6.3 Nanoformulations of Bioactive Compounds

Nanotechnology has revolutionized various fields of science and developed novel applications in several fields of industry, including the food industry. Nanotechnology has answered many of the quests for healthier food and related products, and shows increasing consumer acceptability. At the nanoscale, macroscale properties like sensory attributes, processability and stability of food materials or active compounds are modified. Nanotechnology can also help in designing bioactive functional food ingredients with improved physical properties, like water solubility, thermal and chemical stability, physiological performance and bioavailability, along with sensory attributes. Bioactive functional food at nanoscale is engineered by various mechanisms like encapsulation of active materials into nanoparticles or nanocapsules, formation of nanoemulsions and liposomes, incorporation into nanofibers, to list a few.[14,53–58] Many bioactive compounds that are used as nutraceuticals are highly lipophilic, which affects their bioavailability when administered orally. Excipient food matrices can help in solubilizing, transporting and controlling the release, metabolism and absorption of bioactive compounds. While the excipient ingredients do not have any bioactivity by themselves, these are able to promote the bioactivity of the co-ingested bioactives, even when administered orally. It is possible to engineer nanocolloidal systems, micro/nanoemulsions and solid lipid nanoparticles with bioactive compounds using excipient food matrices.[59] A review highlighting developments in nanodelivery systems that can overcome the challenges in incorporating lipophilic bioactives into food was published recently. Various delivery systems like emulsions, microgels and biopolymer nanoparticles can be used for this purpose (Figure 6.1).[60] The author suggests that future research should focus on developing commercially viable delivery systems.[60] While there are many reports of technologies that support the use of hydrophobic compounds, there are not many that discuss the developments in hydrophilic compounds. Development of delivery systems using hydrophilic compounds is also associated with various challenges. Liposomes, multiple emulsions, biopolymer particles and solid fat particles are some of the techniques used to develop delivery systems using hydrophilic bioactive compounds like water-soluble colors, preservatives, flavors, enzymes and vitamins.[61] Lipid based formulations are one of the most commonly used delivery system in food related application. A review on four lipid-based encapsulation systems discusses their fabrication methods, physicochemical properties and potential advantages and disadvantages when used as a delivery system.[62] Nanoemulsions, liposomes, solid lipid nanoparticles and nanostructured lipid carriers were the four lipid-based delivery system discussed in the review. The authors point out that along with the physicochemical analyses of the nanocarriers, studies on the interactions of food systems with nanoencapsulated bioactive compounds are also required.[62]

Food proteins are a versatile matrix choice for incorporating nutraceutical compounds to create a wide range of multicomponent matrices. Apart from