Austin Journal of Nanomedicine & Nanotechnology

Austin Publishing Group

Open Access
Full Text Article

Editorial

Chitosan: Growing Importance in Biomedical and Bioanalytical Sciences

Sandeep Kumar Vashist*

Department of Microsystems Engineering, University of Freiburg, Germany

***Corresponding author:** Sandeep Kumar Vashist, Department of Microsystems Engineering - IMTEK, University of Freiburg, Laboratory for MEMS Applications, Georges-Koehler-Allee 103, 79110 Freiburg, Germany, Tel: +49 761 2037252; Fax: +49 761 20373299; E-mail: sandeep.kumar.vashist@hsg-imit.de

Received: May 20, 2014; Accepted: June 20, 2014; Published: June 23, 2014

Chitosan is a linear polysaccharide, composed of β-(1-4)-linked D-glucosamine and N-acetyl-D-glucosamine, which is obtained by the deacetylation of naturally occurring chitin, the structural material found in the shells of crustaceans (crabs and shrimps) and cell walls of fungi. Being biocompatible, biodegradable (to harmless natural metabolites), and equipped with several unique properties, it is an attractive material for many biomedical and bioanalytical applications [1,2]. Due to its pH-dependent solubility, it forms stable films on various surfaces under neutral and basic pH conditions. At pH lower than 6.5, the amines are positively charged and are responsible for the solubility of chitosan, where at higher pH, they become increasingly deprotonated, thereby leading to the insolubility of chitosan. This has led to several interesting chitosan-based applications based on the deposition and removal of chitosan simply by changing the pH. Moreover, the amine groups present on its surface provides the means for the covalent attachment of biomolecules and formation of nanocomposites in combination with other polymers or nanoparticles. During the last two decades, chitosan has been employed extensively for biosensing [3], controlled drug release [4], wound healing, nutrition supplements, winemaking, agriculture, water purification and tissue engineering [5].The chitosan films have also been integrated in several lab-on-a-chip devices for the immobilization of biomolecules, cells, or nanoparticles by employing standard microfabrication technology, such as solution casting, spin casting, electrodeposition, and nanoimprinting [6]. A variety of methods have already been devised for the fabrication, modification, and characterization of chitosan, which have led to a large variety of chitosan-based materials and nanocomposites for significantly improved applications.

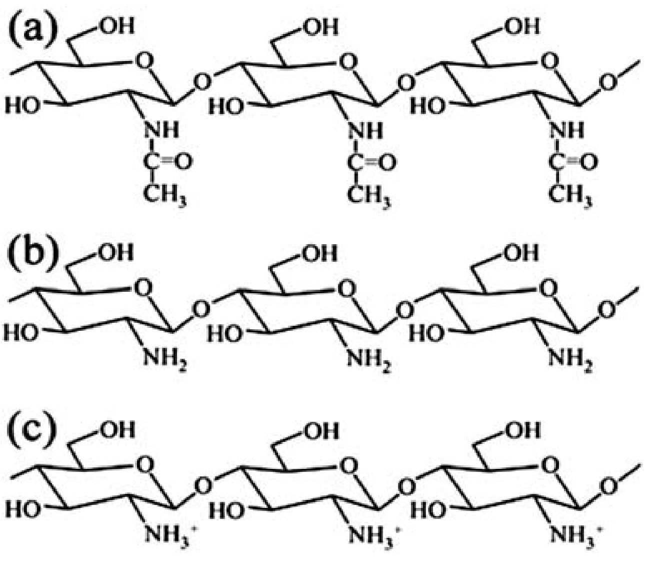

Figure 1: Structural formulas of chitin and chitosan showing the three possible states of the amine group: (a) chitin, amine group acetylated; (b) chitosan, amine group free; (c) chitosan, amine group protonated. Reproduced with permission from The Royal Society of Chemistry [6].

Chitosan salts have been increasingly used as biopesticides in agriculture as they increase the resistance of plants to pathogens, insects and soil-borne diseases. It has been also used by National Aeronautics and Space Administration (NASA) to protect plants in space [7]. It is an important additive in water filtration as the use of chitosan with sand filtration removes up to 99% turbidity. Similarly, it is used as a fining agent to clear wines and beers. It has growing applications in the manufacture of bio-inspired materials and is being investigated for the development of engineered human organs or tissues. Being transparent, the unmodified chitosan films have been used for optical sensors. As the wet chitosan films are porous and highly permeable to ions, the chitosan coated-electrodes have been widely used for the electrochemical sensing of a plethora of analytes [3]. The modified chitosan nanoparticles have been used for the delivery of oral insulin [8], nonviral genes, biomolecules and several drugs [4].

However, the growing concerns about the safety of nanomaterials have stressed the need for stringent evaluation of chitosan toxicity and biocompatibility. Moreover, there is an absolute need to draft the international regulatory guidelines to evaluate the toxicity of nanomaterials [9], the absence of which has led to highly contradictory results. The industrial and healthcare requirements [9] also need to be adhered to in order to develop commercially-viable chitosan-based products. Till date, chitosan has not been approved by United States Food and Drug Administration (FDA) for drug delivery. However, chitosan active biopesticides have been approved by Environmental Protection Agency (EPA) for agriculture and horticulture to protect plants and crops due to its low potential for toxicity and its abundance in natural environment. Additionally, the use of chitosan as the fining agent in winemaking has been approved in Europe. Based on its ability to rapidly clot blood, the use of chitosan in bandages and hemostatic products has been approved in Europe and US. These products have already been used by US army and UK military in Iraq and Afghanistan wars. On the other hand, there have been conflicting results pertaining to the use of chitosan as a fat binder, which is

Citation: Sandeep Kumar Vashist. Chitosan: Growing Importance in Biomedical and Bioanalytical Sciences. Austin J Nanomed Nanotechnol. 2014;2(4): 1024.

supposed to limit the absorption of fat in the body. As the mechanism of interaction between the chitosan and fat is unknown, FDA has issued strict warning letters to the nutritional supplement companies to restrict them from making false claims pertaining to the healthcare benefits incurred by the use of chitosan [10]. Researchers are also investigating the use of chitosan as a soluble dietary fiber. The coming years will witness some prominent chitosan-based products making their way into the market, which will lead to significantly improved biomedicinal and bioanalytical sciences.

References

1. Dash M, Chiellini F, Ottenbrite RM, Chiellini E. Chitosan-A versatile semi-synthetic polymer in biomedical applications. Prog Polymer Sci. 2011; 36: 981-1014.
2. Shukla SK, Mishra AK, Arotiba OA, Mamba BB. Chitosan-based nanomaterials: a state-of-the-art review. Int J Biol Macromol. 2013; 59: 46-58.
3. Suginta W, Khunkaewla P, Schulte A. Electrochemical biosensor applications of polysaccharides chitin and chitosan. Chem Rev. 2013; 113: 5458-5479.
4. Bhattarai N, Gunn J, Zhang M. Chitosan-based hydrogels for controlled, localized drug delivery. Adv Drug Deliv Rev. 2010; 62: 83-99.
5. Kim IY, Seo SJ, Moon HS, Yoo MK, Park IY, Kim BC, et al. Chitosan and its derivatives for tissue engineering applications. Biotechnol Adv. 2008; 26: 1-21.
6. Koev ST, Dykstra PH, Luo X, Rubloff GW, Bentley WE, Payne GF, et al. Chitosan: an integrative biomaterial for lab-on-a-chip devices. Lab Chip. 2010; 10: 3026-3042.
7. Progressive Plant Growing is a Blooming Business. NASA. 2006.
8. Mukhopadhyay P, Mishra R, Rana D, Kundu PP. Strategies for effective oral insulin delivery with modified chitosan nanoparticles: A review. Prog Polymer Sci. 2012; 37: 1457-1475.
9. Vashist SK, Venkatesh AG, Mitsakakis K, Czilwik G, Roth G, Stetten FV, et al. Nanotechnology-based biosensors and diagnostics: technology push versus industrial/healthcare requirements. BioNanoSci. 2012; 2: 115-126.
10. List of Distributors and Manufacturers Receiving Warning or Advisory Letters for Unsubstantiated Weight Loss Claims. US Food and Drug Administration. 2004.

Austin J Nanomed Nanotechnol - Volume 2 Issue 4 - 2014
ISSN : 2381-8956 | www.austinpublishinggroup.com

Citation: Sandeep Kumar Vashist. Chitosan: Growing Importance in Biomedical and Bioanalytical Sciences. Austin J Nanomed Nanotechnol. 2014;2(4): 1024.