Exploiting Small-Molecule Self-Assembly Properties to Create Edible Supramolecular Structures

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The need for creating new food products with enhanced nutritional properties has forced researchers to seek new ways of structuring food materials. Of particular interest to our group is the modulation of the physiological effects of edible fats and oils via the the creation of novel nano and microstructures in the food material. Here we show how the the self-assembly properties of monostearin, a high melting point emulsifier, into lamellar liquid crystalline phases and conversion to crystal hydrates can help encapsulate oil into multilamellar monolgyceride microvesicles. These microvesicles interact via electrostatic interactions to form a plastic material with the functionality of a baking shortening. This oil microencapsulation was also shown to have a significant effect on lipid and insulin metabolism in humans: an attenuated increase in blood lipids as well as a decreased insulin release into the blood. This controlled release of lipids via structuring of the food material promises to lead to the development of more healthful foods and has profound implications for obesity and type II diabetes. Edible oils can also be gelled via judicious use of small-molecule organogelators. Hydroxystearic acid (HSA) is one such organogelators. This molecule will self-assemble into nanofibers, which themselves aggregate into long crystalline fibers of several hundred microns in length. This organogel network can form at concentrations as low as 0.5% w/w in the oil, creating a transparent and elastic gel. The mechanism of formation of this unique fractal fibrous network created via nucleation and crystal growth processes, rather than diffusion or reaction limited aggregation, will be discussed considering the structure of HSA. Other potential novel structuring strategies will also be discussed.