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Extraction and physicochemical characterization of fungal-derived chitosan from *Pleurotus ostreatus* (mushroom) stems

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The Polymers are macromolecules composed of repeating monomeric units and are widely used across industries. Based on their origin, polymers are generally classified into synthetic polymers and biopolymers. Synthetic polymers, derived from petroleum-based sources, offer desirable properties but pose significant environmental concerns due to their non-biodegradability and persistence in ecosystems. These limitations have accelerated the exploration of biodegradable and sustainable alternatives, such as biopolymers. Among these, chitosan stands out as the second most abundant natural polymer after cellulose. It is derived from the deacetylation of chitin, a polysaccharide found in the exoskeletons of crustaceans, some insects, and in fungal cell walls. Chitosan is valued for its biodegradability, biocompatibility, and functional versatility in applications such as biomedicine, agriculture, food packaging, electrochemical devices and, wastewater treatment. However, commercial chitosan production is primarily based on crustacean shells, which contain a high proportion of calcium carbonate ($CaCO_3$). This necessitates the use of strong acids during processing, resulting in hazardous chemical waste and raising both environmental and economic concerns. Moreover, the supply of crustacean shell waste is seasonal and geographically limited. To overcome these challenges, this study investigates the extraction of chitosan from *Pleurotus ostreatus* stems, a non-edible agricultural by-product typically discarded after harvest. Due to their fibrous structure, low mineral content, and absence of calcium carbonate, these residues offer an environmentally friendly alternative that requires less chemical input during processing. Chitosan was extracted through a three-step process involving deproteinization with sodium hydroxide (NaOH), followed by demineralization using dilute hydrochloric acid (HCl), and finally deacetylation with concentrated NaOH. Characterization using Fourier-transform infrared spectroscopy (FTIR) confirmed the presence of characteristic functional groups, with absorption bands observed at 3403 cm^{-1} (–OH and –NH stretching), 1635 cm^{-1} (amide I), 1560 cm^{-1} (amide II), and 1028 cm^{-1} (C–O–C stretching), and X-ray diffraction (XRD) revealed a semi-crystalline structure. The process yielded 8% chitosan, which is lower than the yield of standard chitosan (typically 10–20%), but the ash content was 0.1%, lower than commercial chitosan (0.3–1.0%), indicating high purity of the extracted product. This study demonstrates that mushroom stem waste is a sustainable, non-animal, and environmentally friendly source of chitosan. The proposed method offers a cleaner and cost-effective alternative to conventional crustacean-based extraction, promotes agricultural waste utilization, and supports the development of sustainable biomaterials.

Keywords: Biopolymer, Chitosan extraction, Deacetylation, Mushroom waste utilization, Sustainable material