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Preparation and Functional Evaluation of Agarose Derivatives

Jai Prakash Chaudhary,[1] Stalin Kondaveeti,[2] Vishal Gupta,[2] Kamalesh Prasad,[2,3] Ramavatar Meena[1,3]

[1]Scale-Up and Process Engineering Unit, CSIR-Central Salt and Marine Chemicals Research Institute, G. B. Marg, Bhavnagar 364002, Gujarat, India

[2]Marine Biotechnology and Ecology Discipline, CSIR-Central Salt and Marine Chemicals Research Institute, G. B. Marg, Bhavnagar 364002, Gujarat, India

[3]Academy of Scientific and Innovative Research, CSIR-Central Salt & Marine Chemicals Research Institute, G. B Marg, Bhavnagar 364002, Gujarat, India

Correspondence to: R. Meena (E-mail: rmeena@csmcri.org)

ABSTRACT: A facile microwave-assisted one-pot synthesis of sodium carboxymethylagarose and calcium carboxymethylagarose from *Gracilaria dura* agarose (Ag) has been described. The process is user friendly, and the highest degree of substitution was obtained within 15 min compared with the conventional method, which requires more than 3 h. Solubility and gelling behavior of the modified Ag products were found to be dependent on degree of substitution of the products. The characterizations were done by using Fourier transform infrared spectroscopy, ^{1}H- and ^{13}C-nuclear magnetic resonance spectroscopy, thermogravimetric analysis, scanning electron microscopy, Inductively coupled plasma spectrophotometry (ICP), rheology, conductometer analysis, and DNA gel electrophoresis. These agarose derivatives were easily soluble in water and exhibited low thermal hysteresis, improved conductivity, and improved the DNA resolution ability of the parent *G. dura* Ag hydrogels. These hydrogels may have potential applications in the areas including electrochemical devices, microbiology, biomedical, and pharmaceuticals fields. J. Appl. Polym. Sci. **2014**, *131*, 40630.

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INTRODUCTION

Low-temperature (≤70°C) water-soluble polysaccharides, including agar or agarose (Ag), are particularly useful in foodstuffs when incorporation takes place at the pasteurization phase. Because of the high viscosity and nontoxicity, carboxymethylated biopolymers are frequently used in food science as a thickener, stabilizer, and as a constituent of other products, such as toothpaste, laxatives, diet pills, water-based paints, detergents, textile sizing, and various paper products. In the recent years, unmodified and modified biopolymer materials are becoming more promising than the synthetic polymer materials for food, pharmaceutical, and cosmetic industries because of their polyelectrolyte nature.[1–4] Carboxymethylated derivatives of various naturally occurring polysaccharides such as gellan, dextran, starch, chitosan, guar gum, cellulose, and xylan have been reported in the literature, using conventional heating for more than 3 h.[5–12] The multistep carboxymethylation of polysaccharide has also been reported in the literature to obtain the polysaccharide derivatives of desired properties for specific applications.[13–15] Anionic polymers are widely used to add coagulation, curtailing water production in oil wells, release of chemicals, and water purification.[16–18] Gelation of Ag depends on several factors such as concentration, thermal hysteresis, presence of heavy metals, ions, and ionic strength of the solution.[19]

Ag, the red seaweed polysaccharide, is widely used in biomedical and bioengineering applications. The basic disaccharide repeating units of Ag consists of (1,3) linked β-D-galactose and (1,4) linked α-L−3,6-anhydrogalactose as shown in Supporting Information Figure S1(a). Polymer-based conducting hydrogel materials represent an important class of materials that synergize the advantageous features of hydrogels and organic conductors to be used for applications such as bioelectronics and energy storage devices.[20,21] In the year 2000, the chemistry Nobel Prize was awarded to Alan J. Heeger, Alan G. MacDiarmid, and Hideki Shirakawa for the discovery and development of conductive polymers, as well as the ability of salts to prevent the convulsive effects during administration of certain anesthetics; this led to the increase in interest in this field.[22,23] In modern technology, there exists a strong demand for materials that show conductivity, good transparency, and environmental friendly characters.[24] Griess et al.[25] have reported

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