

which prevents seaweeds from dehydration once they get exposed to air [38]. The composition of alginate obtained from different seaweeds varies in accordance with their growth conditions, seasonal changes, and other environmental factors. These variations also can later affect the mechanical properties of alginate [39, 40].

There are several alginate-coated food products (reformed meat, pet food, carb sticks, onion rings and a few others) available in the market and widely distributed [41–43]. Every year, about 30,000 metric tons of sodium alginates is used in food, pharmaceutical, and textile industries as thickening, stabilizing, and jellifying agents [44].

During alginate biofilm formation, calcium ions act as gelling agent and are used to bind alginate chains by means of ionic interaction. Calcium ions bind strongly with guluronate blocks, which leads to inter-chain organization. This structural alignment is known to be “egg-chain” mechanism [45]. Therefore, alginate films have high water vapor permeability, impermeability to greases and oils, and barrier property to oxygen [9]. During microwave cooking, lack of crispiness in the packed food has been observed; to overcome this problem, active packaging with susceptor (used for converting electromagnetic energy to heat) is developed specifically for microwave heating. Due to its edible property, alginate film with high concentration of salt is used as a susceptor in microwave cooking [46].

11.4 Biosynthesis of Alginate

Alginates are commonly represented as a family of related molecules. The structure of alginates can be explained as unbranched (1-4)-linked polysaccharides consisted of β -D-mannuronate and its α -L-guluronate as its C5-epimer. Though alginate is manufactured mainly from brown seaweeds, some bacteria of the genera *Pseudomonas* and *Azotobacter* can also produce this biopolymer [41, 47–49]. It is known that the polysaccharide arrangements in the structural blocks of the monomer residue in the alginate produced by seaweeds are similar to those synthesized by *Azotobacter vinelandii* [20].

Biosynthesis of alginate from *A. vinelandii* was first studied by Pindar and Bucke [50]. They have explained the biosynthesis procedure in four stages: (i) synthesis of precursor, (ii) transfer and polymerization of cytoplasmic membrane, (iii) transfer and modification of periplasm, and (iv) transport through outer membrane [51]. Mostly, all commercially