Evaluation of a casein micelle structure using neutron small-angle scattering

H. Takagi[A]

[A] *Institute of Materials Structure Science, High Energy Accelerator Research Organization (KEK)*

The bovine casein micelle has been extensively studied over past decades, but the details of its inner structure have not yet been definitively identified. However, two structural models of casein micelles have been widely accepted based on the results of these studies. One is the submicelle model, which is composed of smaller submicelles with a diameter of ~20 nm and colloidal calcium phosphate (CCP) cross-linked between the submicelles. As a result, the casein micelles consist of aggregates of submicelles. The other is a nanocluster model, where nanoclusters of CCP are randomly distributed in a uniform matrix of casein proteins.

Recently, small-angle X-ray scattering (SAXS) and small-angle neutron scattering (SANS) are used to investigate the micelle structure. Our research group has been proposed the micelle model including water domains [1-3] which is developed from the model including hard regions proposed by Bouchoux [4]. In the model including water domains with about 20 nm in size, micelle involves a few water domains, which were often observed in electron microscopy images, and enough CCPs exist to generate interference between them.

In this study, the casein micelle structure was investigated by SANS technique. Reconstructed milk obtained by adding various ratio of D2O/H2O mixed water into freeze-dried skim milk were used as samples. It was confirmed that experimentally obtained SANS profile was different from that obtained by SAXS. By calculating scattering length densities, the matching point between the scattering length density of casein micelle and serum was obtained to be D2O/H2O = 40/60. SANS profiles were fitted and analyzed using the micelle model including water domains which is proposed by our research group as a new casein micelle model. It was found that SANS profile could be almost reproduced, when the channel structure having periodic length of 17.9 nm was taken into account in the micelle model with water domains. Fig. 1 shows experimentally obtained SANS profiles of D2O/H2O = 100/0 (circle) and the calculated curve.

[1] H. Takagi *et al*., Milk Sci., **71**, 10 (2022).
[2] H. Takagi *et al*., Food Chem., **393**, 133389 (2022).
[3] H. Takagi *et al*., Soft Matter, **19**, 4562 (2023).
[4] A. Bouchoux *et al*., Biophys. J., 99, 375 (2010).

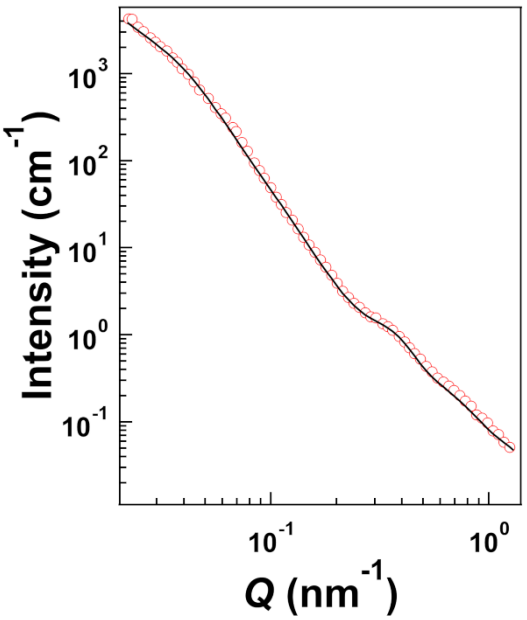

Fig. 1. Experimentally obtained SANS profiles of D2O/H2O = 100/0 (circle) and the calculated curve.