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Seaweed-derived polymeric materials for multiapplications including marine algal cultivation†

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This study described the preparation of phycocolloids based polymeric materials for multiapplications including seaweed cultivation in open sea water conditions *via* grafting reaction of phycocolloids with vinyl acetate (VAc). Best materials were obtained with high gel strength *G. dura* agar and the composite polymeric material showed good extrusion characteristic in softened state, high mechanical strength, and low moisture sensitivity. The material could be degraded by burying in the soil making it advantageous both from the perspective of utilizing a marine bioresource as raw materials for preparation of polymeric materials having the desired property of required stability under conditions of use.

1. Introduction

Semi-refined carrageenan was utilized by us previously to prepare films which could be converted into capsules and also for non-aqueous packaging applications.[1] However, their moisture sensitivity thwarted applications that involved exposure to moisture. The present study was conceived to overcome this drawback. Another motivation for the study was the recognition that large amounts of plastic materials such as ropes are employed for the cultivation of seaweed which poses a threat to the marine environment.[1–3] Thus it would be useful if certain bio-based polymeric materials can be developed which survive in the water (including seawater) conditions as well as in environmental conditions for aqueous applications but which will degrade in soil. It would be most ideal if the phycocolloids themselves can be utilized for this purpose. Phycocolloids are polysaccharides having excellent gelling properties which make them commercially important. The structures of the repeating units of agar of *Gracilaria dura* (AgrGd) and/or *Gelidiella acerosa* (AgrGa), vinyl acetate (VAc) and κ-carrageenan (κC) are shown in Fig. S1.† The former comprises alternating D-galactose sub-units (G) and 3,6-anhydro-L-galactopyranose sub-units (A) linked by α-(1 → 3) and β-(1 → 4) glycosidic bonds. κ-Carrageenan is made up of repeating disaccharide units of α (1 → 3)-D-galactose-4-sulphate and β (1 → 4)-3,6-anhydro-D-galactose residues connected through glycosidic linkages. Phycocolloids have numerous applications in diverse areas such as food, textiles, personal care, pharmaceuticals, biotechnology, *etc.*[4–6] The microbial and enzymatic biodegradation of poly(vinyl acetate) and their blends/composites has been reported in the literature.[7–10] Subsequently, phycocolloids are well known natural polymers used for wider applications including food application. Therefore, we used this composition to design polymeric materials for multi-applications. Hydrophobic cellulosic materials have been reported in the literature using combined effects of surface chemistry and morphology. Fluorocarbons are the most frequently used materials for this purpose.[11,12] This study successfully demonstrated several applications of the products, and also open new areas for such polymeric materials in biomedical and other areas desired such properties.

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2. Experimental section

2.1 Materials

Aqueous phycocolloids, AgrGa, AgrGd and kappa-carrageenan (κC) sols were obtained from *Gelidiella acerosa*, *Gracilaria dura* and *Kappaphycus alvarezii* using method described in the previous works.[1,14] Vinyl acetate, acrylamide, acrylonitrile and potassium persulphate (KPS) used were purchased from Spectrochem Pvt. Ltd., Mumbai, while glycerol, toluene, methanol and acetone were purchased from Sisco Research Laboratory (SRL), Mumbai. All the chemicals were used as received, without further purification.

