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ORIGINAL PAPER

Preparation and characterization of pH dependent κ-carrageenan-chitosan nanoparticle as potential slow release delivery carrier

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Abstract A polymeric carrier has high potential as active ingredient delivery vehicle owing to its biocompatibility and biodegradability. In this work, pH dependency of the oppositely charged polymers in forming nanoparticle was investigated. A positively charged chitosan and a negatively charged κ-carrageenan were mixed at varied mass ratios (v/v) with a pH ranged from 3 to 6, respectively, to form nanoparticles through polyelectrolyte complexation. The main interest of this research, is to evaluate the effect of pH on the formation of stable active ingredients encapsulated nanoparticle for sustained release. Based on the FTIR result, the presence of new absorption band at 1584 cm^{-1} and slight shift in the spectrum, indicated the complexation of the polymers. The Zetasizer's measurements showed that irrespective to the combination of chitosan and κ-carrageenan, increase in pH solution decreased the size and the zeta potential of the nanoparticles. Furthermore, depending on the combinations, the yield and the swelling percentage of the nanoparticle could reached up to 80 and 200%, respectively. Among the mass ratio combinations, the ratio 1:1 at pH 4 had the best physical properties. The encapsulation efficiency of the κ-carrageenan-chitosan nanoparticles exhibited higher preference towards more water soluble active ingredients, ascorbic acid as compared to caffeine and lidocaine. In addition, the slow release of active ingredients from the κ-carrageenan-chitosan nanoparticles, is plausibly due to the electrostatic interaction and compactness of the nanoparticles. Thus, they might be suitable for prolonged release applications.

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Keywords κ-carrageenan · Chitosan · Nanoparticle · Polyelectrolyte complex · pH dependent

Introduction

Chitosan is a linear aminopolysaccharide composed of D-glucosamine and *N*-acetyl-D-glucosamine, linked randomly by β-(1, 4) glycosidic bonds. This semi-crystalline polysaccharide is partially deacetylated derivative of chitin, found in crustacean shells such as crabs and shrimps [1]. The crystallinity of chitosan is affected by the degree of the deacetylated chitosan. The maximum and the minimum crystallinity appear in 0 and 100% of the deacetylation of the chitosan, respectively. The commercially available chitosan is usually within 50–90% degree of deacetylation. Chitosan is a natural and biocompatible polysaccharide which carries positive charged amino groups [2, 3]. Hence, chitosan with high molecular weight is insoluble in neutral and alkaline solutions but soluble in mild acidic ones, as a result of amino groups protonation in the presence of acids [4].

Carrageenan can be extracted from algae of class *Rhodophyta* (red algae) using water or alkaline water followed by alcohol precipitation. The algae is abundantly found in the genus of *Chondrus*, *Eucheuma* and *Kappaphycus*. κ-Carrageenan is a linear polysaccharide made up of galactose and/or anhydrogalactose units, linked by glycosidic bonds. It consists of one negatively charged sulphated ester group, which is soluble at temperatures higher than 60 °C. By sufficient amount of gelling cations, κ-carrageenan could form gel without difficulty. Therefore, carrageenan is a good excipient for gel formulation, suspension stabilizer, thickening agent in food and cosmeceutical products and suitable as controlled and sustained release delivery carriers [5].