

generally applied procedure [9] involves extracting the alginate as sodium alginate. The insoluble calcium and magnesium alginates present in the brown seaweed cell walls are extracted by maceration and converted to soluble sodium alginates, eventually obtained as alginic acid or calcium alginate. The consecutive addition of acid, alcohol, and sodium carbonate affects the conversion. The extraction procedures applicable to alginate extraction encounter problems such as insolubility from seaweed residuals interfering with the ease of separation. Filtration of the solution of dissolving alginate as sodium alginate requires large volumes of water, as the increased viscosity of the solution makes the separation onerous. The fine particulate nature of the seaweed residuals can block the filter; so filter aids are required to ease the process and make it cost effective. Also, the chemicals utilized for extraction influence the physicochemical properties of alginates. There exists a need to establish extraction and processing by alternate and milder methods, so as to overcome the problems faced in the traditional extraction procedures along with the detrimental effects on the quality and quantity of alginate yield. Enzymatic extraction techniques of alginate from seaweed using enzymes such as alginate lyase, laminarinase, which could degrade the seaweed cell wall to release free alginate, have been studied, but not standardized to routine extractions. The main hurdles facing alginate producers are the varying available areas for alginate farming and production due to increasing non-alginate uses for the same types of seaweed, increasing government proscriptions on the harvesting of natural seaweeds, and decreasing ease of access to large natural seaweed resources. Natural seaweed releases alginate alone into the surrounding sea water, but in the marine environment, it is converted to sodium salt of alginates. Hence, potassium alginate also is present in the extract from cells of marine seaweed. Calcium alginate is obtained from sodium alginate, where sodium is substituted with calcium.

2.2.2 Production of Alginate by Bacteria

Alginate-producing microbes can be screened by the cetylpyridinium chloride (CPC) method and the plate assay method. In the CPC method, enrichment culture technique is employed to screen for microorganisms capable of producing alginate lyase enzyme through their ability to grow on alginate-containing solid media plates; a clearance zone is formed after flooding the plates with agents such as 10% (w/v) CPC, which can form complexes with alginate, absent in the presence of digested alginate.

In the plate assay method, alginate-containing agar plates are flooded with Gram's iodine in place of CPC. Gram's iodine forms a bluish black complex with alginate but not with hydrolyzed alginate, giving rise to