

be synthesized by associative or segregative processes, and additional stability enhancement can be brought about by internal biopolymer cross-linking. Biopolymer nanoparticles synthesized by the thermal processing and electrostatic complexation of whey protein isolate and beet pectin were used to encapsulate anthocyanins.<sup>20</sup> Although the encapsulation improved the heat stability of anthocyanin, the antioxidant activity was reduced due to the thermal processing. In the presence of ascorbic acid, the distinctive color of the anthocyanin was also lost. The authors suggest that this method is good for improved stability of anthocyanin, but when considering all the properties, alternative strategies are required for better applicability.<sup>20</sup>

Micellar nanoparticles are another group of effective carrier-delivery system that can protect and carry active compounds. Mimicking nature, casein micelles were developed to encapsulate and stabilize hydrophobic nutraceuticals, in this case, vitamin D2, for enrichment of non/low fat food products. The encapsulation efficiency of vitamin D2 and its protection from photochemical degradation inside the casein micelles were studied, and encapsulation was found to provide partial protection against UV-induced degradation. Caseinates are popular encapsulation materials and this study suggests that casein micelles are potential nano-vehicles that can be used for the entrapment, protection and delivery of bioactive nutraceuticals and functional compounds within food products.<sup>98</sup>

Pomegranate, also known as “the jewel of autumn”, is a mine of nutrients and antioxidants. It is one of the oldest known edible fruits, and is revered as a symbol of prosperity, fertility, health and eternal life. Polyphenols of pomegranate—pomegranate extract, punicalagin or ellagic acid—were encapsulated in PLGA–poly(ethylene glycol) (PLGA–PEG) nanoparticles by double emulsion-solvent evaporation method and the anticancerous activity of the nanoparticles was tested in MCF-7 and Hs578T breast cancer cell lines. Encapsulated punicalagin nanoparticles were the most potent in inhibiting cancer cells.<sup>99</sup> Larger, microcapsules are also significant delivery systems. A new method was developed for pomegranate seed oil encapsulation by spray drying, which can be used in the food industry. All parts of the fruit, including the seed and peel, are nutritional, but they are discarded as waste during industrial processing of pomegranate. To utilize the nutritional properties of pomegranate seed discarded from the juice and concentrate industries, a method to extract and encapsulate pomegranate seed oil was developed. To overcome the instability and oxidative deterioration, microencapsulation by spray drying was used and skimmed milk powder was used as the encapsulating agent. The authors also report the effect of various parameters used for the encapsulation technique on the encapsulation efficiency.<sup>100</sup> de Conto and coworkers reported the use of commercial microencapsulated omega-3 fatty acids and rosemary extract in white pan bread. They evaluated the influence of these additives on the sensory and technological qualities of the bread. Rosemary extract from *Rosmarinus officinalis* is rich in antioxidants and is extensively used in various cuisines and the food industry.<sup>101</sup>