Structure of casein micelle dispersions during ultrafiltration process

F. PIGNON

Laboratoire de Rhéologie, UMR 5520 (UJF Grenoble I, INPG, CNRS) BP 53,
F-38041, Grenoble, Cedex 9 France

Understanding the mechanisms involved in the structural development in the vicinity of membrane during ultrafiltration process constitutes a considerable challenge in the improvement of this technique for industrial applications. In the case of skimmed milk, an important aspect to consider is the structure of the main milk protein: casein micelles itself.

Casein micelles in milk are complex macromolecular assemblies highly polydisperse with a globular form of 100 nm mean radius of gyration. These micelles are composed of four distinct types of caseins, namely α_{s1}, α_{s2}, β and κ, as well as minerals, essentially calcium and phosphate called colloidal calcium phosphate. Theirs structure and stability play key roles in the processing of milk. There are two plausible models for the internal structure of casein micelles. The first model represents the structure in terms of casein sub-micelles [1] with size from 10 to 20 nm, while the second model describes the structure as a relatively uniform protein matrix containing disordered colloidal calcium phosphate [2].

Structure of casein micelles

Recently on "ID2 - High Brilliance Beamline", the globular and internal structure of casein micelles has been studied using SAXS and USAXS techniques covering an exceptionally wide range of scattering vector [3,4]. It revealed several new features about internal structure of casein micelles and of theirs evolution with environmental factors (pH, temperature, addition of EDTA) [5]. The results in high q region of the scattering intensity behavior suits well with the model which describes casein micelles as a relatively uniform matrix containing a disordered colloidal calcium phosphate.

In situ SAXS during ultrafiltration process

New advances were brought in the understanding of the mechanisms implied in the formation of the deposits thanks to *in-situ* SAXS performed in specifically developed ultrafiltration cells [6]. The structural arrangement and concentration profiles in deposited layers were obtained during frontal filtration of casein micelles dispersions. The mechanisms responsible for the reduction of permeation flux in the early stage of filtration is associated to an exponential increase of the concentration at the membrane surface [7]. At longer filtration times the decrease of permeation flow is directly related to the deformation and compression of the micelles in the immediate vicinity of the membrane [3,4].

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