A new approach to improving the nutritional profile of fats in food products

Solids fats such as butter, shortening, or hydrogenated vegetable oils are a ubiquitous component of foods which contain a significant portion of liquid oil structured by a high-melting fraction, or "hardstock". Fats contribute to many of the desirable attributes associated with foods, such as texture, taste, and overall product performance. They can provide oral sensations such as creaminess of ice cream and custards, and the "melt in your mouth" property associated with chocolates and confections. Solid fats also restrict the migration of oil within foods, which can be critical for maintaining product quality. However, these desirable functional properties of fats are generally associated with a high content of saturated and/or trans-fatty acids. Trans fats in particular have come under heavy scrutiny in recent years, and governing bodies in several developed nations are in the process of banning the use of partially hydrogenated oils, as these fats represent the most significant source of dietary trans-fats in the food chain. This has put pressure on the industry to find suitable alternatives which can maintain the desired product performance.

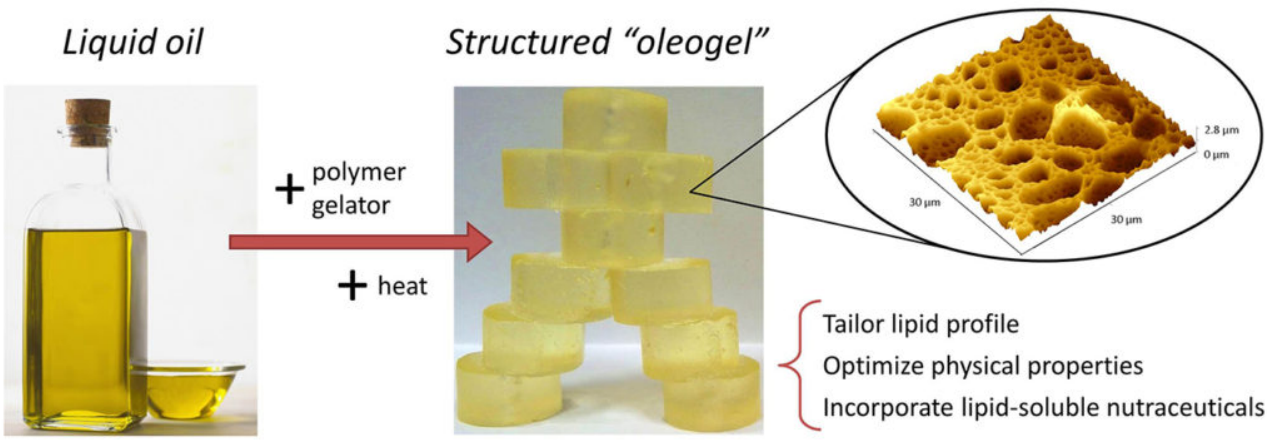

Fig. 1. Structuring edible oils using ethylcellulose is achieved by dissolving the polymer in heated oil. When cooled, the polymer forms a space-filling 3-dimensional network, trapping the oil in discrete pockets (micrograph inset). The physical and nutritional properties of the oleogel can be tailored by appropriately modifying the formulation.

In recent years, an alternative route to structuring edible oils, termed "oleogelation", has emerged as a potential strategy to impart the functional properties associated with solid fats, while removing high melting point trans and saturated fatty acids. A number of oleogelators have been identified with potential for food applications; however, the range of physical properties which can be achieved with most of these structuring agents is quite limited. In this regard, the polymer oleogelator ethylcellulose (EC) is a unique exception. EC oleogels are prepared by dissolving the polymer in oil via heating, and subsequently cooling the solution leads to the formation of a three-dimensional network which traps the oil in discrete pockets (Fig. 1). Our group has shown that the oil source, addition of food grade additives, and thermal processing conditions can be used to tailor the hardness, texture, and performance of EC oleogels.

Here, we have combined EC with a secondary, lipid-based oleogelator which structures oil by forming a crystal network; a 7:3 mixture of stearyl alcohol (SO) and stearic acid (SA). This ratio has greater oil binding properties at low concentrations due to the formation of a mixed SOSA crystal with an optimal molecular packing arrangement. We hypothesized that the polar headgroups of these amphiphilic molecules could allow them to form hydrogen bonds with EC, thus forming a “hybrid” polymer/crystalline oleogelator system. Light micrographs demonstrated that the presence of EC drastically altered the crystallization behavior of the SOSA network (Fig. 2). Alone, the SOSA molecules formed randomly distributed crystals with a platelet-like morphology, while addition of EC in the hybrid system produced arching, branched clusters of needle-like crystals which assembled along the polymer backbone. X-ray diffraction experiments showed that despite the differences in microstructure, the molecular packing arrangement of the SOSA crystals was unaffected by EC, indicating the mixed crystal was preserved. The SOSA molecules also influenced the properties of EC, effectively plasticizing the polymer chains, which manifested as a depression in the glass transition temperature, and subsequent dissolution.

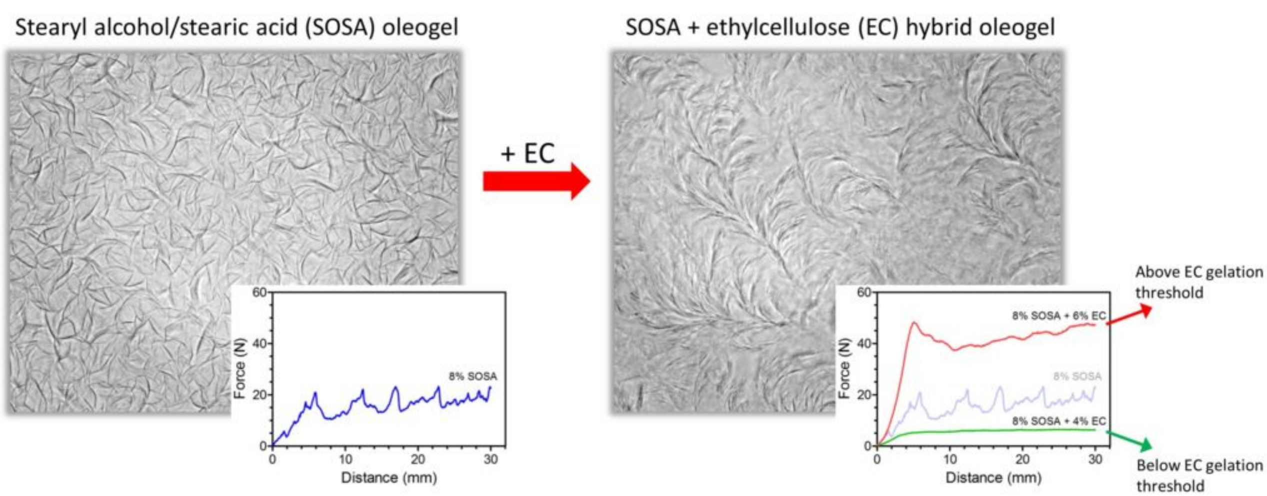

Fig. 2. Microstructure and large deformation flow curves of oleogels structured with SOSA (left) and the hybrid EC/SOSA system (right). Formulations of oleogels used to produce flow curves are indicated in the figure.

The improved plasticity of the hybrid network was demonstrated using back extrusion flow curves (Fig. 2). Gels structured with SOSA alone exhibited significant brittle fracture in the steady-state flow regime, while the combined system produced a substantially stronger gel than either EC or SOSA alone, and displayed a smoother flow profile, akin to fats. These attributes were indicative of a synergistic improvement in the gelation properties. Furthermore, when the EC content was below the gelation threshold (i.e. did not form a space-filling network), the resulting gel was softer, and displayed no brittle fracture. This flow profile was comparable to various commercial fat spreads (i.e., margarines). These results lead us to believe that a hybrid EC/crystalline oleogelator with a suitable melting profile could produce structured oils with appropriate functional properties expected from traditional fats.

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