

Sustainable emulsions stabilized by cruciferin that forms dynamic interfacial architectures

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Plant based proteins pave the way to sustainable milk drinks and industrial emulsions in general. Cruciferin, a protein from rapeseed, has great potential as green emulsifier [1], but details about its structure and mobility at oil-water interfaces are largely unknown. These properties are studied using small-angle neutron and x-ray scattering, and neutron spin-echo spectroscopy. From the atomistic modeling of the scattering curves we deduct that trimeric conformations prevail the scene. The surface coverage is characterized well by the analysis of the small-angle scattering curves. Coarse-grained modeling reveals protein protrusions from the central core of the subunits (“arms”) that are more compressed in the interfacial film compared to the aqueous dispersion. The interfacial mobility is only marginally lower than in solution, indicating the arms still transiently extend and preserve a network, for the first time revealing the mechanism how cruciferin forms highly elastic 2d gel-like oil-water interfaces, as observed in macroscopic rheology. The high interfacial mobility may help in self-repairing non-stabilized interfacial fractions, reducing coalescence. Thus, this study serves as showcase how scattering experiments reveal molecular understanding of proteins at oil-water interfaces, which can stimulate development of new plant-based emulsion products, and contribute to the global protein transition.

Keywords:

Protein, Emulsion, Small-angle scattering, Neutron spin-echo spectroscopy, Neutron scattering, Coarse grained structure, Dynamics, Rheology

References:

[1] Holderer, O., Landman, J., Kohlbrecher, J., Wu, B., Zolnierczuk, P., Müller, M., Frielinghaus, H., Förster, S., Schwärzer, K., Sagis, L., Shen, P., Yang, J., & Heiden-Hecht, T. (2025). Dynamic Interfacial Architectures: Cruciferin-Stabilized Oil/Water Interfaces for Sustainable Emulsions. *Advanced Materials Interfaces*, 12(17), e00368.