Influence of structure and processing on plant-based wax on physical properties of micro-oleogels

Saathana Ambikaibalan [1,2], Sepideh Khodaparast [3,4], Michael Rappolt [2], Andy Brown [1], Anwesha Sarkar [2,4]

[1] School of Chemical and Process Engineering, University of Leeds, LS2 9JT, Leeds, UK
[2] Food Colloids and Bioprocessing Group, School of Food Science and Nutrition, University of Leeds, LS2 9JT, Leeds, UK
[3] School of Mechanical Engineering, University of Leeds, LS2 9JT, Leeds, UK
[4] National Alternative Protein Innovation Center (NAPIC), UK

pmsamb@leeds.ac.uk

Wax-based oleogels are used as natural structuring agents to convert liquid oils into semi-solid forms, enabling applications in food, pharmaceutical, cosmetic, and allied industrial applications. However, the influence of structure and processing conditions of oleogels on their bulk properties is not yet fully understood, particularly for room-temperature oleogelation process. In this study, two different waxes, rice bran wax (RBX) and rapeseed wax (RSX) were selected to prepare oleogels in sunflower oil. A two-step process was applied, employing oleogel formation followed by formation of oleogel-based particles *i.e.* micro-oleogel *via* controlled shearing at 25 °C. A combination of polarized light microscopy (PLM), differential scanning calorimetry (DSC), X-ray diffraction (XRD), small angle X-ray scattering (SAXS) were employed to characterize the multiscale structure of the wax crystals and their influence on the bulk physical properties of the micro-oleogels. XRD alongside SAXS analyses revealed that RBX had an orthorhombic crystal structure compared to RSX, which had triclinic packing. Microscale structural assessment revealed that RBX-oleogels exhibited needle-shaped crystals, whereas RSX-oleogels formed spherulitic structures. Both structures underwent a significant reduction in size after conversion to micro-oleogels, where the shear-induced micro-oleogelation process allowed forming a stable self-supporting gel at 25 °C with orders of magnitude higher viscosities at lower shear rates (10 s^{-1}), unlike the parent oleogels at the same concentration of wax (10 wt%). Remarkably, the micro-oleogelation processing step did not influence the nanoscale crystal structure of the waxes, suggesting that bulk physical properties of the micro-oleogels were primarily governed by the microscale structure of the wax particles. Overall, our multiscale analysis demonstrates that processing plays a crucial role in determining the microscale structure, which in turn govern the rheological behaviour and stability of oleogels without altering their nanoscale crystal structures. Future studies will focus on how these micro-oleogels behave at liquid-liquid interfaces.

Keywords:
Rapeseed wax, Rice bran wax, Oleogel, micro-oleogels, X-ray diffraction, Polarised light microscopy

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