



IFPRI Project Abstract

Accelerated acoustic prediction of aging and failure

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Project Objective:

This project aims to predict stability time scales using a low-energy acoustic platform to non-destructively accelerate the aging of wet dispersions. The method works by increasing the activity of particles through pulses of high frequency ultrasound, which increases the rate of destabilization without raising the temperature of the systems. The PI will test this method on different kinds of formulations that best represent the technological interests of the IFPRI member base.

Approach:

We apply acoustic waves to two academic model systems, including a colloidal gel of polymeric poly(methyl methacrylate) particles suspended in a slightly density-mismatched solvent, and a oil/water nanoemulsion system with two co-surfactants. A separate set of industrial samples from an IFPRI partner is also undergoing testing. An acoustic transducer transmits ultrasound waves of variable powers into the samples over an aging time period between 1-6 hours. The macroscopic phase separation and microscopic destabilization mechanisms (flocculation, Ostwald ripening, and coalescence) are tracked over a period of days to weeks. Comparisons between naturally aged and acoustically aged samples are made in parallel.

Recent Results:

Results indicate that the application of acoustic pressure in the range of 30-50 kPa hastens microscopic coarsening in both systems, with a delayed effect on visible phase separation. For colloidal gels, acoustic aging leads to a 1.5x increase in the rate of visible sedimentation that corresponds to an increase in the local volume fraction measured using confocal microscopy. However, changes in the radial distribution function and the contact number distribution are less apparent, an observation that is also present in IFPRI dispersion samples. For nanoemulsion systems, acoustic aging increases the rate of Ostwald ripening by 5x. The larger droplets cream and form a concentrated layer at the top of the material, leading to an increase rate of coalescence that is independent of the applied acoustic power.

Next Steps:

Future research will comprehensively reveal the stability criteria for both colloidal gel and nanoemulsion systems, in which the role of acoustic energy density on the effective diffusion coefficient of the colloidal systems will be investigated. Findings from the two academic model systems will be applied to functional IFPRI samples including capsule suspensions and emulsions.
