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FACTORS ASSOCIATED WITH VARIATION IN MILK PROTEIN CONTENT

ČIMBENICI U SVEZI S PROMJENOM SADRŽAJA BJELANČEVINA U MLIJEKU

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ABSTRACT

Milk composition is economically important to milk producers and processors and nutritionally important to consumers. Regarding all these facts there are multiple reasons to improve milk composition. An overview of the effects of the most important factors on milk protein content (disease, season and environmental temperature, parity, stage of lactation, genetics and selection, nutrition) and their reflection on Slovenian research work and practice are presented in the article with special reference to the impact of dietary fiber on milk fat and paralelly on milk protein content.

INTRODUCTION

Like in other developed countries dairying in Slovenia is entering a period of economic pressure which will bring a new drive for efficiency in milk production on the farm and an awareness of the importance of the compositional quality of milk in relation to its use as a raw material in the food industry. Beside the hygienic quality and the somatic cell count in the milk the value of a given milk is calculated by summation of the value of the individual milk constituents and the financial return to the farmer is determined by the amounts of fat, protein and lactose that he sells. For a farmer's management decisions not only the milk price depending on milk protein content is important. Milk protein content is usually accompanied by changes in milk production and in milk fat concentration. Low milk protein concentrations are also connected with fertility problems in a dairy herd. All these reasons demand a perfect knowledge off all possible effects and their interactions which can cause the variability in milk protein content.

DISEASE

The predominant disease studied is mastitis, although other diseases might affect milk protein content and particularly milk nitrogen distribution (DePeters and Cant, 1992). Mastitis results in a reduction in casein content and in increase in whey protein content of milk. Similar studies are not known in Slovenian conditions.

SEASON AND ENVIRONMENTAL TEMPERATURE

The effect of environmental temperature, most frequently measured as season, on milkprotein content is difficult to describe because it is often confounded by stage of lactation and nutritional effects (Laben, 1963). High environmental temperature reduces total protein content of milk.

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Total milk protein content (IR determination) is lowest in the summer and highest in the winter (Bruhn and Franke, 1977; De Peters and Cant, 1992). Similar results (Figure 1) were also obtained in Slovenian investigations (Orešnik et al., 1996).

PARITY

As parity increases, milk protein content declines (Waite et al., 1956). Later investigations and results (Figure 2) out of Slovenian dairy herds (Orešnik et al., 1996) also support this statement.

Milk protein peaked for cows in the first lactation and gradually declined with advancing age. A raising of milk protein content in the 6th lactation is a result of cows' culling policy where only the best and healthy cows stay in production for more than five lactations.

STAGE OF LACTATION

The time elapsed after calving considerably influences milk composition, presumably because the needs of the calf change with age. The time at which the cow becomes pregnant again also affects milk composition. Contents of protein decrease rapidly following calving to a low at about 5 to 10 wk of lactation, followed by a gradual increase through the end of lactation. This is a general confined statement also supported by results in our investigations (Orešnik et al., 1996, Figure 3).

GENETICS AND SELECTION

More research has probably been conducted evaluating the effect of breed on milk protein than any other factor. Holstein cows are lowest in total milk protein content, whereas Yersey cows contain the highest percentage of total milk proteins (Fegan, 1979). There also exist differences in milk protein content between different breeds of cattle in Slovenia (Table 1).

Figure 1. Monthly contents of protein
Slika 1. Mjesečni sadržaj bjelančevina

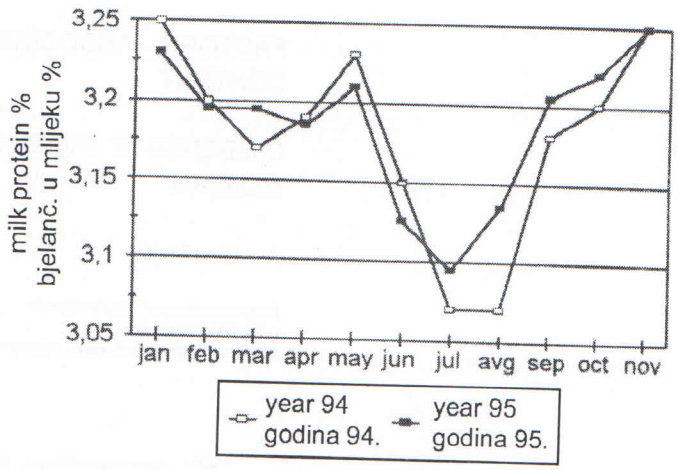

Figure 2. Parity and milk protein %
Slika 2. Paritet i bjelančevine u mlijeku

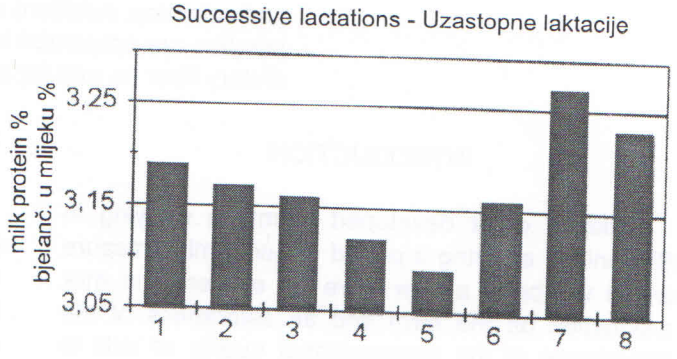

Figure 3.Milk protein % in lactation
Slika 3. Postotak bjelančevina u mlijeku u laktaciji

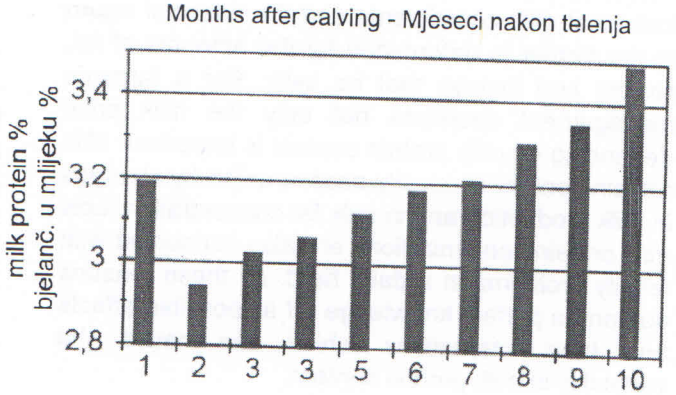

Table 1: Differences in average milk yield and milk composition between different cattle breeds in 1995 (Govedorejska služba Slovenije, 1996)

Tablica 1. Razlike u proizvodnji i sastavu mlijeka između različitih pasmina goveda u 1995. (Govedorejska služba Slovenije, 1996)

	Milk yield Proizvodnja mlijeka	Fat Masnoća	Protein Bjelančevina
Breed - Pasmina	kg	%	%
Simmenthal	3835	3.94	3.24
Brown - Smeđa	4276	3.98	3.19
Black and White Crno-bijela	5691	4.00	3.14

The increased concentration of protein is usually accompanied by increased production of milk and there exist positive genetic and phenotypic correlation between milk yield and milk protein concentrations. Breeding for increased protein content in milk is a part of a modern selection program. In those programs selection should be for milk, fat and protein yield with relative economic emphasis determined by the net economic value of the components (Pogačar, 1996).

NUTRITION

Changes in milk composition from traditional breeding techniques are slow, although new techniques of genetic manipulation may allow faster progress. In contrast, changes brought about by nutritional means generally occur rapidly, and nutrition may therefore be a more appropriate means of responding to today's rapidly changing market demands. In 1992 an average milk protein concentration of 3.11% was reported for Slovenian milk producers. After the new milk price regulation according to milk protein concentration in 1993 milk protein content rose up to 3.21% in 1995 (Govedorejska služba Slovenije, 1996) and after preliminary results up to 3.26% in 1996. Better feeding strategies on farms are the only explanation for this improvement.

Since Powell, 1938. published his conclusion: "There is a definite correlation between the activity of the rumen and the composition of milk", many characteristics of diets have been identified as capable of altering the concentration of fat or protein in milk, too many to be usefully interpreted in this paper. Several reviews dealing with this topic are already published and every textbook includes chapters about nutrition and milk composition. Therefore it is sufficient only to enumerate the characteristics of the diet and feeding techniques which can change the milk protein content:

1. Dietary nitrogen quantity and protein quality (degradability)
2. Intake of energy, density of energy and source of energy in the ration
3. Forage to concentrate ration
4. Carbohydrate solubitly and fermentability
5. Oil and fat content of the ration
6. Crude fiber amount and chemical composition
7. Mean particle length in the diet
8. Mineral and vitamin composition of the diet
9. Feed intake
10. Frequency of feeding
11. Abrupt changes in ingestion of different feedstuffs
12. Condition of the cow.

Nutrition offers clear opportunities for manipulating the composition of milk. A complication in any attempt to modify milk composition by nutritional means is the existence of many interrelationships among the various aspects of output by the dairy cow. Of particular importance are related changes in milk yield, milk protein and milk fat concentrations. The increased concentration of protein is usually accompanied by increased production of milk with a decreased concentration of fat. In contrast to this statement according nutritional research there exists significant positive correlation between milk fat and milk protein concentration when they are varied by stage of lactation or genetics. (Emery, 1977;

Orešnik et al., 1996; Pogačar, 1996). These two provable and adverse legalities open the possibility for a new approach in the interpretation of interactions between different nutrients regarding milk protein content.

If it is accepted that feeding more energy, more protein and less fiber causes important increases in the concentration of protein in milk, then it is also known that a too high energy concentration with insufficient amounts of structural crude fibre in the ration causes serious damage in the rumen - acidosis. This disorder is the result of an excessive ingestion of feeds rich in readly fermentable carbohydrates. The ingestion of cereal concentrates in large amounts provides the substrate for rapid proliferation of facultative organisms that produce large amounts of lactic acid and low cell yields (Van Soest, 1987). A too low amount of structural crude fibre in the ration results in low rumen pH and produces chronic acidosis leading to rumen parakeratosis. Diets that produce acute and chronic acidosis are associated with characteristic changes in microbial population and with reduced feed intake. Reduced feed intake, low microbial yields, changes in VFA production and failure in absorbtion of nutrients out of the rumen may cause a depression in both milk fat and milk protein content. Treatment or prevention of acidosis consists of feeding enough coarse forage to induce rumination and neutralisation of rumen contents by buffering capacity of saliva.

Grazing high producing dairy cows on high quality pasture usually is connected with a ‚low milk fat content. In Slovenian pasture conditions a low milk fat content in summer months is followed by a low milk protein content. In our opinion the low milk fat and low milk protein contents are a consequence of low crude fibre amounts in the ration. Young grass is low in fibre and its tender physical form additionally affects its ability to stimulate chewing and rumination. In this case feeding higher amounts of coarse roughage may paralelly improve milk fat and milk protein concentration. A field trial with additional feeding of grass silage to grazing cows supports this hypothesis.

Table 2. Average milk yield, milk fat and milk protein concentrations (Orešnik et al., 1996)

Tablica 2. Prosječna proizvodnja mlijeka i koncentracija masti i bjelančevina u mlijeku

	Year - Godina	
	1994	1996
Milk yield - kg Proizvodnja mlijeka - kg	23.66	23.89
Fat % - Masnoća %	3.52[a]	3.73[b]
Protein % - Bjelančevina %	3.08[a]	3.23[b]

On four different farms (M-KG Kočevje, 1100 Friesian cows) in 1996 in comparison with 1994 in summer months at the equal average milk yield per day significant higher milk fat and milk protein concentrations were found. In the summer period 1996 beside pasture, hay, maize silage and the same amount of concentrates, 8 to 14 kg of grass silage were included in the ration. Grass silage structural crude fiber could provide improvements in rumen fermentation followed by higher milk fat and milk protein contents.

REFERENCES

1. Bruhn, J. C., A. A. Franke (1997): Monthly variations in grass composition of California herd milks. J. Dairy Sci. 60, 696-699.
2. Davis, C. L., R. E. Brown (1970): Low-fat milk syndrome. A. T. Phillipson (ed.), Oriel Press Ltd. Newcastle upon Tyne, 545-565.
3. DePeters, E. J., J. P. Cant (1992): Nutritional factors influencing the nitrogen composition of bovine milk. J. Dairy Sci., 75, 2043-2070.
4. Emery, R. S. (1978): Feeding for increased milk protein. J. Dairy Sci. 61, 825.
5. Fegan, J. T. (1979): Factors affecting protein composition of milk and their significance to dairy processing. Aust. J. Dairy Technol. 34, 77-82.
6. Govedorejska služba Slovenije (1996): Poročilo 1995 in programi za leto 1996. Ljubljana, junij, 135 s.
7. Grieve, D. G., S. Korver, Y. S. Rijpkema, G. Hof (1986): Relationship between milk composition and some nutritional parameters in early lactation. Livestock Prod. Sci. 14, 239-246.

8. Laben, R. C. (1963): Factors responsible for variation in milk composition. J. Dairy Sci. 46, 1-9.
9. Munro, G. L., P. A. Grieve, B. J. Kitchen (1984): Effect of mastitis on milk yield, milk composition, processing properties and yield and quality of milk products. Aust. J. Dairy Technol. 39, 7-12.
10. Orešnik, A., A. Ilc, V. Zgonc (1996): Možnosti za povečevanje vsebnosti beljakovin v mleku. Zbornik predavanj Posvetovanje o prehrani domačih živali "Zadravčevi-Erjavčevi dnevi", Radenci, 101-113.
11. Pogačar, J. (1996): Možnosti povečanja količine mleka in vsebnosti mlečne maščobe in beljakovin s selekcijo. Zbornik BF, Kmetijstvo(Zootehnika) Suppl. 24, s. 53-60.
12. Powell, E. B. (1938): One cause of fat variation in milk. Proc. Amer. Soc. Anim. Prod. p. 40.
13. Thomas P. C., D. G. Chamberlain (1984): Manipulation of milk composition to meet market needs. Recent Advances in Animal nutrition, 219-244.
14. VanSoest, P. J. (1987): Nutritional ecology of the ruminant. Comstock Publishing Associates, Cornell University Press, Ithaca and London, 193/194.
15. Waite, R., J. C. D. White, A. Robertson (1956): Variation in the chemical composition of milk with particular reference to the solids-not-fat. I.The effect of stage of lactation, season of year and age of cow. J. Dairy Res. 23, 65-75.

SAŽETAK

Sastav mlijeka je gospodarski važan proizvođačima i prerađivačima mlijeka a kao hrana važan je potrošačima. S obzirom na sve ove činjenice ima mnogo razloga za poboljšanje sastava mlijeka. U ovom članku dat je kratak prikaz djelovanja najvažnijih čimbenika na sadržaj bjelančevina u mlijeku (bolest, godišnje doba i temperatura okoliša, paritet, stadij laktacije, genetika i selekcija, hranidba i njihov odraz na istraživanje i praksu u Sloveniji s posebnim osvrtom na djelovanje vlaknine u hrani na masnoću mlijeka i istovremeno na sadržaj bjelančevina u mlijeku.