VOLUME 3 ISSUE 1 2023

ISSN 2583-1690

INTERNATIONAL JOURNAL OF BIOLOGICAL AND ENVIRONMENTAL INVESTIGATIONS

Forum for Biological and Environmental Sciences

Published by Saran Publications, India

International Journal of Biological and Environmental Investigations

Contents available at Journals Home Page: www.ijbei.net

Editor-in-Chief: Prof. Ajai Kumar Srivastav

Managing Editors: Dr. Abhishek Kumar & Dr. Abhai K. Srivastava

Published by: Saran Publications, Gorakhpur, India

ISSN: 2583-1690

Extraction and Purification of Chitin and Chitosan Production from Crustaceans

Telange Yogita B.[1], Sanket R. Bhor[2] and Shinde S.E.[3]*

[1]Department of Zoology, Maratha Vidya Prasarak Samaj's Karmaveer Ganpat Dada More Arts Commerce and Science College, Niphad, Nashik 422303, Maharashtra, India

[2]Department of Zoology, Maratha Vidya Prasarak Samaj's Arts, Commerce and Science College, Tryambykeshwar, Nashik 422212, Maharashtra, India

[3]Department of Zoology, M.J.P.V Arts, Commerce, and Science College Dhadgaon District Nandurabar, Maharashtra, India

**Corresponding Author*

Received: 2nd March, 2023; **Accepted:** 18th April, 2023; **Published online:** 29th April, 2023

https://doi.org/10.33745/ijbei.2023.v03i01.001

Abstract: The aim of this study was to report the yield of extraction, as well as the physicochemical and cell reinforcement properties of removed chitosan from Crustaceans. In this work, chitin and chitosan from Crustaceans were acquired by treatment with HCl and NaOH. It is obtained from the cell walls of certain growths, exoskeletons, and inner design of spineless creatures and exuviae of crustaceans. The purpose of the study was to report the yield of extraction, as well as the physicochemical and cell reinforcement properties of removed chitosan from Crustaceans Plastic is the most advantageous material man has at any point found because of its relative affordability, simplicity of assembling, adaptability, and impenetrability to water. Plastics are utilized from paper clasps to spaceships and dislodged materials like wood, metal, bones and horns, stone, calfskin, paper, and even ceramics in a large portion of their previous purposes. Be that as it may, plastic appeared to make an extreme impact. An answer can be accomplished by the utilization the Bioplastics. Bioplastics are very much like plastics, however, rather than non-sustainable oil as the source, it utilizes natural sources like plant sources (corn starch, soybean oil, hemp oil, and so forth) and microbial sources. They can be made by utilizing plant sugar transformation, maturation, and development. Dissimilar to petro plastics they are biodegradable when arranged appropriately subsequently decreasing waste creation and ecological contamination. The vital business wellsprings of chitin are shells of Crustaceans, for example, shrimps, crabs, lobsters, and krill that are provided in enormous amounts by shellfish handling enterprises.

Keywords: Chitin, Crustaceans, Cellulose, Bioplastic, Chitosan

Citation: Telange Yogita B., Sanket R. Bhor and Shinde S. E.: Extraction and purification of chitin and chitosan production from crustaceans. Intern. J. Biol. Environ. Invest. 3(1): 1-5, 2023.

https://doi.org/10.33745/ijbei.2023.v03i01.001

Introduction

Chitin is the second most plentiful Naturally Occurring polysaccharide after cellulose. It is obtained from the cell walls of certain growths, exoskeletons, and inner design of spineless

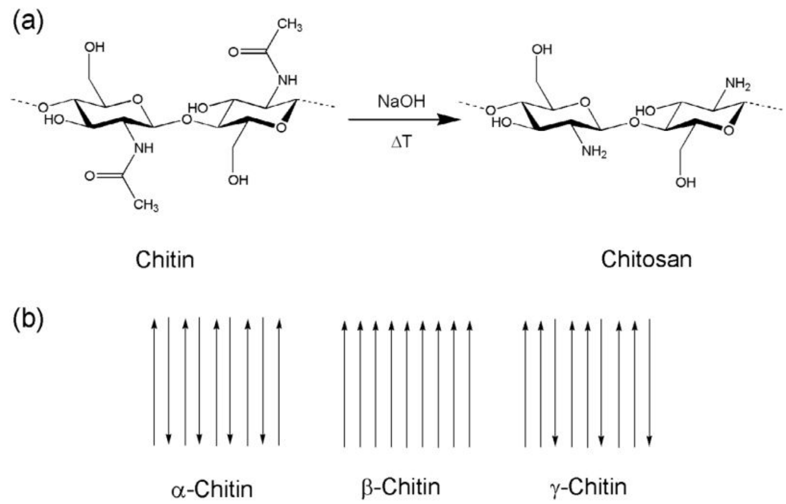

Fig. 1: Molecular structure of -- (a) Chitin (chemical name: poly acetylamino glucose, Molecular Formula: $C_8H1_3O_5N$; Molecular Weight: 203.19); and (b) chitosan.

creatures and exuviae of bugs. It has been accounted for that chitosan displays organic exercises against microorganisms. Chitosan is delivered from shrimp shells (Teli and Sheik, 2012)**.** Chitin and chitosan are drawing extraordinary interest given their helpful organic properties, like biodegradability, biocompatibility, non-antigenicity, and non-harmfulness (Kho and Lim, 2003; Shahidi *et al*., 2005). Since they are flexible biopolymers, their expected applications in different modern fields are by and large effectively examined. For instance, chitin and chitosan have been recorded to be helpful as antimicrobial, emulsifying, thickening, and settling specialists in the food business (Shahidi, 1999). They have likewise shown outstanding bioactivity in biomedical fields, including wound recuperating advancement, invulnerable framework improvement, and hemostatic, hypolipidemic, and antimicrobial action (Ong *et al*., 2008). Chitin is a hard, inelastic, N-acetylated amino polysaccharide (Fig. 1a) with high hydrophobicity, making it insoluble in water and most natural solvents (Kumar, 2000; Dutta, *et al*., 2004). Based on different directions of its microfibrils, chitin exists in nature in three translucent allomorphic structures: ⊍-, ⊎-, and γ-chitin (Fig. 1b). ⊍-Chitin has antiparallel chains. It is answerable for the inflexibility of the polymer and is the most bountiful form (Sajomsang and Gonil, 2010). ⊎-Chitin comprises equal chains, delivering monoclinic gems with intramolecular cooperations (hydrogen bonds) notwithstanding intermolecular ones (Dweltz, 1961). ⊎-Chitin is found in the spines of diatoms, squid pens, and pogonophoran tubes. γ-Chitin is a combination of equal and antiparallel chains consolidating the properties of both ⊍-structure and ⊎-form13; it is available in parasites, yeasts, and bug cocoons (Jang, *et al*., 2004).

Chitin consists of N-acetylated-D glucosamine (GlcNAc) and 2-amino-D-glucose (D-glucosamine, GlcN) linked by ⊎-1, 4 glycosidic bonds. Chitosan is the main deacetylated derivative of chitin. There are three crystalline allomorphic forms of chitin, with different microfibril orientations. The exoskeleton has several functions in Crustaceans: (i) as a protective covering and (ii) as a facilitator of metamorphosis. The exoskeleton is rich in chitin and is shed from the body during metamorphosis**.** Considerable amounts of chitin are present in shellfish like crab, Lobsters, shrimp, prawns, Crawfish, and crayfish (from 14 - 35% on a dry weight basis) and constitute a worldwide growing waste disposal problem of the shellfish industry. Chitosan is the *N*-deacetylated derivative of chitin. Again, marine crustacean shells are widely used as the primary source for the production of chitosan from chitin (Vårum and Smidsrød, 2005).

Chitosan is practically the main cationic polysaccharide in nature, and it is nontoxic and biodegradable in the human body (Pilai *et al*., 2009). This unique property is significant concerning biomedical applications (Pavlichko, 1999). In any case, since chitosan does not break down in impartial and fundamental fluid media, its biomedical use is restricted. The chemical alteration of chitosan gives subordinates that are dissolvable at a nonpartisan and essential pH. Also, substance alteration can be utilized to connect different practical gatherings and to control hydrophobic, cationic, and anionic properties (De *et al*., 2000; Fan *et al*., 2010). Further review and improvement of chitin, chitosan, and their subordinates for use in applied biomaterials should be done (Sashiwa and Aiba, 2004). These focuses can be considered in later improvements in the field of biomaterials from Crustaceans.

For chitin extraction, 2N HCl and 1.25N NaOH arrangements were utilized to accomplish decalcification and deproteinization, separately. For chitosan extraction, a half NaOH arrangement was utilized to accomplish deacetylation. Since it is made out of synthetic compounds (petrol based), it takes too long to even think about debasing (impressively non-biodegradable) and ill-advised removal has led to squandering issues and contamination subsequently destructing our current circumstance. Extraction of chitin includes two stages, demineralization and deproteinization, which can be directed by two strategies, compound or organic. Chitin and its subsidiaries have extraordinary monetary worth as a result of their organic exercises and their modern furthermore, biomedical applications. It may be very well removed from three sources, specifically Crustaceans, bugs, and microorganisms. Chitins and chitosan are the absolute most bountiful regular polysaccharide materials and are utilized to increment inborn invulnerable reactions and infection obstruction in people and creatures.

From the Literature review, it is observed that there are methods of extraction and purification of Chitin from different species of Crustaceans (Fig. 2). Table 1 illustrates the chemical vs biological methods for extraction of chitin.

The new environmental regulation and growing environmental awareness throughout the world have triggered a search for new products and processes that are compactable with the environment. Plastics are made of straight long-chain polymers or lines of smaller molecules that are known as monomers. Bioplastics are a form of plastic derived from renewable biomass sources, such as vegetable oil, corn starch, pea starch, or microbiota, rather than fossil-fuel plastics which are derived from petroleum. Extracting biopolymers like chitin and chitosan from prawn shells is utilized for developing biodegradable bioplastic.

Chitin is a long-chain biopolymer made of *N*-acetyl glucosamine which is insoluble in water.Thus Biodegradable plastics were created from fully biodegradable materials. This means that they can break down much faster and recycling them takes less energy. This study promises the making of Biodegradable plastics using the material waste of prawn shells which is environmentally friendly and cost-effective.

In terms of structure, chitin may be compared to the polysaccharide cellulose and, in terms of function, to the protein keratin. Chitin has also proven useful for several medical and industrial purposes. This product is chiefly used in wastewater treatment for decreasing heavy metal ions in environmental pollution control; it is also used in making chitosan and glucosamine series chemicals. As the research results during recent several decades, chitin can be used in light industry.

In pharmaceutical, cosmetics, and agriculture, it was found that chitin is a chemical with good prospects. White to light yellow flake, it is a

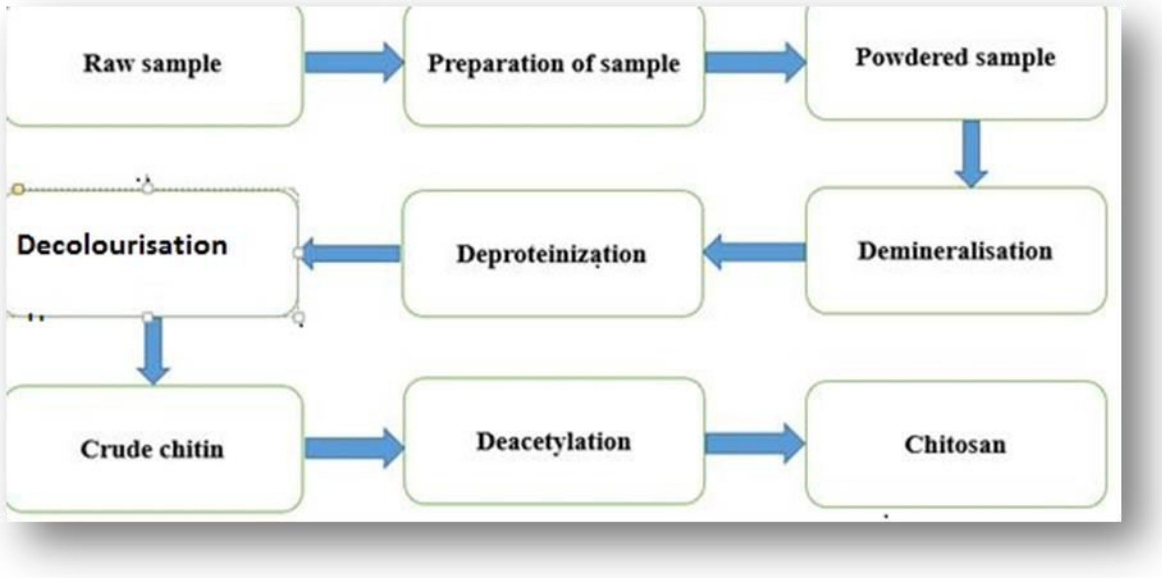

Fig. 2: General method for extractions and purifications of chitin and chitosan.

Table 1: Chemical Vs Biological methods for chitin Extraction

Chitin Recovery	Chemical Method	Biological method
Demineralization	Mineral solubilization by acidic treatment including HCl, HNO_3, H_2SO_4, CH_3COOH and HCOOH	Carried out by lactic acid produced by bacteria through the conversion of an added carbon source
Deproteinization	Protein solubilization by alkaline Treatment	Carried out by proteases secreted into the fermentation medium. In addition, deproteinization can be achieved by adding exo-proteases and/or proteolytic bacteria
	Effluent treatment after acid and alkaline extraction of chitin may cause an increase in the cost of chitin.	Extraction cost of chitin by biological the method can be optimized by reducing the cost of the carbon source. Solubilised proteins and minerals may be used as human and animal nutrients
Chitin Quality		
The major concern in chitin production is the quality of the the final product, which is a function of the molecular mass (average and polydispersity) and the degree of acetylation	A wide range of quality properties of the final product. Using inorganic acids such as HCl for chitin demineralization results in detrimental effects on the molecular mass and the degree of acetylation that negatively affects the intrinsic properties of the purified chitin (Sorlier *et al.*, 2001). This method allows almost complete removal of organic salts, but at the same time the	Homogeneousness and high quality of the Final product.

	reactions of deacetylation and Depolymerisation may occur (Khor, 2001). The comparison of different chitins (degree of acetylation, molecular mass, optical activity) obtained with four different acids showed that the polymer characteristics varied according to the extraction method used.	

cellulose-like biological polymer soluble in concentrated hydrochloric acid, sulfuric acid, and glacial acetic acid, but insoluble in water, dilute acid, alkali, and organic solvents (Goosen, 1996).

References

De Smedt SC, Demeester J and Hennink WE. (2000) Cationic polymer based gene delivery systems. Pharm Res. 17(2): 113-126.

Dutta PK, Dutta J and Tripathi VS. (2004) Chitin and chitosan: chemistry, properties and applications. J Sci Ind Res. 63: 20-31.

Dweltz NE. (1961) The structure of ʊ-chitin. Biochim. Biophys Acta 51: 283-294.

Fan Y, Saito T and Isogai A. (2010) Individual chitin nano-whiskers prepared from partially deacetylated alpha-chitin by fibril surface cationization. Carbohydr Polym. 79(4): 1046-1051.

Goosen MFA. (1996) Application of Chitan and Chitosan. https://doi.org/10.1201/9781003072812.

Kho E and Lim LY. (2003) Implantable applications of chitin and chitosan. Biomaterials 24(13): 2339-2349.

Khor E. (2001) Chitin: Fulfilling a biomaterials promise. Elsevier, New York.

Kumar MNR. (2000) A review of chitin and chitosan applications. React Funct Polym 46: 1-27.

Ong SY, Wu J, Moochhala SM, Tan MH and Lu J. (2008) Development of a chitosan-based wound dressing with improved hemostatic and antimicrobial properties. Biomaterials 29: 4323-4332.

Pavlichko JP. (1990) Polymer interactions to enhance the function of hyaluronic acid. Drug Cosmet Int. 147: 21-24.

Pilai KS, Paul W and Sharma CP. (2009) Chitin and chitosan polymers: Chemistry, solublity and fiber formation. Prog Polym Sci. 34: 641-678.

Sajomsang W and Gonil P. (2010) Preparation and characterization of ʊ-chitin from cicada sloughs. Mater Sci Eng. C 30: 357-363.

Sashiwa H and Aiba SI. (2004) Chemically modified chitin and chitosan as biomaterials. Prog Polym Sci. 29: 887-908.

Shahidi F and Abuzaytoun R. (2005) Chitin, chitosan, and co-products: Chemistry, production, applications, and health effects. Adv Food Nutr Res. 49: 93-135.

Shahidi F, Arachchi JKV and Jeon YJ. (1999) Food applications of chitin and chitosan. Trends Food Sci Technol. 10: 37-51.

Sorlier P, Denuzière A, Viton C and Domard A. (2001) Relation between the degree of acetylation and the electrostatic properties of chitin and chitosan, Biomacromolecules 2: 765-772.

Teli MD and Sheikh J. (2012) Extraction of chitosan from shrimp shell waste and application in antibacterial finishing of bamboo rayon. Int J Biol Macromolec. 50: 1195-1200.

Vårum KM and Smidsrød O. (2005) Structure–property relationship in chitosans. In: Polysaccharides: Structural Diversity and Functional Versatility; (ed.) Dimitriu S., Marcel Decker: New York, NY, USA, pp. 625-642.