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An overview on the development of conventional and alternative extractive methods for the purification of agarose from seaweed

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ABSTRACT

This overview describes the development of the classical and alternative methodologies used for the extraction of agarose from seaweed. The first mentioned methods for agarose extraction, including acetylation of agar, methylation and extraction using polyether compounds, do not show high yield or good quality of agarose extract-product. Besides that, they ceased to be eco-friendly. The low level of their environmental sustainability has led to the development of alternative technologies to produce agarose in a more purified, ecological and cost-effective manner. Examples of these methods include mainly ionic liquid (IL)-based or bio-IL-based extraction. This review is aimed at providing a survey on agarose extraction techniques and methods related to biomolecules separation.

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Introduction

Various types of seaweeds can be used to produce hydrocolloids, which are water-soluble polysaccharides, and the principal extracts that could be obtained from seaweeds are agars, alginates and carrageenan. Hydrocolloids can be dissolved in water to thicken solutions and form gels. The processed food industries have retained the market for seaweed hydrocolloids for use as texturing agents and stabilizers, while agar and its derivative products agarose have been attractive for the purpose as microbiological media.[1] Besides these extracts, growing attention is being placed on the production of biologically active compounds like animal and plant nutritional supplements from seaweed. This will enhance the potential of seaweeds as food supplies, food flavourings, food colourings and nutrients. The agar consists of two fractions: one fraction is a neutral galactose polymer known as agarose and the other fraction is an ionic material containing sulphate and carboxyl groups known as agaropectin. The proportion of agarose and agaropectin in agar varies according to their original sources. The concentrations of agarose and agaropectin are higher in seaweed species such as *Gracilaria*, followed by *Porphyra* and *Gelidium*, but the higher-quality agar with less ash and lower sulphate content can be found in *Gelidium, Porphyra* and *Gracilaria* species, respectively.[2]

Agarose is a hydrophilic linear galactan that is synthesized through the purification of agar. Agarose is composed of repeating units of agarobiose, which is a disaccharide unit made up of[1,3] linked β-D-galactopyranose (G) and[1,4] linked α-3,6-anhydro-L-galactopyranose (A) (Fig. 1).[3] In diluted or hot solutions, agarose, which consists of polysaccharide polymers, exists as a random coil. It undergoes conformational transitions to form ordered helices in the solid state.[4] Agar and agarose are commonly extracted from red seaweed species such as *Gracilaria, Ceramium, Gelidium, Pterocladia, Acanthopeltis* and *Campylaephora*.[5] When heated and cooled, agarose will form a gel that can be used as a supporting medium in gel electrophoresis. It is also a common neutral gelling substance and has wide applications in the field of biotechnology and other industries. Apart from that, the higher porosity, lower electroendosmosis, non-toxicity properties of agarose hydrogel formation and high strength of matrix in agarose make it advantageous over the other media such as polyacrylamide in various applications.[6] Agarose also

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