SYNTHESIS, PROPERTIES AND POTENTIAL APPLICATIONS OF QUATERNARY AMMONIUM DERIVATIVES OF CHITOSAN OBTAINED FROM PLEUROTUS OSTREATUS

Otabek Turlibekov
Oliy Akhmedov
Avazbek Taniberdiyev
National Biopharmaceutical Research Institute
otabekchemist@gmail.com

Abstract. *In the present study, three different methods for chitin extraction from Pleurotus ostreatus (oyster mushroom) were investigated. The influence of sodium hydroxide (NaOH) and hydrochloric acid (HCl) concentrations, stirring conditions, and treatment duration on the quality of the extracted chitin was evaluated. A 3% hydrogen peroxide (H_2O_2) solution was employed during the bleaching stage to remove pigments and residual organic impurities.*

The obtained results demonstrate that fungal-derived chitin extracted under optimized conditions represents a promising renewable precursor for the preparation of functional chitosan derivatives with potential applications in pharmaceutical, biomedical, and advanced biomaterial technologies.

Keywords: *Pleurotus ostreatus; chitin; chitosan; quaternary ammonium; antibacterial activity; biomaterials.*

Literature review

Research Background Chitin is one of the most abundant natural polysaccharides found in crustacean shells, insect cuticles, and fungal cell walls. Among alternative sources, Pleurotus ostreatus has attracted considerable attention because of its rapid growth, high biomass yield, and sustainable cultivation. The quality of extracted chitin directly influences the physicochemical properties and biological performance of chitosan and its derivatives. Therefore, optimization of the extraction process is essential for obtaining high-quality chitin suitable for further chemical modification.

The experimental results demonstrated that the extraction conditions significantly affected the purity and structural preservation of the obtained chitin. Three extraction procedures were developed and experimentally evaluated to determine the most effective method for producing high-quality fungal chitin. Comparative analysis showed that magnetic stirring during alkaline treatment improved the efficiency of

deproteinization, whereas stronger alkaline and acidic conditions enhanced purification but increased the possibility of partial polymer degradation.

Materials and Methods

Dried Pleurotus ostreatus dried bodies were used as the raw material. Each experiment was performed using 5.0 g of dried mushroom biomass. Analytical-grade NaOH, HCl, H_2O_2, bidistilled water, and 96% ethanol were used for deproteinization, demineralization, bleaching, washing, and dehydration.

General Procedure for Chitin Extraction Chitin extraction consisted of washing, alkaline deproteinization, acid demineralization, bleaching, washing to neutral pH, dehydration with 96% ethanol, and drying at room temperature. These sequential steps were designed to remove proteins, mineral components, pigments, and other impurities while preserving the chitin structure.

Method 1 Five grams of dried Pleurotus ostreatus were treated with 0.1 M NaOH (1:10, w/v) under magnetic stirring at room temperature for 4 h. The sample was then treated with 0.6 M HCl for 4 h, washed to pH 7, bleached with 3% H_2O_2 for 4 h, dehydrated with 96% ethanol, and dried at room temperature.

Continuous magnetic stirring improved reagent diffusion and protein removal while preserving the polymer structure. This method provided an effective balance between purification efficiency and structural integrity of chitin.

Method 2 The second method followed the same procedure as Method 1, except that the alkaline treatment was performed without magnetic stirring. After deproteinization, the sample was washed to pH 7, treated with 0.6 M HCl for 4 h, bleached with 3% H_2O_2 for 4 h, dehydrated with ethanol, and dried.

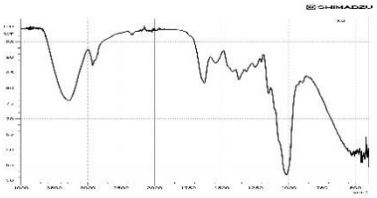
The absence of stirring reduced reagent penetration into the fungal biomass, resulting in lower extraction efficiency and reduced product purity compared with Method 1, demonstrating the importance of magnetic stirring during deproteinization.

Method 3 In the third method, 5.0 g of dried Pleurotus ostreatus biomass was treated with 0.5 M NaOH (1:10, w/v) under magnetic stirring for 4 h, followed by 24 h incubation. After washing to neutral pH, the sample was demineralized using 1.0 M HCl under magnetic stirring for 4 h and incubated for an additional 24 h. The material was then bleached with 3% H_2O_2 for 24 h, washed, dehydrated with 96% ethanol, and dried at room temperature.

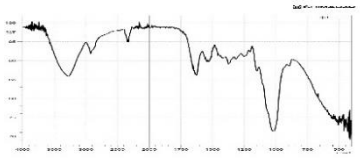
The increased reagent concentrations and extended treatment time enhanced the removal of proteins, pigments, and inorganic impurities, resulting in highly purified chitin. However, these harsher conditions also increased reagent consumption, processing time, and the risk of partial polymer degradation.

Results

The three extraction methods differed mainly in reagent concentration, treatment duration, and stirring conditions. Method 1 combined mild chemical conditions with magnetic stirring, providing efficient purification while preserving the chitin structure.



Method 1



Method 3

Method 2, performed without stirring, showed lower extraction efficiency and product purity due to reduced reagent diffusion. Method 3 employed stronger chemical treatments and longer incubation times, producing highly purified chitin but with a greater possibility of polymer degradation. Overall, Method 1 provided the best balance between purification efficiency, structural preservation, and processing time.

Conclusion

Scientific Assessment The results demonstrate that reagent concentration, stirring conditions, and extraction time are the key factors influencing chitin isolation from Pleurotus ostreatus. While stronger chemical treatments improve purification efficiency, they may also compromise polymer integrity. Based on extraction efficiency, FTIR analysis, reagent consumption, and processing time, Method 1 was identified as the most suitable protocol for obtaining high-quality fungal chitin for further physicochemical characterization and chemical modification based on IR structure