We report on grazing incidence small angle X-ray scattering (GISAXS) on casein micelles (CMs) and high-density lipoprotein (HDL) granules extracted from milk and egg-yolk, respectively. Both multi-molecular assemblies are widely used as ingredients in food. During processing CMs and HDL granules undergo a number of structural changes and it is the aim of our research to make such changes visible on a molecular level.

CMs are the major protein component in milk and thus the main component in dairy products like yogurt and cheese. Pressure-driven microfiltration is used to separate CMs from smaller components such as whey proteins in milk. During the filtration process the smaller particles pass through the pores of a membrane while the larger CMs become retained and form a deposit layer. This deposit however, induces an increase of the filtration resistance (by pore blocking for instance), which leads to a reduction of the performance of the filtration process. Knowledge about the structure of CMs in deposits on membranes could help to make filtration more efficient in future. Using GISAXS on a solid/air interface, we have recently shown that the spherical solution structure of the CMs deforms into a prolate ellipsoidal shape during the deposition process [1]. Here, we present new GISAXS data on deposits formed at different trans-membrane pressures. The results indicate that at high filtration pressures CMs can also assume an oblate ellipsoidal shape at high filtration forces. In addition, we show first experimental results of time-resolved GISAXS performed in a cross-flow filtration cell under fluid flow conditions. The measurements on the liquid/solid interface show that deposits of CMs become more compact with increasing filtration time.

High density lipoprotein granules from egg yolk are extensively used as an emulsifier in products such as mayonnaise. During the manufacturing process of mayonnaise the pH decreases from neutral to under pH 4.5 leading to a higher incorporation of low density lipoprotein (LDL) in the HDL-granules structure. We have investigated films of HDL-granules using both X-ray scattering experiments in reflection geometry and atomic force microscopy (AFM) at pH 4.0 and pH 6.5. Compared to pH 6.5, the repeating distance of phospholipids at pH 4.0 is larger and less diffuse as the analysis of the Debye ring in the scattering patterns reveals. From the GISAXS signal we could extract two prominent lateral particle sizes in the HDL-granule film. Compared to the radii of gyration at pH 4.0, we observed a significant expansion of both sizes at pH 6.5. This indicates rougher contact areas and a stronger steric hindering for the incorporation of the LDL vesicle in the HDL-granules under native conditions.


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