CHAPTER I

INTRODUCTION

1.1 Statement of Problem

Chitosan is a natural non-toxic biopolymer, derived by deacetylation of chitin, a major component of the shells of crustacean such as crab, shrimp, and crawfish. Chitosan has attracted more and more attention in biomedical fields owing to its low toxicity, biocompatibility and biodegradability. Chitosan has been shown to be an effective agent for inhibiting the growth of an array of common bacteria (gram positive as well as gram negative) and fungi. Chitosan is insoluble in water, alkali and organic solvents, but it is soluble in dilute organic acid solution below pH 6.5. The application of chitosan was therefore limited owing to its insolubility at physiological pH. Chitosan in its soluble form exhibits antibacterial activity due to the fact that its amino group ($-NH_2$) is converted to an ammonium ion ($-NH_3^+$) that can bind ionically with the negatively-charged membrane of bacteria. Quaternary ammonium derivatives of chitosan show superior antibacterial activity to the unmodified chitosan because the unmodified chitosan shows its positive charge only in acidic condition, whereas the quaternized chitosan exhibits solubility and permanent positive charge at a wider pH range. The quaternization cannot only introduce positive charge but also hydrophobicity to chitosan, the two parameters that are believed to affect the antibacterial activity.

This research aims to increase the antibacterial activity of chitosan surface by introducing quaternary ammonium groups via a heterogeneous two-step process: reductive alkylation using selected aldehydes to from *N*-alkyl chitosan film followed by quaternization with selected alkyl iodides to from quaternized *N*-alkyl chitosan. Antibacterial activities of the surface-quaternized chitosan are tested against both gram-positive and gram-negative bacteria in comparison with virgin chitosan. Using this approach, it is anticipated that chitosan can exhibit good antimicrobial activity even in its insoluble form. The outcome of this study should provide fundamental information that can lead to the development of chitosan as antimicrobial filler for

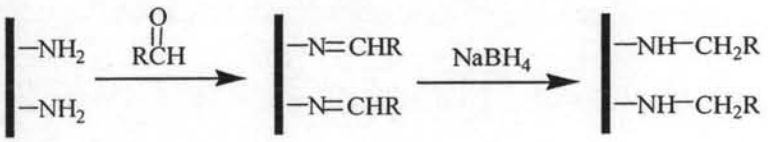
bio-related applications. This is also another way of adding value to the locally abundant polymer.

1.2 Objectives

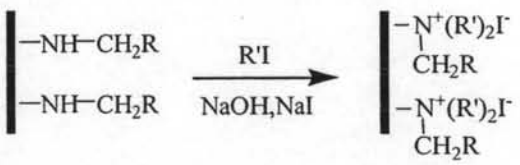
1. To prepare quaternary ammonium-functionalized chitosan surface
2. To determine antibacterial activity of chitosan surface bearing various quaternary ammonium groups

1.3 Scope of the investigation

1. Preparation of *N*-alkyl chitosan films by a reaction between chitosan and selective aldehydes via Schiff 's base intermediate.



2. Preparation of quaternized *N*-alkyl chitosan films by a reaction between *N*-alkyl chitosan films and selected alkyl iodides.



3. Characterization of the surface-modified chitosan using:
   - Attenuated total reflection- Fourier transform infrared spectroscopy (ATR-FTIR) for identifying functional groups on the surface-modified chitosan films.
   - Air-water contact angle measurements for determination of hydrophobicity/hydrophilicity of the chitosan films.
   - Zeta potential measurement for determination of surface charge of the chitosan particles.

4. Determination of antibacterial activity of the surface-modified chitosan films against *Staphylococcus aureus* (gram positive bacteria) and *Escherichia coli* (gram negative bacteria).