CHAPTER I
INTRODUCTION

Some microorganisms can cause diseases to our bodies if we eat or have a contact to these microorganisms. In order to inhibit the growth of microorganisms, antimicrobial agents are used in food, household products, textile and biomedical devices. Antimicrobial agents can inhibit the growth of microorganisms by various mechanisms. For example, Triclosan which is used in many contemporary consumer and professional health care products (Schweizer, 2001). It was thought to act as a non-specific biocide by affecting membrane structure and function (Meincke *et al.*, 1980). Another one is iodine and silver, a potent antimicrobial agent that is frequently used in the management of wounds (Wright *et al.*, 1998; O'Neill *et al.*, 2003).

Although some of commercially available synthetic antimicrobial agents are effective and have been proved to be safe at a limited concentration, they may cause irritation to our tissues or be toxic due to accumulation in the bodies after use for a long period of time. Accordingly, it is interest to investigate new antimicrobial agents from natural resources for use in materials in contact with the bodies in order to reduce the risk of toxicity.

Alginate is a co-polymers of (1→4)-linked residues of β-D-mannuronic and α-L-guluronic acids (Wong *et al.*, 2002). It is located in the cell wall and in the matrix of the algae such as *Laminaria* sp. and *Ascophyllum* sp. In the presence of multivalent cations such as Ca^{2+}, an aqueous solution of alginate will become a gel. Gel formation occurs due to the ionic interaction between guluronic acid residues from two or more alginate chains and cations, yielding a three-dimensional network of alginate molecules well described by the ' egg-box model ' (Lloyd *et al.*, 1998). Alginate can be processed into various forms such as membrane, film and fiber forms. Because of its good biocompatibility, biodegradability, and non toxicity (Goth *et al.*, 2004), much interest has been paid on them.

Alginate has historically been known to have a haemostatic function and to be capable of absorbing specific solutes therefore it is logical that they should be evaluated as suitable components for modern wound dressing (Hermes and Narayani,

2002). However, alginate itself has no antimicrobial activity and this may not be able to prevent infection caused by microorganisms.

Chitosan is a copolymer of glucosamine and *N*-acetylglucoamine units linked by β-(1-4) glycosidic bonds (Yang *et al.*, 2005). It is obtained by *N*-deacetylation of chitin which is the second most naturally occurring biopolymer after cellulose and exists largely in the shells of crustacea and insects (Lim and Hudson, 2004). In recent years, a number of investigations have been carried out to exploit the potential application of chitosan (Liu *et al.*, 2001). It has been studied as biomedical materials due to its wound healing effect (Tamura *et al.*, 2002) and can inhibit the growth of a wide variety of bacteria and fungi. Several mechanisms were proposed for the antibacterial activity by chitosan. One of the mechanism is the polycationic nature of chitosan interferes with the negatively charged residues of membrane macromolecules at the bacteria surface and causes cell death due to leakage of intracellular components. Another one is blocking of description to RNA from DNA by adsorption of penetrated chitosan to DNA molecules (Tokura *et al.*, 1997). The growth of *E.coli* was inhibited in the presence of more than 0.025% chitosan (Kumar, 2002). Chitosan is soluble in acetic acid but poor solubility in neutral water and other organic solvents (Zhang *et al.*, 2003). To improve the solubility of chitosan, a partial chemical modification is required. Carboxymethylated chitosan (*O*-CM chitosan), a water-soluble chitosan derivative, has been reported to posses antimicrobial activity. It has been reported to inhibit the growth of *E.coli*, *S.aureus*, *C.albicans*, *B.cereus* and *B.megaterium* (Li *et al.*, 2002; Liu *et al.*, 2001; No *et al.*, 2002). Besides Carboxymethylated chitosan, *N*-(carboxybutyl) chitosan which is used in wound management displayed inhibitory, bactericidal, and candidacidal activities when tested against 298 cultures of various pathogens (Muzzarelli *et al.*, 1990). In addition, there are some water-soluble chitosan derivatives, *N*-(carboxyacyl) chitosans, prepared by reactions with carboxylic anhydrides (Hirano and Moriyasu, 2004) probably having antibacterial activity due to the structure is similar to *N*-carboxybutyl chitosan. However, there has been no report on antimicrobial property of *N*-(carboxyacyl) chitosans. Thus, it would be interesting to investigate if *N*-(carboxyacyl) chitosan, which possesses positive charges on the ammonium groups, could show any antimicrobial activities.

In this study, two water-soluble chitosan derivatives, *O*-CM chitosan and *N*-(carboxyacyl) chitosan were synthesized and then *O*-CM chitosan/sodium alginate and *N*-(carboxyacyl) chitosan/sodium alginate blend fibers were prepared by wet spinning process. Structure, miscibility, surface morphology, mechanical properties and antibacterial properties against gram-negative bacteria (*Escherichia coli*, *Pseudomonas auruginosa*), gram-positive bacteria (*Staphylococcus aureus*, *Staphylococcus mutans*), and yeasts (*Saccharomyces cerevisiae*, *Candida albicans*) of the blend fibers were investigated.