Topic for submission:

Natural and synthetic polymers

Hydrogel-forming potential of sulphated exopolysaccharide (EPS) from Porphyridium cruentum for skin wound healing applications

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Introduction

Gel-like materials have been on the forefront of biomedical research due to their properties such as easily adaptable shape, water-holding ability, and their adjustable degrading rate. Hydrogels from natural origin are gaining attention both for its growing popularity as "green" materials, and due to their many useful properties as compared to synthetic ones, as they are often biocompatible, and biodegradable. They can be locally absorbed, eliminating the danger of damaging the wound during its removal (4).

Marine algae and their metabolites have been widely recognized for their bioactive properties with applications in various industries, such as pharmaceutical, biomedical, cosmetics, and food (5,6). The red unicellular microalgae from the genus *Porphyridium (Porphyridiales, Rhodophyta)* is a natural source for a variety of interesting bioactive compounds, including several pigments (such as carotenoids), phycoerythrin, oligosaccharides, phycobiliproteins, and sulfated polysaccharides (EPS) (7,8). These polysaccharides have unique, and potentially useful, rheological properties when prepared in an aqueous medium. They have relatively high viscosity, behave like non-Newtonian fluids, and undergo reversible thermal gelation upon heating (9,10). EPS have also shown to possess several biological properties of high interest as therapeutic agent, such as anti-bacterial (11), antiviral (9), immunomodulatory, and anti-oxidant properties (12). These properties make EPS an attractive natural material to be used as a new hydrogel platform for healing and regeneration of chronic wounds.

Methods

Sentence on the production of the EPS…The rheological behavior of aqueous solutions of EPS formulations (0.5, 1.5, 2,5 wt% in 0.1M NaOH) in the presence of divalent and trivalent metal ions (M^{2+} and M^{3+}) was measured and compared to gel-cation systems of alginate, a well-characterized polymer. Samples were assayed for their post-gelling properties using a rheometer with a flat-plate geometry. Frequency sweep tests were conducted at a low strain of 0.5%. Biocompatibility was assayed via an indirect contact assay using Human Dermal Fibroblasts (HDF).

Results

In our study, EPS formulations were able to form gels in the presence of Ce^{3+}, Fe^{2+}, Ca^{2+}, Mg^{2+}, and Cu^{2+}. Polymer and crosslinker concentration, as well as crosslinker nature, had a significant effect on gel formation, and post-gelling properties. Higher polymer concentrations (1.5 and 2.5%) led to the formation of stiffer gels. However, overall EPS formulations led to less stiff and stable hydrogels than alginate formulations, revealing that there are further optimizations needed for both gelling conditions and polymer-cation formulations. All formulations used were revealed to be biocompatible after indirect contact assay using HDF cells.

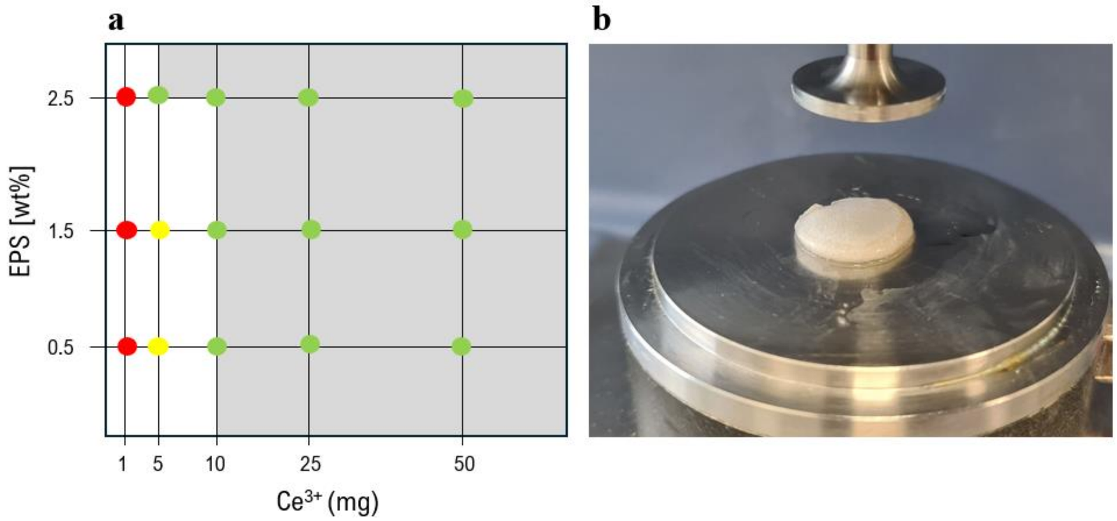

Figure 1. (a) Conceptual diagrams displaying the effect of varying EPS and Ca+ concentration on the hydrogel forming capacity of EPS; (b) Macroscopic view of EPS-cerium hydrogel ready for rheology analysis.

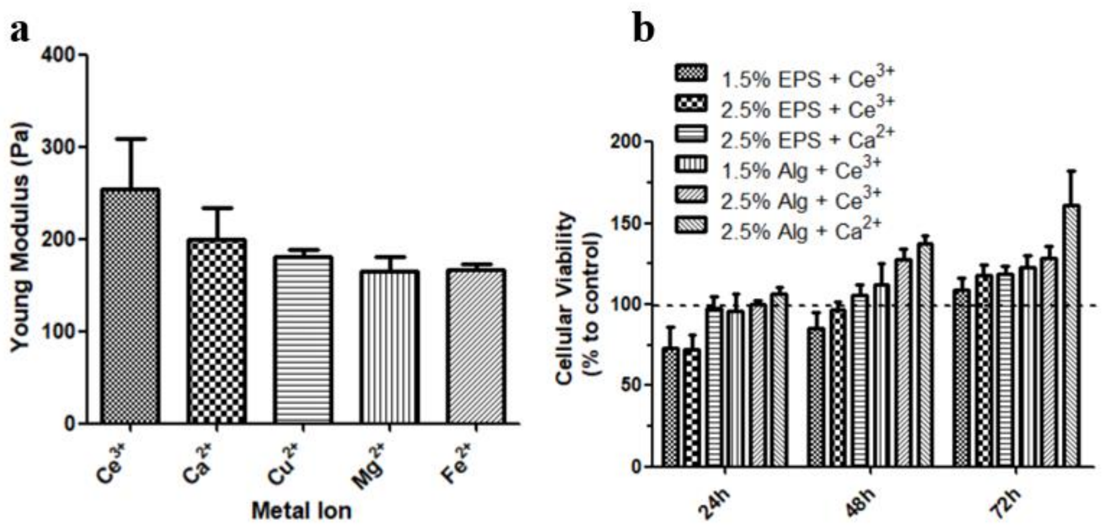

Figure 2. (a) Rheological analysis of the gel stiffness quantified in Young's modulus of EPS hydrogels crosslinked with different polyvalent cations (Ce^{3+}, Ca^{2+}, Cu^{2+}, Mg^{2+},

Fe^{2+}); (b) Cellular viability as measured with resazurin assay. Viability is represented as percentage relative to control (no treatment).

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