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ORIGINAL PAPER

Preparation of alginate and chitosan nanoparticles using a new reverse micellar system

Morteza Hasanzadeh Kafshgari · Mohammad Khorram · Mohsen Mansouri · Abdolreza Samimi · Shahriar Osfouri

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Abstract Alginate and chitosan nanoparticles were prepared using a new reverse micelle system, composed of cetyltrimethylammonium bromide (CTAB) as a surfactant, isooctane as a solvent, and 1-hexananol as a co-solvent. The obtained nanoparticles were characterized by FTIR, DLS and TEM techniques. The main objective of this study was to investigate the effects of polymer concentration, water content, and volumetric ratio of co-solvent to solvent on the physical and morphological properties of the prepared nanoparticles. To evaluate the results, the design of experimental was initially carried out and then the obtained data were statistically analyzed using the Qualitek-4® software. Results revealed that the size of the prepared alginate and chitosan nanoparticles varied in the range 220–490 and 210–1,050 nm, respectively. Furthermore, increasing either alginate or chitosan concentration increased the size of their nanoparticles. The results also showed that the size of nanoparticles was decreased with increasing the volumetric ratio of co-solvent/solvent. Finally, the size of alginate nanoparticles was increased by increasing the water content while it decreased the size of chitosan nanoparticles. Considering the statistical analysis of experiments, the polymer concentration is the major parameter affecting nanoparticles' size. In contrast, water content has the smallest effect on the size of nanoparticles. However, the difference between the particle sizes of chitosan and alginate nanoparticles cab be attributed to the electrostatic repulsion between chitosan and CTAB.

Keywords Reverse Micelle · CTAB · Nanoparticles · Chitosan · Alginate

Introduction

Alginate and chitosan are both natural polymers that are mucoadhesive, biodegradable and biocompatible polymers that enable numerous pharmaceutical and biomedical applications such as drug delivery and cell encapsulation [1, 2]. Sodium alginate which is widely used in food, drinks, bioengineering and pharmaceutical industries is the water soluble salt of alginic acid, a naturally occurring non-toxic polysaccharide found in all species of the brown algae [3]. Soluble sodium alginate can be cross-linked by divalent cations, e.g., Ca^{2+} and Mg^{2+}, forming the 'egg box junctions' and insoluble calcium alginate [4].

Meanwhile, biopolymer chitosan is a polysaccharide derived from chitin by deacetylation, although this *N*-deacetylation is almost never complete. Chitosan has a pK_a value of approximately 6.5 and its free amino groups can be protonated in mild acidic solutions, provides positive charges to the glucosamine residue. Positive charges on chitosan import very different physical and chemical properties contrasted to chitin. Chitosan is inexpensive and exhibits an excellent film-forming ability, biocompatibility, nontoxicity, physiological inertness, antibacterial properties, high mechanical strength and a susceptibility to chemical modifications [5–7]. Because of the positive charges on chitosan, it has found a number of applications such as bandage materials for wounds [8], absorption enhancers across intestinal epithelium, mucosal sites for

M. H. Kafshgari · M. Khorram (✉) · M. Mansouri · A. Samimi
Department of Chemical Engineering, University of Sistan and Baluchestan, P.O. Box 98164-161, Zahedan, Iran
e-mail: khorram_m@hamoon.usb.ac.ir

S. Osfouri
Department of Chemical Engineering, Persian Gulf University, 7516913817 Bushehr, Iran