Near infrared scattering to predict the milk-fat creaming dynamics for standardization of cream yield, and butter production process: a new project just started

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Introduction

Several factors - such as physico-chemical characteristics, genetics, physiology and feeding – concur in defining the technological properties of milk fat, supported by adequate analytical techniques for their control in optimizing the transformation process.[1,2] The cream yield, when natural milk fat creaming is required, is highly influenced by the residual fat content in milk after creaming. The physico-chemical characteristics and the size of fat globules affect the creaming process. Nowadays in Italy, the Official Labs for QC cannot benefit from methods able to quickly estimate the distribution and size of fat globules both in raw and creamed milk. To satisfy this need, last spring the Lombardy Region (North West of Italy) has approved and funded a new project based on the use of FT-NIR. This paper shows the main objectives and the experimental plan that will be adopted in carrying out this two-year project.

Materials and methods

A population of cows from the progeny of 4 reproducers (at least 4 animals per reproducer), fed with or without the use of silage, milked at a fixed timetable in a conventional milking parlour or spontaneously in an automatic milking system, has been identified. Each animal will be monitored throughout the whole period of lactation (9–10 samplings). During the first year, the experimental design concerns the analysis of about 500 samples by NIR spectroscopy, and in parallel of 200 samples by a reference method (laser light scattering—LLS).[3] The first year will also be dedicated to the software development, the optics and the optimization of spectra acquisition, the validation of mathematical models for predicting the fat globule distribution and the amount of fat creaming. Also the transferability of this technology into low-cost instruments operating in the range 800–1100 nm will be checked. A second sampling (at least 1000 samples) will be made

during the second year for the transfer of the technology to the Official Regional Labs, and the validation of the developed model in wider cow population, on the basis of genetics, feeding, stage of lactation and milking technology. Different cow's breedings (Italian Friesian, Jersey and Swiss Brown) will be taken into account. Sampling will be conducted on a monthly basis in selected farms. To evaluate the suitability of the model in optimizing the technological creaming process, about 200 bulk milk samples and 100 cream samples will be analyzed. Spectra will be collected by a NIRFlex N500 (BUCHI Italia, Assago, Milan), and a Milkoscan FT2 (FOSS Italia, Padova). Fat creaming will be computed by using the Mie theory and applying Monte Carlo models.

Results and discussion

The main objectives of the project are: a) the implementation of a software based on physical and mathematical models for signal processing; b) the draft of experimental protocols that can be easily applied in routine analysis by the Regional structures in charge of monitoring milk functional properties during the lactation period, and equipped with the required NIR instrumentation; c) the use of this software in SME with appropriate instrumentation, to assess the quality of milk as a function of its destination, as well as the optimization of the butter production process.

As indicators of results the quality of the obtained models will be considered, in terms of model robustness, assessed through rigorous criteria such as the prediction error on an independent validation set; the reproducibility of results due to the confirmation on an adequate number of samples analyzed in parallel with the reference technique (LLS), and the transfer of software and technology to the Official Labs for QC, by using low-cost instruments operating in the range 800–1100 nm.

During the first two months, several activities are already planned and some actions useful for coordinating and organizing samples choice, collection and analysis have been acting.

In details, the main coordination activities have been related to: i) Signature of the Consortium agreement between partners; ii) Kick-off meeting (July 29th 2009); iii) Decision about the starting and the ending date (Sept. 1st 2009 – Aug. 31st 2011); iv) Signature of the external consultant contract; v) Draft of the sampling procedure; vi) Hire of the light scattering apparatus (Alfatest srl, Rome, supplier for Malvern Instruments, England); vii) Optimization of the operative conditions by using FT-NIR and IR instrumentations.

The partnership involved in the project was chosen taking into account the expertise, the location and the external collaborations of each partner, to have high probability in satisfying the needs of the final users of results. A brief description of each partner is reported:

Coordinator: Research Centre for Fodder Crops and Dairy Production (CRA-FLC), Lodi, Italy.

The Research Centre for Crops and Dairy Productions (CRA-FLC) is a structure of the Agricultural Research Council (CRA), a National Research Organization that operates under the supervision of the Ministry of Agriculture, with general scientific competence within the fields of agriculture, food, fishery and forestry. CRA-FLC derives from the fusion of 3 Institutes dedicated to Crops Science, Animal Science and Dairy Science to cover the whole chain from feed to food.

The expertise of the Dairy Unit is recognized around the world for its great know-how on milk and cheese characterization for technological and nutritional aspects with specific studies

made on proteomics and metabolomics. At the Dairy Unit is located the "CRA Laboratory for InfraRed Spectroscopy": a reference point for all CRA structures, on the basis of more than 30 years of specific expertise in the IR and NIR fields. CRA-FLC has a wide net of co-operation with European, extra-European and International Institutions, and participates in projects at Regional, National and European level. Expertise on different agro-food chains using IR and NIR spectroscopy, and on dairy field also applying Official Methods (IDF-ISO) is guaranteed, as evidenced by several scientific papers published in National and International Journals.

Partner 1: Breeder's Association in Lombardy (ARAL), Crema, Cremona, Italy

ARAL started up in 1970 thanks to the will of the 9 Provincial Breeders' Association in Lombardy (APA). It was intended to be the Regional Office within the National Breeders' Organization.

ARAL partners are all organizations legally recognized to operate in the livestock raising sector, and whose mission is the development and growth of the sector. The Breeders' Organization has been entitled by the Italian State for the accomplishment of the Genealogic Registers for Productive Animals, and of the Functional Controls. It is engaged, as one of its main targets, in genetic selection and improvement of livestock and animal husbandry. Within this context ARAL's institutional task is to run the Chemical Laboratory of Lombardy APAs that carries out all milk tests in order to analyze the chemical parameters required by the Functional Controls.

Partner 2: BUCHI Italia, Assago, Milan, Italy

BUCHI is a leading world-wide supplier in key technologies such as evaporation and separation for research laboratories as well as near infrared spectroscopy and distillation and extraction for quality control purposes. The goal is to sustain a high level of competence in product development, manufacturing and application around these technologies. We believe that providing high quality products and responsive service will support the innovation and effectiveness of our customers.

BUCHI is not only a provider of individual instruments but a solution provider, combining different components to a complex application system.

Acknowledgements

This research is funded by Lombardy Region, Research Program 2007–2009, Project n. 1347.

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