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Determination of variation in protein composition of bovine milk using capillary zone electrophoresis

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Background

Milk protein composition is an important factor for the nutritional value and technological aspects of milk. The Dutch Milk Genomic Initiative aims to exploit the natural genetic variation in milk protein composition. To determine the possibilities of changing protein composition by breeding first the variation in protein composition has to be known. Capillary zone electrophoresis (CZE) is an analytical technique capable of simultaneously separating and quantifying proteins.

Aim

Aim of this study is to determine the variation in protein composition of raw milk of Dutch Holstein Frisian (HF) cows using CZE.

Materials and methods

Raw milk samples of 2000 HF cows participating in the Dutch Milk Genomics initiative were analyzed with CZE as described by Recio and Olieman (1996). Individual proteins were quantified according to their peak area relative to total protein area corrected for migration time. Method reproducibility was determined by calculating the coefficient of variation (CV) from a reference milk sample that was added in all 103 runs.

Results

With CZE we were able to simultaneously,

1. Separate and quantify the major milk proteins with good reproducibility.

Table 1, Reproducibility for quantification of the major milk proteins

Protein	CV (%)	Protein	CV (%)	Protein	CV (%)
α-Lactalbumin	4.3	α_{S2}-Casein	5.4	κ-Casein	3.4
β-Lactoglobulin	4.2	α_{S1}-Casein	1.9	β-Casein	2.1

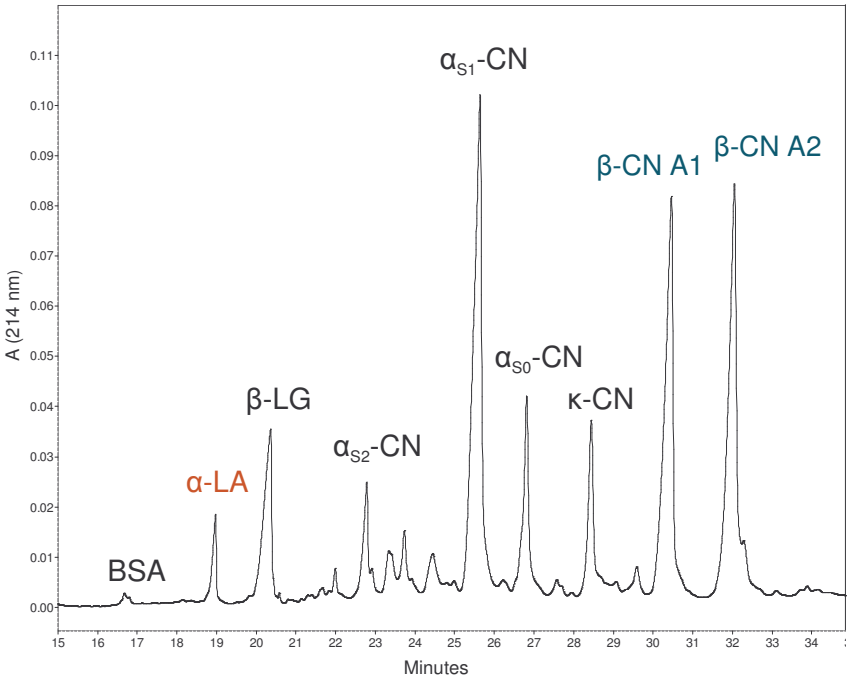
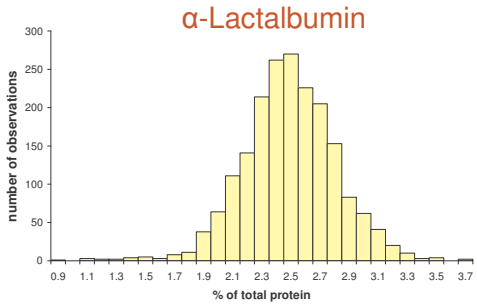


Figure 1: Electropherogram of raw milk of a single cow. BSA= Bovine Serum Albumin; α-LA = α-Lactalbumin B; β-LG = β-Lactoglobulin A ; α_{S2}-CN = α_{S2}-Casein-11P A ; α_{S1}-CN = α_{S1}-Casein-8P B ; α_{S0}-CN = α_{S1}-Casein-9P B; κ-CN = κ-Casein-1P A; β-CN A1 = β-Casein-5P A1; β-CN A2 = β-Casein-5P A2

A



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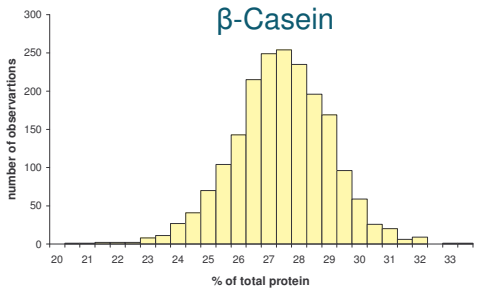

Figure 2, Variation in quantity of A: α-Lactalbumin; B: β-Casein in 2000 samples (expressed as percentage of total protein)

2. Separate proteins which differ in their degree of phosphorylation.

3. Separate minor proteins such as BSA and the proteins belonging to the γ-casein and proteose-peptone fractions.

4. Determine genetic variants of the major milk proteins: α-LA (B), β-LG (A, B), α_{S2}-CN (A), α_{S1}-CN (B, C), κ-CN (A+B, E), β-CN (B, A1, A2, A3)

Table 2, Mean, range (expressed as percentage of total protein) and coefficient of variation of the major milk proteins.

Protein	Mean (range) % of total protein	CV (%)
α-Lactalbumin	2.4 (0.9 - 3.7)	13.0
β-Lactoglobulin	8.3 (4.1 - 12.9)	14.4
α_{S2}-Casein-11P	3.5 (1.1 - 5.4)	16.4
α_{S1}-Casein-8P	21.2 (12.6 - 25.8)	6.5
α_{S1}-Casein-9P	7.4 (3.1 - 12.9)	14.9
κ-Casein-1P	4.0 (2.3 - 6.4)	14.3
β-Casein-5P	27.2 (20.4 - 33.4)	5.8

Conclusion

Large variation in protein composition between individual cows exists which offers great opportunities for steering milk protein composition by breeding.

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