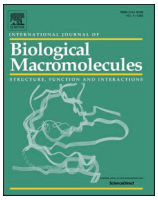
International Journal of Biological Macromolecules 241 (2023) 124610



Contents lists available at ScienceDirect

International Journal of Biological Macromolecules

journal homepage: www.elsevier.com/locate/ijbiomac





Developing nano-micro size chitosan beads using imidazolium-based ionic liquid: A perspective

Ismaila Olalekan Saheed [a,b], Faiz Bukhari Mohd Suah [a,*]

[a] Green Analytical Chemistry Laboratory, School of Chemical Sciences, Universiti Sains Malaysia, 11800 Minden, Pulau Pinang, Malaysia
[b] Department of Chemistry and Industrial Chemistry, Kwara State University, Malete, P.M.B 1530 Ilorin, Nigeria

ARTICLE INFO

Keywords:
Chitosan beads
Imidazolium
Ionic liquids
Nano-micro size

ABSTRACT

The aggressive search for unique materials in recent years has put forward chitosan and modified-chitosan as materials with unique structural and morphological characteristics for various important applications. Just as imidazolium-based ionic liquids are the commonly applied ionic liquids (ILs) type for chitosan modifications for various applications, their further modifications into beads for enhancing their properties is now gaining most attention. However, most of the currently prepared imidazolium ILs modified-chitosan beads are not in nano size due to preparation difficulties. In response to this and referencing the research works in the literature, the possible breakthrough directions including synthesis routes, and physical and mechanical transformation processes are proposed. These procedures are expected to provide certain theoretical and empirical basis, as well as technical guide for developing nano-micro size chitosan beads using imidazolium based ILs.

1. Introduction

Chitosan stands out among the polysaccharides as a promising material for various applications due to its wide availability and chemical versatility [1–5]. The availability and non-toxicity of chitosan has encouraged scientists to apply chitosan for the development of biocompatible products [6]. Physically conditioning of chitosan by casting into beads have present improve stability [7,8], enhance adsorption properties such as higher surface area and porosity [1,7], better drug loading applications [8] and improved access to internal sorption sites desirable for drug delivery and sorption applications [9].

Chitosan beads can be prepared through various techniques such as emulsion crosslinking, template-sacrifice, ion-imprinting, ionotropic gelation, coprecipitation and extrusion [9,10]. The preparation methods and structure selections of chitosan beads depend on several requirements such as shape, dimension, chemical and thermal stability, release time of the active ingredients, and residual toxicity of the chitosan bead products [9]. Frequently, the methods do involve the use of organic solvents and the formation of emulsions or coacervates; and at times crosslinking process could be employed in a second step [8]. These various methods of bead preparations can achieve different forms of chitosan bead such as micro-/nano-beads [11–13], molecularly imprinted beads [3], core-shell beads [14] and multi-porous beads [15]. Due to interesting structural and morphological feature presentations of chitosan beads including, higher surface area and porosity, improve mechanical and chemical stability, effective interfacial interaction, improve access to internal pores, ease of separation from solution, chitosan-based nanoparticles offer superlative effectiveness in adsorption applications [16], and drugs delivery at specific sites to permit drug absorption and provide a controlled release [10,17].

Modification of chitosan using ILs (molten salts with a melting temperature $< 100\ ^{\circ}C$) can remarkably improve their physical-chemical properties [18]. Imidazolium based ILs is a widely investigated ILs type for chitosan beads preparation due to their unique properties such as possession nitrogen-rich heteroatoms, low melting point, high chemical and thermal stability and good ionisation performance features [19]. Imidazolium ILs can facilitate the synthesis of small particles due to their low surface tension that contribute to high nucleation rates [20]. It is capable of disrupting hydrogen bonds in chitosan to promote dissolution [21,22] as shown in Fig. 1. Solubility of chitosan in imidazolium ILs increases as the hydrogen bond accepting capacity of the ILs increases. The anion and imidazolium cation contribute to the dissolution process conceivably through the disruption of hydrogen bonds in chitosan, featuring interactions between –OH and $–NH_2$ of chitosan with the acidic proton on the imidazolium ring [22]. Electronic and steric stabilization of nanoparticles can also be enhanced in ILs to reduce growth

* Corresponding author.
E-mail address: fsuah@usm.my (F.B.M. Suah).

https://doi.org/10.1016/j.ijbiomac.2023.124610
Received 4 January 2023; Received in revised form 12 April 2023; Accepted 22 April 2023
Available online 26 April 2023
0141-8130/© 2023 Elsevier B.V. All rights reserved.