

maximum level of alginate production was 2 g/L [18]. At a shaking rate of 170 rpm, and in the absence of pH control, a mutant strain of *A. vinelandii* NCIB 9068 produces 6.22 g/L alginate [9]. On increasing the rate of agitation from 200 to 400 rpm, the growth rate of bacteria was almost doubled from 0.165 to 0.239 h⁻¹. However, alginate production was found to peak at 400 rpm with the highest yield of 4.51 g/L obtained close to the termination of fermentation. Increased agitation or shaking speed along with variation of other determinants like aeration and phosphate concentration was often employed by different researchers to achieve optimal production of alginate.

2.2.6 Commercial Production of Alginate

The extraction of alginate from algal material is carried out commercially to produce alginate. Initially, acidification of insoluble counterion of alginate is effected by extracting the milled algal tissue with 0.1–0.2 M mineral acid. Alginic acid thus brought into solution is neutralized with an alkali such as sodium carbonate or sodium hydroxide to form water-soluble sodium alginate. Different separation techniques may be employed to remove algal materials, other than alginate, such as sifting, flotation, centrifugation, and filtration. After this elimination of impurities, sodium alginate is precipitated by addition of alcohol, calcium chloride, or mineral acid, reconverted to the sodium form as required, and finally dried and milled. About 35 years ago, a similar route for microbial production of alginate was suggested [19]. But this requires that the biological pathway to alginate formation be clarified, if maximal microbial alginate production is to be achieved commercially. In this regard, numerous questions are still in search of answers [14–18].

2.3 Characterization of Physicochemical Properties of Alginate

Alginates are linear unbranched polysaccharides containing different numbers of β -d-mannuronic acid (M) and α -l-guluronic acid (G) residues. The monomer composition G/M ratio and the molecular weight of alginates are known to have effects on their properties. The chemical composition and sequence of the two types of residues are affected by the biological source and the growth and seasonal conditions of the marine plants. The seaweed species, harvesting region, season, sea current, water temperature, and processing method are all factors that affect important structural features of the alginates.

Slightly more than 200 different grades of sodium alginate are commercially available from manufacturers [20]. The molecular weight average of