

# Obtaining and Derivatization of Chitosan on The Basis of Insects



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## Abstract

Recently, there has been a great deal of attention around the world to finding new raw materials of chitosan, which exhibits high biological activity and to synthesize its new derivatives. During our research, we aimed to obtain chitosan from various local wasps (*Apis mellifera*, *Polistes Chinensis*, *Vespa Orientalis*), to study its structure using physicochemical methods: IR and NMR spectroscopy, GPC, XRD, and synthesis of water-soluble products.

**Keywords:**  $\alpha$ -Chitin; Chitosan; Crystal System; N-alkyl; N-acyl derivatives

**Abbreviations:** IR: Infrared; NMR: Nuclear Magnetic Resonance; GPC: Gel-permeation Chromatography; XRD: X-ray Diffraction; CI: Crystalline Index, DDA: Degree of Deacetylation

## Introduction

Chitin and its important derivative chitosan is the linear polysaccharide, which consists of the  $\beta$ -(1 $\rightarrow$ 4) linked N-Acetyl-D-glucosamine (Glc-NAc) and D-glucosamine (Glc-N) units. In nature, chitin occurs in a variety of organisms, including infusoria, amoebae, chrysophytes, some algae, fungi, crustaceans, worms, insects, mollusks, and in the cell walls of fungi and microorganisms (bacteria) [1]. Chitin has 3 polymorph forms:  $\alpha$ -,  $\beta$ - and  $\gamma$ - chitin. In these forms, chitin microfibrils are oriented differently and are differentiated using IR and NMR spectroscopy and X-ray diffractometry [2]. In the solid-state, chitin chains are bound with hydrogen bonds that affect many of its physicochemical properties. Chitosan is obtained through alkaline hydrolysis of acetamide groups of chitin. Chitin and chitosan are widely used in medicine, cosmetology, agriculture, textile, paper industry, genetic engineering, pharmacology, and other fields because of their many important biological activities. Chitosan is obtained from crustaceans on an industrial scale. Recently, great attention has been paid to the separation of chitin and chitosan from insects and their use as an alternative raw material for chitin [3,4].

Chitosan is soluble in dilute organic solvents pH <6.5 because the pKa value of N-amino groups is 6.5. The solubility of chitosan in aqueous acid solutions with a pH of  $\geq$  6.5 leads to limitations in application fields (cosmetology, food, and biomedicine). This is because the use of chemicals in biological applications requires the material to be treated at a neutral pH. Numerous studies have

been conducted to increase the water solubility of chitosan and thereby expand its application. Improving the water solubility of the polymer involves the chemical modification of N-amino functional groups. As a result, water-soluble N-substituted products are obtained. N-substitution reactions include: N-alkylation, N-acetylation, N-hydroxylation and etc. [5].

In this research, we obtained initially chitin from local raw materials (*Apis mellifera*, *Polistes Chinensis*, *Vespa orientalis*) and chitosan by deacetylation of chitin. After that, we studied its physicochemical properties. In the next step, we synthesized N-alkyl and N-acyl derivatives based on low molecular weight chitosan and analyzed their structure.

## Conclusion

During our research, chitosan with a high yield (5-6%) based on *Apis mellifera* was obtained compared to other wasps, and its structure was analyzed using IR, <sup>1</sup>H and <sup>13</sup>C NMR spectroscopy methods. IR spectra were analyzed to determine the polymorph form of the extracted chitin, it was observed that a split signal was formed in the absorption region belonging to the amide I band, which indicates that  $\alpha$ -chitin was obtained. When the molecular weight of chitosan was analyzed using GPC, an increase or decrease in molecular weight depending on DDA was determined. Analysis using the XRD method revealed that a crystal system with a tetragonal structure of chitosan was obtained with a CI = 31.65%. Therefore, N-alkyl and N-acyl derivatives of chitosan were synthesized with some cyclic and

aliphatic aldehydes and acid anhydrides, and their structures were analyzed.

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