Technical Brief (UST-006)

Stability of curcumin nanoemulsions produced by Ultra Shear Technology

Summary: Ultra Shear Technology™ (UST™) produced optically clear nanodispersions of curcumin encapsulated in 60 nm oil droplets. Nanoemulsions were stable for at least three months at room temperature and following multiple freeze-thaw cycles.

Background: The potential therapeutic use of curcumin is severely compromised by its insolubility in water and low oral bioavailability. Bioavailability is further decreased by the conjugation of free curcumin in which pharmacologically inactive metabolites are rapidly formed. However, free curcumin is better preserved when encapsulated [1] and systemic bioavailability is increased significantly when provided in lipid-based formulations [2], [3], [4].

The correlation between small oil droplet size and the increased absorption of bioactive curcumin from soybean oil nanoemulsions has been demonstrated [5]. Oil droplet size is a function of both formulation (the relative hydrophobicity and concentrations of bioactive, oil, and surfactant) and the method of physical shear used to prepare nanoemulsions. Progressively smaller particle sizes are produced by intense fluid shear during the UST process, where course emulsions are repetitively forced through a nanoscale valve at unprecedented high pressure [6].

Methods: Curcumin powder (Stratum Nutrition, Carthage, MO, USA) was dissolved at 10 mg/mL in isopropyl myristate (IPM) or argan oil (AO) oil phase. Surfactant phase was a combination of two surfactants in which hydrophilic-lipophilic balance (HLB) was adjusted to match each oil phase. Course emulsions were prepared by rotor-stator homogenization at 35,000 rpm for two minutes. Course emulsions were cycled through the UST valve for 1-10 cycles at 45,000 psi. The progression of particle size reduction was monitored by dynamic light scattering (DLS) measurements after each cycle. Increased optical clarity was quantified by UV/Vis spectroscopy.

Results: Course emulsions prepared by rotor-stator homogenization produced milky orange suspensions prone to rapid phase separation. Oil droplet size was decreased to 100 nm following four cycles through the UST valve. A minimum particle size of 63 nm was observed in AO nanoemulsions after eight cycles (**Figure 1A**). A minimum particle size of 82 nm was observed in the IPM formulation after six UST cycles. Nanoemulsions transitioned from opaque to optically clear yellow dispersions due to decreased Rayleigh light scattering as particle size decreased (**Figure 1B**).

AO and IPM nanoemulsions were stable for at least three months room temperature storage (**Figure 1C**). Nanoemulsions frozen at -20°C remained stable over seven consecutive freeze thaw cycles.

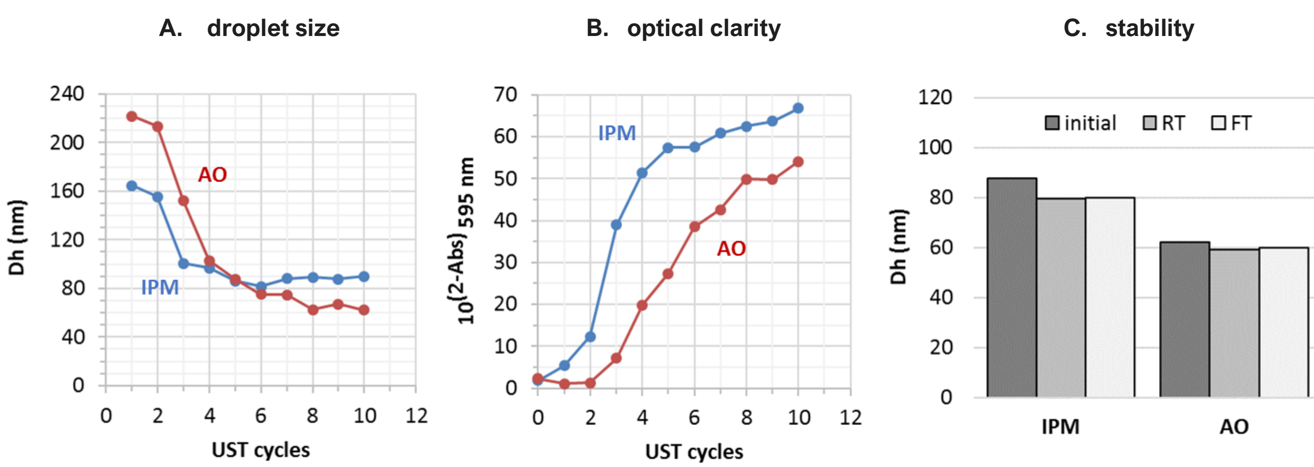

Figure 1. (A) Progressive reduction of oil droplet size in argan oil (AO) and isopropyl myristate (IPM) nanoemulsions as a function of the number of passes through the UST valve. Droplet size expressed as mean hydrodynamic diameter (Dh), **(B)** Clarification of nanoemulsions commensurate with decreased light scattering of smaller oil droplets. Expressed as transmittance. **(C)** Stability of nanoemulsions following three months storage at room temperature (RT) or frozen at -20°C and followed by seven consecutive freeze thaw (FT) cycles.

References:

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