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REVIEW ARTICLE

Alginate as Promising Natural Polymer for Pharmaceutical, Food, and Biomedical Applications

Dhalendra Kothale[1], Utsav Verma[1], Nagesh Dewangan[1], Partha Jana[1], Ankit Jain[1,2,*] and Dharmendra Jain[1,*]

[1]Department of Pharmaceutical Sciences, Pharmaceutics Research Projects Laboratory, Dr. Harisingh Gour University, Sagar (M.P.) 470 003, India; [2]Department of Materials Engineering, Indian Institute of Science, Bangalore, Karnataka 560012, India

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Abstract: Alginates are biopolymers usually obtained from brown seaweed, brown algae (Ochrophyta, Phaeophyceae), and bacteria (*Azatobacter vineland* and *Pseudomonas* species) belonging to the family of polycationic copolymers. They are biocompatible, biodegradable, non-antigenic, and non-toxic biopolymer with molecular mass ranges from 32,000-40,000 g/mol in commercial grades. These can be used as edible films or coatings in food industries and also some natural or chemical additives could be incorporated into them to modify their functional, mechanical, nutritional as well as organoleptic properties. Due to their high viscosity and extraordinary shear-thinning effect, they can be used as dietary fibers, thickening, gelling and stabilizing agents. Commercial alginates have vast applications in the fields of biomedical engineering, biotechnology, environmental contaminants treatments, food processing, and pharmaceuticals. Alginates can be used in wound dressings, bone regeneration, neovascularization, protein delivery, cell delivery, theranostic agents, oral drug delivery, controlled release systems, raft formulations, immobilization of biological agents and treatment of environmental contaminants. Various carrier systems can be formulated by the use of alginates like hydrogel, tablets, microcapsules, films, matrices, microspheres, liposomes, nanoparticles, beads, cochleate, floating and supersaturated drug delivery systems. This review presents a broad range of promising applications of alginates, and it can be a great interest to scientists and industries engaged in exploring its hidden potential.

Keywords: Alginate, drug delivery, environmental applications, food applications, pharmaceuticals, tablets.

1. INTRODUCTION

Alginates are derived from marine kelp, which belongs to the family of polycationic co-polymers [1]. Stanford (1881) discovered natural biomaterial polymer usually acquired from brown seaweed, brown algae (Ochrophyta, Phaeophyceae), *Ecklonia maxima*, *Lessonia nigrescens* and *Sargassum are the* species from which, commercial alginates are extracted. Some bacteria are also utilized for the extraction of alginates such as *azetobacter vineland* and *pseudomonas species. Laminaria hyperborean, Laminaria digitata, Saccharina japonica* (formerly *Laminaria japonica*), *Ascophyllum nodosum*, and *Macrocystis pyrifera* are other sources of alginates. The extract can be collected after filtration by adding any of the sodium or calcium chlorides for the precipitation of alginate. Commercial alginates have enormous applications, such as food processing, biomedical engineering, wound dressing, biotechnology (cell immobilization), and pharmaceuticals for delivery of proteins, small chemical entities, and theranostics [2]. Alginates have homopolymeric MM or GG blocks are interspersed within the heteropolymeric MG or GM blocks because 1-4-linked β-D mannuronic acid (M) and α-L-guluronic acid are attached by glycosidic bonds in alginate polymer [3]. Alginates are biocompatible, biodegradable, non-antigenic, and a non-toxic natural polymer having the capability to form chelates and pH-sensitive gels [3, 4]. The molecular mass of commercial sodium alginate ranges from 32,000-400,000 gm/mol. However, the polymers with high molecular mass are highly viscous, which leads to the problem in processing conditions. For example, the damage comes as a consequence by mixing protein and cells in highly viscous alginate solutions due to the high shear rate [2]. There are three parameters that are essential for alginates solubility in water, *i.e.* (a) ionic strength of alginate medium, (b) presence of gelling ions in the solvent, and (c) pH of solvent must be high, and deprotonation of carboxyl group must be done to make the alginate soluble [5]. In an aqueous environment, the solubility of monovalent salts of alginates is because of the differences in chemical potential between water present in bulk and the

*Address correspondence to these authors at the Department of Pharmaceutical Sciences, Pharmaceutics Research Projects Laboratory, Dr. Harisingh Gour University, Sagar (M.P.) 470 003, India; Tel: +91-8989443681; E-mails: ankitjainsagar@gmail.com; dharmjain@gmail.com

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