Hybrid alginate beads embedding lipid mesophase nanoparticles: pollutant trapping validation

Sandrine DELPEUX-OULDRIANE, Samuel GUILLOT, Aude GAGNER, Laurence BUREL, Hamidreza RAMEZANI, Fabienne MEDUCIN, Louis HENNET

CNRS - ICMN 3 A avenue de la recherche scientifique, 45071 Orléans cedex 2

sandrine.delpeux@cnrs-orleans.fr

While mesophase emulsions are well known in the field of drug delivery, lipid-based dispersed nanostructures have not yet been developed for water treatment applications. Our goal is to develop a composite material containing nanostructured emulsions capable of trapping external moieties such as emerging pollutants. In particular, we aimed to investigate the driving forces responsible for pollutant absorption.
Structured emulsions were formulated using eco-friendly precursors: squalane as the oil phase and monolinolein as the structuring lipid. The particles were stabilized by a triblock copolymer. An ultrasonic probe was used as a fragmentation tool, producing small particles with diameters in the 250–300 nm range. The internal structures were tuned by varying the lipid-to-oil ratio and were fully characterized using scattering techniques (SAXS).
The absorption kinetics of endocrine-disrupting compounds (bisphenol, phthalates, parabens, etc.) were investigated, showing that absorption rates correlate with both the type of internal structure and the interfacial area within the droplets. Trapping efficiencies were determined indirectly by monitoring pollutant concentration as a function of contact time between the mesophase dispersions and the pollutant solution reservoir, using UV spectroscopy and liquid chromatography.
To obtain a material that is easy to handle and suitable for water treatment applications, the mesophase particle dispersions were encapsulated in a biopolymer matrix based on sodium alginate. Using a dripping technique, the final material was prepared in the form of macroscopic colloidal beads. Since pollutants can directly access the internal emulsion droplets through the polymer network, the capture ability of the lipid mesophase particles is preserved. As observed for the structured emulsions, the absorption properties of the composite material depend on the lipid content and therefore on the nature of the internal structures and the interfacial area. We have shown that the absorbed pollutant affects the interfacial curvature in the monolinolein/squalane/water system.

Keywords:
emulsions, lipid mesophases, pollutant trapping