

immobilized enzymes or cells as soon as the desired alcohol production is achieved. The use of immobilized cells is also said to ease the process of yeast cell separation [65].

12.7.2 Probiotics

Probiotics are beneficial live microorganisms that are consumed to improve the immunity and overall health of humans [66]. The commonly known probiotic foods such as fermented milks and yogurt, cheese, ice cream, and dairy desserts face major problem in the retention of viability of microbes. The factors that influence the viability of probiotic bacteria include titratable acidity, pH, oxygen concentration, storage temperature, lactic and acetic acid concentrations, and interaction with other microbes in the product [67].

Microencapsulation technique favors the viability of probiotic cultures by protecting them from environmental conditions and also helping in their controlled release. The encapsulation of probiotics in alginates is preferred due to the ease of production or handling, nontoxic nature, biocompatibility, increased viability, and low cost of production [68]. The microencapsulation with sodium alginate is also proved to form a versatile gel matrix, a biocompatible and nontoxic protection layer for probiotic microbes from pH, heat, oxygen, and others factors when the food is exposed to different processing and storage conditions [46]. Among all the microencapsulation techniques such as spray drying, spray congealing, and spray freezing, the ionic gelation method is preferred due to its simple and inexpensive procedure [69]. As discussed earlier, the microencapsulation of probiotics using alginate in the desired size for food application can be achieved by both external ionic and internal ionic gelation methods (Figure 12.7). But time, cost, and complexity involved in the internal ionic gelation method make it less preferable than the external ionic method.

The use of microencapsulated probiotic bacterial culture protects the microbes from detrimental conditions in fermented milk products [53, 70]. The process of microencapsulation of probiotics with alginates helps to improve its viability in fermented milks [71–73] and in gastrointestinal tract [74–78]. Alginate is also preferred as an encapsulating agent because of its biocompatibility, simplicity, availability, cheapness, and good intestinal digestibility [53, 70].

Chandramouli *et al.*, [79] reported that the calcium alginate encapsulated *Lactobacillus acidophilus* was viable in the acidic condition (pH 2.0). It is also reported that a maximum viability of 106 CFU/mL was achieved when the culture was encapsulated with 2% calcium alginate. In another study by Kim *et al.*, [80], *L. acidophilus* ATCC 43121 encapsulated with calcium