A portable NIR device for the optical supervision of milk coagulation process

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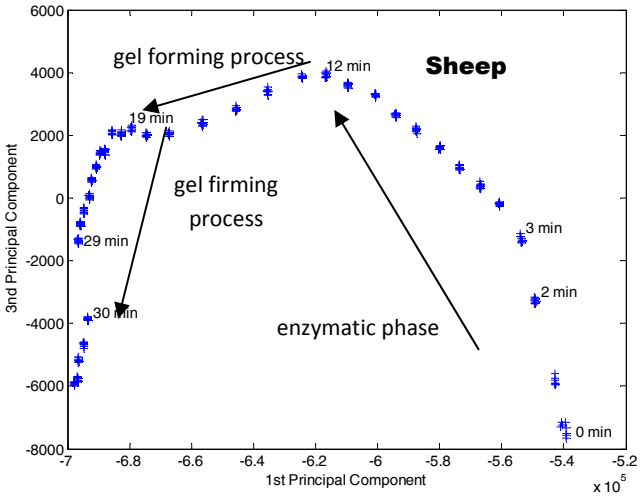
The coagulation of milk is the fundamental process in cheese-making, based on a gel formation as consequence of physicochemical changes taking place in the casein micelles, the monitoring the whole process of milk curd formation is a constant preoccupation for dairy researchers and cheese companies (Lagaude et al., 2004).

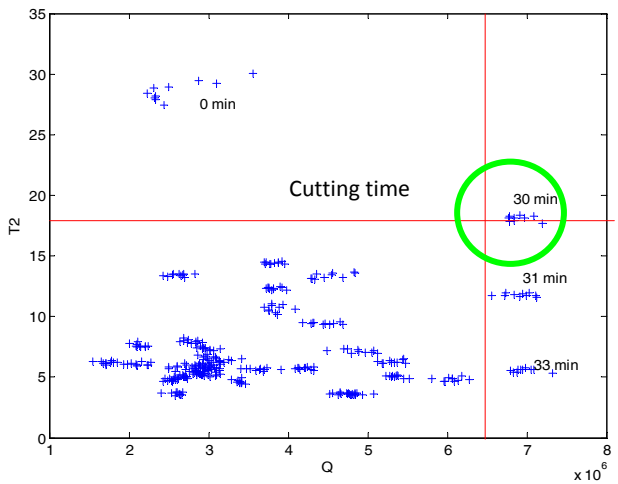
In addition to advances in composition-based applications of near infrared spectroscopy (NIRS), innovative uses of this technology are pursuing dynamic applications that show promise, especially in regard to tracking a sample in situ during food processing (Bock and Connelly, 2008). In this way the literature describes cheese making process applications of NIRS for curd cutting time determination, which conclude that NIRS would be a suitable method of monitoring milk coagulation, as shown i.e. the works published by Fagan et al. (Fagan et al., 2008; Fagan et al., 2007), based in the use of the commercial CoAguLite probe (with a LED at 880nm and a photodetector for light reflectance detection).

The objective of this work is to propose an original portable NIR equipment to supervise the milk coagulation process.

The Physical Properties Laboratory and Advanced Technologies in Agrofood of the Technical University of Madrid has developed a portable device based on NIRS. The principal components of this equipment are: a Hamamatsu spectrometer (C9913GC, TG – Cooled NIR I), from 800 to 1700 nm of wavelength, a light source from Ocean Optics (LS-1-LL Tungsten Halojen), dedicated electronic for data acquisition and a specific Labview program to establish control parameters for the spectrometer able to work not only on PC but also on PDA. All these elements are mounted on a backpack, together with the optical fiber, which can be substituted for the specific probe for each application, being the responsible of the equipment versatility. For this application has been selected a 200 μm VIS-NIR stainless steel fiber type T200 (Ocean Optics) coupled to a flat second-surface mirror, operating in transflectance mode.

The experiments has been carried out on sheep and goat milks, by immersion of the probe directly in milk, acquiring spectrum each 1 minute during the 35 minutes of coagulation process. The increasing values of transflected light registered for the detector allows identifying, based on PCA analysis, the different kinetics that occur along the gel formation and the time to reach the optimal gel firmness to cut the curd.





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