

Gold nanoparticles as nanoprobess for membrane rigidity in model liposomal carriers

Lipid-based vesicles are gaining increasing attention as food-grade carriers for the delivery of bioactive compounds, flavors, and nutrients. Their mechanical properties play a crucial role in determining their performance in complex food environments, affecting ingredient protection, release kinetics, and shelf life. In this study, we introduce a nanoplasmonic strategy to probe the bending rigidity of model liposomal membranes using citrate-capped gold nanoparticles (AuNPs) as optical sensors.

To this end, we prepared a library of unilamellar liposomes having low polydispersity and similar size from a set of synthetic phosphatidylcholines (PC), with varying acyl chain lengths and degrees of unsaturation. These vesicles serve as simplified but relevant analogues of food-compatible lipid carriers.

Upon interacting with the liposomal surface, AuNPs spontaneously adsorb and cluster, resulting in distinct red-shifts in their localized surface plasmon resonance (LSPR), which correlate with lipid membrane stiffness. Notably, our UV-Vis spectral analysis revealed the appearance of isosbestic points in a specific liposome concentration range. The isosbestic wavelength is unique to each lipid composition and dependent on membrane rigidity. This method offers a non-invasive, label-free strategy for real-time monitoring of the mechanical properties of lipid vesicles. Our findings lay the groundwork for future investigations on how the encapsulation of food ingredients may modulate the mechanical behavior of lipid-based delivery systems. By combining plasmonic nanoparticles with food-relevant lipid models, this approach provides valuable insights for the design and characterization of functional liposomal carriers in food applications.

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