The influence of wax-based oleogelators on microstructure evolution, rheology and diffusion

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Oleogels are emerging as promising fat-structuring systems in plant-based meat analogues, offering improved texture and oil retention using healthy unsaturated oils. This study investigates rapeseed oil oleogels structured with 10% (w/w) of candelilla wax, beeswax, or rice bran wax, focusing on their microstructure, thermomechanical properties, viscoelastic properties and oil diffusion behaviour[1] . A novel combination of low-strain rheo-microscopy, rheology, differential scanning calorimetry (DSC), light microscopy (LM) and confocal laser scanning microscopy fluorescence recovery after photobleaching (CLSM-FRAP) was employed. The results showed that candelilla wax formed a dense, homogenous crystal network, beeswax produced needle-like aggregates, and rice bran wax exhibited mixed spherulitic and fine crystal structures. DSC and rheo-microscopy revealed distinct crystallization patterns, with rice bran wax showing two crystallization events. Oil diffusion analysis using CLSM-FRAP was performed in four different regions; in-between crystals, in crystals, in mixed regions with both crystals and oil, and at random locations. The CLSM-FRAP analysis demonstrated that candelilla wax significantly retarded oil diffusion across all regions, while rice bran wax allowed faster diffusion in crystal-rich areas, indicating looser packing. In addition, work on nanolevel has been performed using transmission electron microscopy (TEM) showing the microstructure of oleogels in plant-based meat analogues. These findings in this work highlight the critical role of wax type in designing oleogels with tailored structural and diffusion properties for food applications.

Keywords:
Oleogels, plant-based meat analogues, microstructure, diffusion, rheo-microscopy, thermomechanical properties

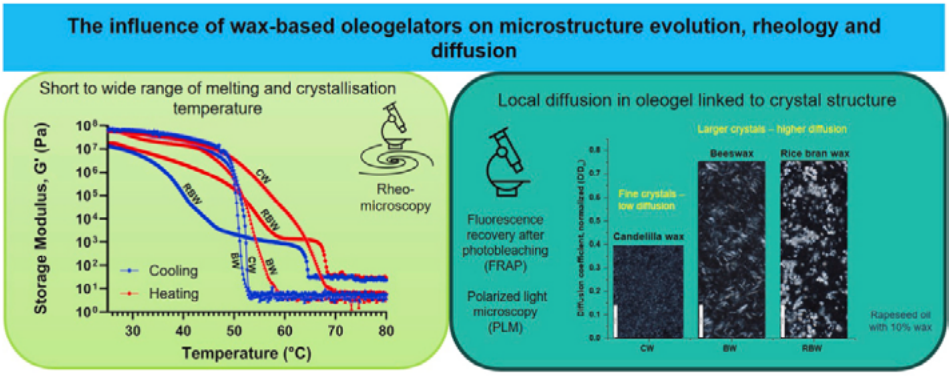

Illustration showing melting and crystallisation behaviour to the left and local diffusion linked to the microstructure to the right in the investigated oleogels

References:

[1] Ahlinder, A.; Lorén, N.; Hemeryck, A.; Lindroth, S.; Altskär, A.; Krona, A.; Eckardt, J. (2026) The influence of wax-based oleogelators on microstructure evolution, rheology and diffusion. Food Hydrocolloids 171, 111739. (https://doi.org/10.1016/j.foodhyd.2025.111739)

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