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Carboxymethyl guar gum synthesis in homogeneous phase and macroporous 3D scaffolds design for tissue engineering

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ARTICLE INFO

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Guar gum (PubChem CID: 44134661)
Dimethyl sulphoxide (PubChem CID: 679)
Dimethyl amino pyridine (PubChem CID: 14284)
Monochloroacetic acid (PubChem CID: 300)
Lithium chloride (PubChem CID: 433294)
Ammonium bicarbonate (PubChem CID: 14013)
Boric acid (PubChem CID: 7628)
Sodium chloride (PubChem CID: 5234)
Potassium chloride (PubChem CID: 4873)

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ABSTRACT

Guar gum (GG) is a galactomannan obtained directly from the C*yamopsis tetragonoloba* seeds pericarb. The biopolymer hydrates hugely in three chain associated coil formations. Chaotropic Hofmeister ion like lithium interacts at the hydrogen bonding sites and render GG homogenization in polar solvents like dimethyl sulfoxide. This phenomenon was used for the first time for galactomannan derivatisations in homogeneous phase. Higher degree of substitution (DS) that was hereto unattainable in GG was achieved due to Hofmeister ion assisted assembly deformations. Furthermore, carboxymethyl guar gum (CMGG, DS = 1.10) blends well in poly-vinyl alcohol (PVA) at 2:1 mass ratio and enabled hydrophilic porous scaffold design for cell propagation. CMGG-PVA scaffolds porosity was 70–90% and the tensile strength was 6.32 MPa. CMGG-PVA scaffolds were useful as cell factories and in tissue engineering. New generation guar gum derivative scaffolds were non cytotoxic and permitted cell propagation in growth medium.

1. Introduction

Polysaccharides are convenient tools for tissue engineering scaffolds design (Ahadian et al., 2015; Balakrishnan & Banerjee, 2011). Polysaccharide hydrogels are risk free and elicit low or no immunogenic reactions. Covalently modified hyaluronates and biohybrid alginates were extensively investigated in tissue engineering areas (Collins & Birkinshaw, 2013). Polysaccharides in tissue engineering are however often constrained due to lack of structural robustness, specificity and soft matter characteristic. Alginates, experienced uncontrolled polymer degradation and depletion of cell proteins due to electrostatic repulsions. Tissue engineering cellulose nano-crystals are generally not available in consistent quality and cytotoxic reactions were widely reported.

Guar gum (GG) is a hydrated biopolymer obtained directly from the C*yamopsis tetragonoloba* seed pericarbs. GG is used regularly as functional food, in cosmetics, processed food like icecreams and drug delivery (Krishnaiah, Satyanarayana, Rama Prasad, & Rao, 1998). The biopolymer comprises of β 1–4 mannose chain interposed with α 1–6 galactose substituents in almost every second unit. GG hydrates hugely in three chain coil formations due to galactose units' preferential intra molecular hydrogen bonding. The mannose surfaced assembly of the biopolymer is one interesting platform in the protein interfaces (Ghosh, Abdullah, & Mukherjee, 2015). GG *per se* is a non-ionic polymer but it exceptionally binds with lectins and antibodies due to the presence of surface mannose moieties and glycobiology interactions (Pettolino et al., 2001). GG blends well with a range of polyalcohols, proteins and lipids. Protein interactions with partially substituted GG were intelligently applied in designing artificial tear to help circumvent dry eye diseases (Mafi, Pelton, Cui, & Ketelson, 2014). The unique biopolymer structural characteristic has incited us to explore in appropriate scaffolds design for tissue engineering applications.

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