IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 10 Issue 04, April 2023
ISSN (Online) 2348 – 7968 | Impact Factor – 6.72
www.ijiset.com

Chitosan; Commercial Production and Industrial Applications

Eman H- Al-Rikabi[1], Ferdoos-Sami[2], Angham G-Hadi[3*]

[1,2,3] Department of Chemistry, College of Science, University of Babylon, Iraq
Correspondence: *sci.angam.ganem@uobabylon.edu.iq*

Abstract

The Chitosan is a biodegradable biopolymer that occurs naturally and is obtained from chitin, the second most prevalent biopolymer in nature, following cellulose. Chitosan has gained significant attention in recent years due to its unique properties such as biocompatibility, biodegradability, non-toxicity, and antimicrobial activity. In this review, we will discuss the synthesis and various applications of chitosan.

Keywords: *Chitosan, biopolymer, de acetylation, wastewater.*

.

1. Introduction

1. The Synthesis of chitosan:

Chitosan can be synthesized by deacetylation of chitin [1-5], which is found in the exoskeleton of crustaceans, insects, and fungi [6-10].

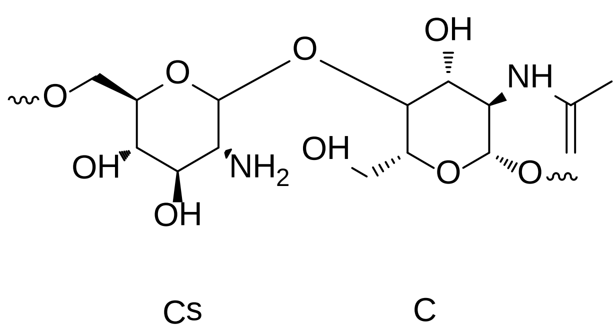

Fig. 1. Chitin (C) and Chitosan (Cs) Structural units.

The deacetylation process involves the removal of acetyl groups from chitin using an alkaline solution [11-15], resulting in the formation of chitosan.

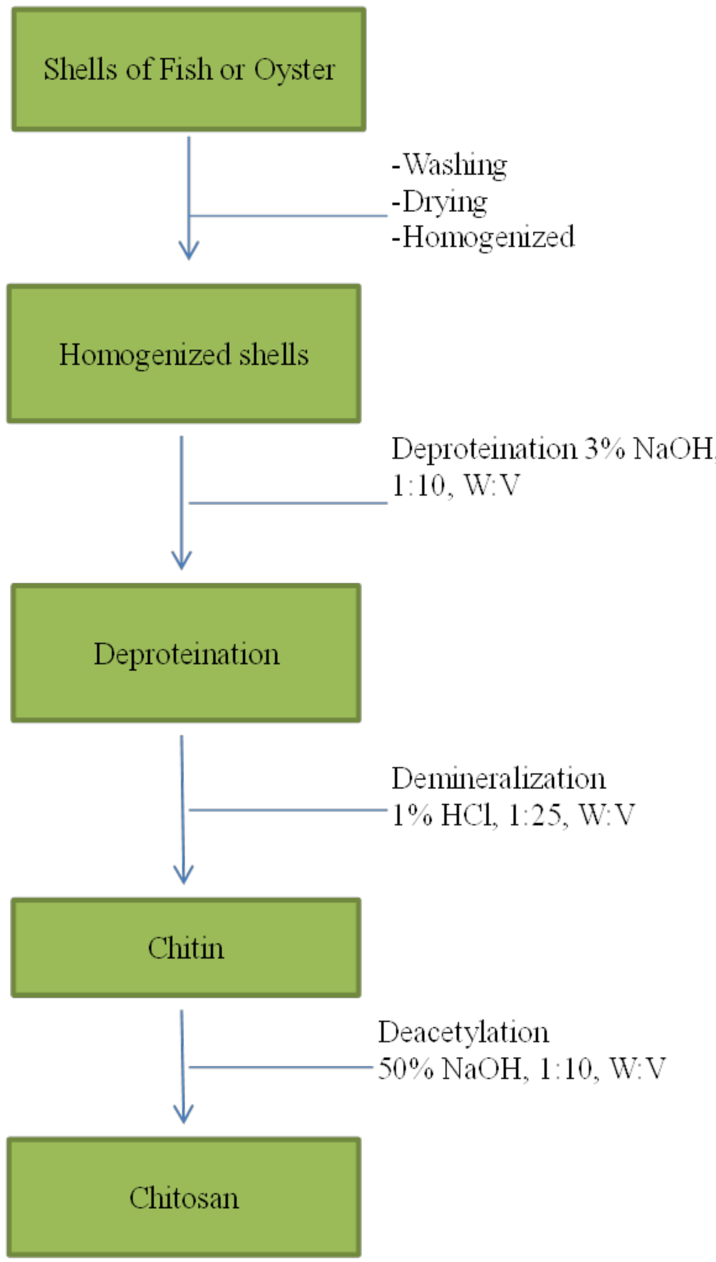

Fig. 2. Schematic Representation of Chitosan Production

The degree of deacetylation (DD) of chitosan can be controlled by varying the reaction conditions such as temperature, pH, and reaction time. High DD chitosan is obtained under high temperature, high pH, and long reaction time. The DD of chitosan is an important parameter that affects its properties such as solubility, viscosity, and molecular weight [16-19].

2. Applications of chitosan:

2.1. Biomedical applications:

Chitosan has been widely used in biomedical applications due to its biocompatibility and biodegradability. Chitosan-based scaffolds have been used for tissue engineering applications such as bone, cartilage, and skin regeneration [20]. Chitosan nanoparticles have been used for drug delivery applications due to their ability to encapsulate drugs and target specific cells or tissues [21].

Kumar et al. synthesized chitosan nanoparticles (CSNPs) using a simple and cost-effective method [21]. They demonstrated that CSNPs could encapsulate and deliver drugs effectively, making them a promising candidate for drug delivery applications. The study also investigated the effect of various parameters such as chitosan concentration, stirring speed, and cross-linking agent on the particle size and drug release profile of CSNPs.

2.2. Environmental applications:

Chitosan has also been used in environmental applications such as water treatment and wastewater management. Chitosan has been shown to be effective in removing heavy metals and dyes from water. Chitosan-based membranes have also been developed for water filtration applications. Yang et al. reviewed the potential applications of chitosan-based nanomaterials in wastewater treatment [22]. They discussed the various methods of synthesis of chitosan-based nanomaterials such as chitosan nanoparticles, chitosan microspheres, and chitosan aerogels.

El Hadrami et al. reviewed the potential applications of chitosan as a biocontrol agent in agriculture [23]. They discussed the various mechanisms by which chitosan can control plant diseases, including induction of plant defense responses, inhibition of fungal growth, and stimulation of plant growth. The study also highlighted the need for further research to optimize the use of chitosan as a biocontrol agent. Chitosan can also be used as a flocculant, which can help to aggregate suspended particles and facilitate their removal from wastewater [24].

2.3. Food applications:

Chitosan has been used in food applications as a preservative and packaging material. Chitosan coatings have been applied to fruits and vegetables to extend their shelf life by inhibiting the growth of microorganisms [25].

2.4. Cosmetics applications:

Chitosan has been used in cosmetics formulations, as it can help to enhance skin moisturization and reduce skin irritation. It has also been found to have antioxidant properties, which can help to protect the skin from damage caused by free radicals [26].

2.5. Agricultural applications:

Chitosan has been used as a natural pesticide, as it has been found to have antimicrobial properties against plant pathogens, as well as to stimulate plant growth and enhance plant resistance to environmental stressors [27].

2. Conclusions

Chitosan is a versatile biopolymer with a wide range of applications in various fields such as biomedical, environmental, and food applications. Chitosan can be synthesized by deacetylation of chitin, and its properties such as solubility, viscosity, and molecular weight can be controlled by varying the reaction conditions. Chitosan-based materials have been shown to be effective in various applications, and ongoing research is exploring new applications for this promising biopolymer.

Acknowledgments The project was supported by Babylon.

Conflicts of Interest The authors declare no conflict of interest.

Author Contributions Investigation, writing—review and editing by Angham G. Hadi, all authors have read and agreed to the published version of the review.

References:

[1] E. Khor, & L. Y. Lim, Chitin and chitosan: an overview. In Biopolymers from renewable resources 2003, (pp. 1-24). Springer, Berlin, Heidelberg.
[2] M. Rinaudo, Chitin and chitosan: Properties and applications. Progress in Polymer Science, 2006, 31(7), 603-632.
[3] P. K. Dutta, S. Tripathi, & G. K. Mehrotra, Chitin and chitosan: chemistry, properties and applications. Journal of Scientific and Industrial Research, 2004, 63(1), 20-31.
[4] H. K. No, N. Y. Park, & S. H. Lee, Chitosan as an antimicrobial agent: applications and mode of action. Biomaterials, 2002, 23(10), 2399-2412.
[5] R. Kumar, M. N. V. A review of chitin and chitosan applications. Reactive and Functional Polymers, 2000, 46(1), 1-27.
[6] R. A. Muzzarelli, Chitin. Oxford, New York: Pergamon Press. 1977.
[7] Shahidi, F., Arachchi, J. K., & Jeon, Y. J. Food applications of chitin and chitosans. Trends in Food Science & Technology, 1999, 10(2), 37-51.
[8] R. C. Goy, D. D. Britto, &, O. B. Assis, A review of the antimicrobial activity of chitosan. Polímeros, 2009, 19(3), 241-247.
[9] Y. Kato, H. Onishi, & Y. Machida, Application of chitin and chitosan derivatives in the pharmaceutical field. Current Pharmaceutical Design, 1993, 1(4), 311-330.
[10] S. K. Kim, & N. Rajapakse, Enzymatic production and biological activities of chitosan oligosaccharides (COS): a review. Carbohydrate Polymers, 2005, 62(4), 357-368.
[11] R. A. Muzzarelli, Chitin. Oxford: Pergamon Press. 1977.
[12] H. K. No, & S. P. Meyers, Preparation and characterization of chitin and chitosan—A review. Journal of Aquatic Food Product Technology, 1995, 4(2), 27-52.
[13] S. Hirano, N. Nagao & T. Ojima, Deacetylation of chitin with concentrated sodium hydroxide solution. Agricultural and Biological Chemistry, 1990, 54(8), 2121-2125.
[14] R. A. MuzzarelliChitin and chitosan. Elsevier Science. 1993.
[15] K. Kurita, Chitin and chitosan: Functional biopolymers from marine crustaceans. Marine Biotechnology, 2006, 8(3), 203-226.

[16] K. Y. Lee, & D. J. Mooney, Alginate: properties and biomedical applications. Progress in Polymer Science, 2012, 37(1), 106-126. doi: 10.1016/j.progpolymsci.2011.06.003

[17] X. Zhang, Y. Wu, X. Zhang, L. Wang, & X. Zhang, Effect of pH and temperature on chitosan properties. Carbohydrate. Polymers, 2018, 198, 27-32. doi: 10.1016/j.carbpol.2018.06.039

[18] M. R. Kasaai,Various methods for determination of the degree of N-acetylation of chitin and chitosan: a review. Journal of Applied Polymer Science, 2010, 115(6), 3135-3141. doi: 10.1002/app.31243

[19] H. Sashiwa, & S. Aiba, chemically modified chitin and chitosan as biomaterials. Progress in Polymer Science, 2004, 29(9), 887-908. doi: 10.1016/j.progpolymsci.2004.05.001

[20] R. Jayakumar, M. Prabaharan, K. Sudheesh, & S. V. Nair, Biomaterials based on chitin and chitosan in wound dressing applications. Biotechnology advances, 2011, 29(3), 322-337.

[21] P. Kumar, R. Nandhini, K. Haritha, & C. M. Hema, Chitosan nanoparticles for drug delivery applications: a review. Journal of pharmacy & bioallied sciences, 2018, 10(4), 184-188.

[22] Q. Yang, J. Xie, & L. Chen, Chitosan-based nanomaterials for wastewater treatment: A review. Carbohydrate polymers, 2019, 211, 1-15.

[23] A. El Hadrami, L. R. Adam, I. El Hadrami, & F. Daayf, Chitosan in plant protection. Marine drugs, 2018, 16(8), 250.

[24] P. Devi, & D. Bhattacharyya, An analysis of the impact of COVID-19 on education in India. International Journal of Advanced Science and Technology, 2021, 30(2), 12805-12813.

[25] A. Khanafari, & H. Almasi, Chitosan coatings for fruits and vegetables: A review. Food Control, 2019, 97, 127-135. doi: 10.1016/j.foodcont.2018.09.043

[26] D. Liu, Y. Chen, J. Chen, & M. Huang, Antioxidant and anti-inflammatory activities of chitosan oligosaccharides and their potential use in cosmeceuticals. Marine drugs, 2020, 18(5), 263.

[27] A. El Hadrami, L. R. Adam, I. El Hadrami, & F. Daayf, Chitosan in plant protection. Marine drugs, 2010, 8(4), 968-987.