

Functionalization of Chitosan

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Research Experiences for Undergraduates

Chitin is one of the most abundant naturally occurring polymers found on the earth and can be found in fungi and in the shells of insects and crustaceans. Upon deacetylation, chitin is converted into another polysaccharide, chitosan. This polymer has been shown to promote wound healing when processed into a bandage. Chitosan is composed of two monomers: glucosamine and N-acetyl glucosamine. The amino groups of chitosan have cationic properties that are believed to have electrostatic interactions with anionic systems. This property has been found to be quite valuable in using chitosan as an antibacterial agent. It has been proposed that the interaction between the anionic cell surface of bacteria and the cationic amino group of chitosan weakens the cell membrane of the bacteria. In order to optimize chitosan's antibacterial properties at physiological pH, the amine group must remain cationic at pH 7.4. This poses a challenge as chitosan's amine group has a pKa of 6.3 which implies optimal protonation occurs at an acidic pH (~5.3). Alteration of the pKa of the amine group is therefore a necessary goal to increase the bioactivity of chitosan. Efforts towards this goal include installation of an arginine group on the chitosan amine. The sidechain of arginine has a pKa of 12.5, and thus will be cationic at neutral pH. The task is complicated by a number of problems including solubility issues with chitosan and characterization of the final product.

Undergraduate student Katie Douglas (Eureka)

succeeded in her efforts of functionalizing chitosan with boc protected arginine. By using standard peptide coupling methods, the carboxylic acid of Boc-arginine and the amino group of chitosan could be coupled forming an amide bond. The Boc group, necessary to prevent the formation of poly-arginine, was removed upon treatment with neat trifluoro-acetic acid. One aspect of this reaction that we are interested in is the relationship between deprotection time and depolymerization. Dynamic light scattering (DLS) provides one method of analyzing the functionalized chitosan via analysis of the hydrodynamic radius of the product.

The hydrodynamic radii of the polymer ranged between 15 to 150 nanometers. Analysis of this parameter with different deprotection times gives us a measure of depolymerization. This data coupled with the amount of functionalization provides a handle for accurate characterization for further tests. In addition this material may provide a superior bandage product due to its cationic properties at physiological pH. Further testing will be necessary to accurately characterize functionalized chitosan as well as antibacterial testing.

Histograms of DLS Results

Hydrodynamic Radius of Functionalized Chitosan after Deprotection

