

MONITORING STRUCTURE DEVELOPMENT IN MILK ACIDIFICATION USING DIFFUSE REFLECTANCE PROFILES

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The structure of dairy products is important for the consumer, and milk acidification plays a central role for structural development. To ensure the best possible consumer experience, it is important that a product's structural properties are stable. Therefore process and quality control tools are needed so that the production can be carried out consistently, regardless of day-to-day variations in the raw materials.

Casein micelles aggregate during milk acidification, which leads to formation of a gel network. This change of structure is important for the development of a range of dairy products. It is therefore essential to monitor these structural changes and a variety of methods have been proposed to continuously follow this coagulation of milk [1]. Especially non-invasive methods for *in situ* production line application have been of interest.

We propose a method for analyzing structural changes in milk based on hyper-spectral light scattering. Our approach is motivated by Carstensen and Møller [2]. They demonstrated the correlation between diffuse reflectance profiles and rheology of a milk sample during acidification. In this work we employ a super-continuum laser light source coupled with an acousto-optical tuneable filter to illuminate the sample. The generated beam is spectrally narrow and can be tuned in the spectral range from 450-1050 nm. This system is described in detail in [3]. It is a research platform, which is constantly developed and adjusted according to research needs. Besides providing a non-invasive method, the system also has potential as a design platform for creating specialized and cost-efficient vision systems.

Our preliminary results are highly encouraging and show a clear relation between rheology and diffuse reflectance. A factorial experiment studying the effects of the content of fat, protein, and temperature in the acidification process is conducted. The purpose of the experiment is to investigate how the change of these parameters affects the diffuse reflectance properties as well as to demonstrate the relation between the optical parameters and structure formation in milk acidification. These measurements are compared to conventional methods such as *pH*, *oscillatory rheology*, *confocal laser scanning microscopy*, and *sensory data*.

References

- [1] J. A. Lucey, Formation and Physical Properties of Milk Protein Gels, *Journal of Dairy Science* **85**, 281-294, 2002.
- [2] J. M. Carstensen and F. Møller. *Online monitoring of food processes using subsurface laser scattering*. In Advances in process analytics and control technologies (APACT 09), Glasgow, Scotland, May 5-7, 2009.
- [3] O. H. A. Nielsen *et al.*, *Supercontinuum light sources for hyperspectral subsurface laser scattering - applications for food inspection*. In 2011 Proceedings of SCIA, Scandinavian Conference on Image Analysis, Ystad, Sweden, May 2011.