Fabrication of Pickering particles from food-grade lipids

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Emulsions form a significant part of the food industry today. Sauces, butter, margarine, milk, ice-cream, soups, dressings, mayonnaise and table spreads are foods that are either wholly or partly food emulsions, or have been emulsified at a certain stage of their manufacture.

Due to the inherent thermodynamically unstable nature of oil in water (o/w) and water in oil (w/o) mixtures, surfactant(s), along with an input of energy, are usually required to provide kinetic stability. Although surfactants have been widely used to reduce the interfacial tension in emulsions, their colloidal solid particles counterparts have been gaining prominence in the last decade. Originally described at the beginning of the last century, solid particles can effectively stabilise emulsions and foams according to a simple stabilisation mechanism – the so called Pickering-type stabilisation. Provided that particles have the correct size and wettability characteristics, they can adsorb irreversibly at the oil-water interface forming a densely packed layer which arrests droplet flocculation and coalescence by steric hindrance [1], as shown in Fig.1. Alternatively or conjointly, particles can stabilise emulsions via the formation of a 2-D or a 3-D particle network. The unique physicochemical features that they exhibit, provide superior long-term stabilisation to the system, while at the same time, the use of excessive amounts of toxic surfactants is minimised or completely avoided.

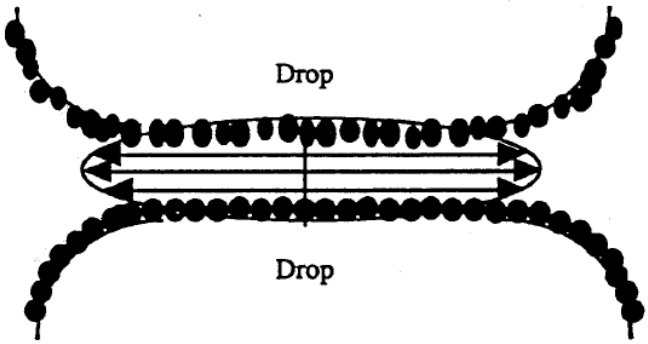

Figure 1. Colloidal particles inhibiting drop-drop coalescence by steric hindrance [2]

In recent years, considerable research activities have been directed towards the use of microparticles and nanoparticles as stabilisers of liquid droplets. Particle stabilisation of emulsions and foams is a growing research area, with the number of related publications increasing exponentially during the last decade. Pickering emulsions have been mainly stabilised by inorganic materials such as silica, clay platelets, iron oxide, hydroxides, metal sulfates and carbon. However, the key challenge remains the identification of edible structures that can act as Pickering stabilisers. Among the encouraging strategies for the creation of food-grade colloidal particles is the use of biopolymers, such as proteins and polysaccharides, but also lipids. Various scientists have explored the potential of different ‘as

obtained' particles of biological origin. Flavonoids, chitin, and hydrophobically modified starch are some examples of particles in the micron and nano-scale that have successfully stabilised o/w emulsions by the Pickering mechanism [3].

A few attempts have albeit been made to actually produce these food-grade particles in a controlled way. Manufacturing methods for the production of microparticles and nanoparticles have been extensively studied in the pharmaceutical technology and drug delivery fields. It is anticipated that the careful design of solid particles will allow the addition of the required functionality to the final product, namely the ability to stabilise double emulsions via the Pickering mechanism. In general, the effectiveness of the solid in stabilising an emulsion is a function of particle size, shape, concentration, wettability and the inter-particles interactions. By means of manipulating formulation properties, evaluating different process routes and altering process parameters, one can theoretically fabricate the ideal particle, both in terms of size, as well as selective functionality, taking into account at the same time the increasing demand for natural ingredients and sustainable development.

Particles made of lipids could be an option for the design of Pickering-type emulsion stabilisers. Crystallised lipid droplets constituting the dispersed phase of an emulsion, are used as templates to construct lipid crystals. Characterisation of such a system is of paramount importance to understand and evaluate its behaviour.

In this work, a system made of edible solid triglyceride particles was studied along with the effect of the presence of a small molecule emulsifier. Tween 80 was selected as it is a very common food ingredient, cheap, generally available and well studied in the model system of o/w emulsions. The key parameters, that have a direct impact on the particle's stability and overall performance, are their size and size distribution, the thermal profile (polymorphic state) and the interfacial properties. Current work provides the fundamental knowledge on the triptych production method – formulation – particles properties that will allow their subsequent use in the stabilisation of simple o/w emulsions.

References

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