Sustainable bio-based nanoparticles for interfacial stabilization of Pickering emulsions

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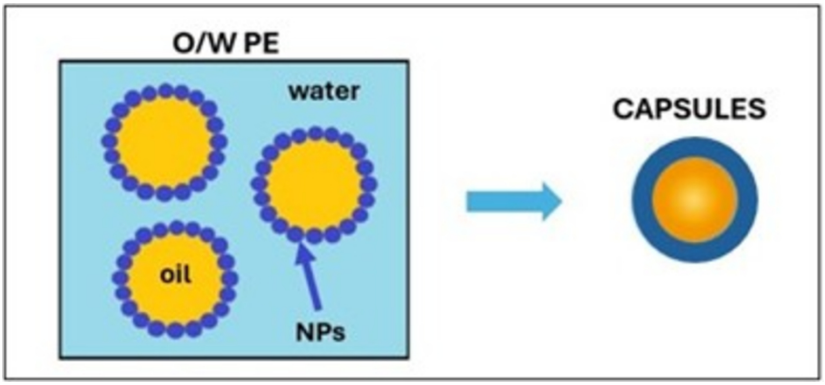
Natural and biodegradable materials are attracting increasing interest as sustainable alternatives to synthetic surfactants for stabilizing Pickering emulsions. In this work, nanoparticles derived from natural, biodegradable, and GRAS materials are investigated as interfacial stabilizers for oil-in-water (O/W) Pickering emulsions designed as platforms for encapsulation and controlled delivery.

In the first step, a bio-derived material (A) was processed into nanoparticles via an anti-solvent precipitation method and characterized for interfacial properties. Contact angle measurements suggested a favourable amphiphilic balance for adsorption at the oil–water interface (~90°). However, the intrinsic hydrophobicity and lyotropic behaviour of material A limited its dispersion in water and hindered efficient interfacial stabilization. To overcome these limitations, composite nanoparticles were prepared by combining material A with a hydrophilic polysaccharide (B) [1]. This strategy improved aqueous dispersibility and enhanced nanoparticles adsorption at the oil–water interface, enabling the formation of Pickering emulsions at lower nanoparticles concentrations than previously reported.

Two homogenization techniques were explored to tune the emulsion microstructure: Ultra-Turrax (UT) mixing and sonication. UT produced emulsions with larger droplets (≈20 μm) that were stable for about one week, whereas sonication produced smaller droplets and significantly improved stability. This tunability is advantageous at the application level, as it allows the emulsion properties to be tailored to specific needs.

While stabilizing the emulsion, the assembly of nanoparticles at the oil–water interface provides a platform for interfacial structuring. The resulting interfacial nanoparticle layer will be consolidated through green hardening strategies to form robust capsule shells with tunable permeability. Encapsulation and release processes will be investigated using confocal laser scanning microscopy (CLSM) [2], enabling correlation between interfacial structuring, capsule formation, and fluorophore diffusion.

Keywords:
Composite bio-based nanoparticles, Pickering emulsions, interfacial stabilization, encapsulation



Pickering emulsions as templates for capsules formation.

References:

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[2] Pygall S.R.et al., Adv. Drug Deliv. Rev., 2007, 59, 1434-1452