1	E2
Alfalfa hay (86.6% DM)	2.6	3.46	3.46
Corn silage (34.8% DM)	8.61	7.83	7.47
Compound feed (87% DM)	5.25	5.43	6.06
Total dry matter (kg)	16.46	16.72	16.99
Concentrate level (%)	31.8	32.4	35.6

Table 4 shows nutrient supply (protein and energy) and how much of the requirement was covered by this supply.

Table 4 *Average daily supply of energy and protein and how much of the requirement was covered*

	C	E1	E2
Supply of milk FU	15.73	15.69	15.94
Supply of IDPN (g)	1306	1376	1455
Supply of IDPE (g)	1340	1382	1427
milk FU coverage (%)	103	103	104

IDPN coverage (%)	100	105	111
IDPE coverage (%)	103	106	110

Milk yield
Table 5 shows the average milk yield throughout the experimental period.

Table 5 *Milk yield (kg/day)*

	C	E1	E2
Average milk yield	18.5	19.1	18.7
Standard deviation	3.4	4.3	3.0

The cows fend on 100% protein level yielded 18.5 kg milk per day, while the cows on 110% protein yielded 0.2 kg more per day and the cows on 105% protein level yielded 0.6 kg more per day. The difference is not significant statistically (P=0.95).

Milk chemical composition
Protein supplementation of the diets apparently caused a better protein synthesis and a better supply of amino acids to the intestine (IDP), which changed milk composition, as showed in Table 6.
As the dietary protein level increased, the milk protein increased from 32.0 g/kg in group C to 32.8 g/kg in group E1 and 33.2 g/kg in group E2, with a step of 0.4 to 0.8 g protein/kg milk and 1.2 g protein/kg milk between the extremes, which is not significant statistically (P=0.99). Moorby, 1996 also observed the increase of milk protein following the higher dietary protein and energy levels.
The trend for fat is inversely compared to the protein, a significant (P<0.05) decrease being observed with the increase of dietary protein level: from 40.7 g/kg milk in group C to 39.5 g/kg milk in group E1 and 37.6 g/kg milk in group E2.
There are, however, several thresholds, not enough known beyond which milk quality reacts to dietary factors. Further investigations will study this aspect so as to quantify the response of milk quality to feeding factors.

Table 6 *Milk composition (%)*

	DM	CP	EE	Lactose
Beginning of experiment				
C	12.74	3.19	3.97	4.99
E1	12.73	3.21	3.96	5.01
E2	12.74	3.22	3.98	4.95
End of experiment				
C	12.85	3.20	4.07	5.00

E1	12.75	3.28	3.84	5.02
E2	12.70	3.32	3.76	4.99

The inversely evolution of the protein and fat levels increased the protein/fat ratio of the milk when supplemental protein was given: 0.786 in group C to 0.854 in group E1 and to 0.882 in group E2 (Table 7).

Table 7 *Protein to fat ratio*

	C	E1	E2
Beginning of experiment	0.803	0.810	0.809
End of experiment	0.786	0.854	0.882

Body weight evolution

The body weight of the three groups correlated with the physiological state and it was not affected by the diets: 78.8 g/animal/day in group C, 70.1 g/animal/day in group E1 and 109.1 g/animal/day in group E2. The differences are not significant statistically (P=0.88).

Conclusions

The highest milk yield was obtained from the group fed on the intermediary protein level (19.1 kg/day in group E1), the other groups having milk yields of 18.5 kg/animal/day (group C, 97% of the highest yield) and 18.7 kg/animal/day (group E2, 98% of the highest yield).

Milk protein increased with the dietary protein level from 32.9 g/kg milk in group C to 32.8 g/kg milk in group E1 and 33.2 g/kg milk in group E2.

Milk fat decreased with the dietary protein level from 40.7 g/kg milk in group C to 38.4 g/kg milk in group E1 and 37.6 g/kg milk in group E2.

The inversely evolution of the milk protein and fat caused the increase of the protein/fat ratio with the higher dietary protein levels: 0.786 in group C to 0.854 in group E1 and to 0.882 in group E2.

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