CHAPTER I
INTRODUCTION

Fibers may be defined as units of matter characterized by flexibility, fineness, and a high ratio of length to thickness (Morton and Hearle, 1975). The fibers are widely produced from many sorts of raw materials both by nature (natural fibers) and mankind (man-made fibers) (Cook, 1984a). To obtain man-made fibers, a process called 'fiber spinning' is required. Generally, fiber spinning techniques can be classified into three main types: 1) wet spinning, 2) dry spinning, and 3) melt spinning (Cook, 1984b).

Although the wet spinning technique is the oldest method of fiber spinning and cannot be competitive in view of productivity with the melt or dry spinning technique, it is the most suitable technique for the production of fibers from polysaccharide materials such as cellulose and its derivatives. Such polymeric materials contain ring structures and a large amount of hydrogen bonds in their molecules, therefore, they have such high melting temperatures that cause them to degrade before melting and the difficulty of solubilization. As a result, it is not suitable to fabricate fibers from this kind of materials by using melt or dry spinning process.

Besides cellulose, alginate, a linear heteropolysaccharide of D-mannuronic acid and L-guluronic acid (Klinkenberg *et al.*, 2001) extracted from various species of brown algae (seaweed), is another sample of polysaccharide which is suitable to be fabricated into fiber form. The alginate fibers are generally used in pharmaceutical industry as wound dressings. Much interest has been paid on alginate because of its good biocompatibility, biodegradability, and non toxicity (Hermes and Narayani, 2002).

Although it was reported that alginate has a high inhibitory activity against the tobacco mosaic virus, and also inhibits the toxicity of terrible cadmium and radioactive strontium (Zhang *et al.*, 2000), it still has no antibacterial property that is very useful in pharmaceutical applications. Many researchers try to introduce the antibacterial property into the alginate material, for example, from the Annual Report and Accounts published by

Advanced Medical Solutions Group Plc. (2001), the silver fibers which have great antibacterial capabilities and cause little harm to human are incorporated into alginate material to produce dressings that provide silver at the wound site whilst maintaining the fluid handling and haemostatic features of alginate. Another way to introduce the antibacterial property to the alginate material is the use of natural antibacterial agents such as honey, which was used to treat infected wounds as long ago as 2000 years before bacteria were discovered to be the cause of infection, chitosan and its derivatives.

Chitosan is a linear cationic polysaccharide composed of D-glucosamine and 2-acetamido-2-deoxy-D-glucosamine (Klinkenberg *et al.*, 2001). It is a natural non-toxic biopolymer extracted from chitin, the building block of crustacean shells, lobsters, shrimps, crabs etc. However, chitin is only manufactured from crustaceans (crab, krill and crayfish) primarily because a large amount of the crustacean exoskeleton is available as a by-product of food processing. Chemically chitin is a polysaccharide with side groups called acetyl groups. When these side groups are modified by N-deacetylation, chitin becomes chitosan. It is these positive charges of amino groups that give chitosan its unique properties especially in antibacterial property.

Due to the positive charges of amino groups of the chitosan, it can bound to negatively charged bacterial surface and then inhibit the growth of bacteria (Sudarshan *et al.*, 1992). Sudarshan *et al.* (1992) reported that, at lower concentration, chitosan may have bound to the negatively charged bacterial surface to disturb the cell membrane and cause cell death due to leakage of intracellular components; at high concentration, chitosan may have additionally coated the bacterial surface to prevent leakage of intracellular components as well as to impede mass transfer across the cell barrier.

Besides chitosan, carboxymethylated chitosan (CM-chitosan), a water-soluble chitosan derivative, has been reported to possess antimicrobial activity (Kim *et al.*, 2002). 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; and No *et al.*, 2002).

From the above text, chitosan and CM-chitosan are interesting natural antibacterial agents. They can be used to introduce antibacterial property into the alginate fiber.

Due to the negative charges of alginate, it can form ionic interaction with positive charges of chitosan (Tamura *et al.*, 2002). It is interesting to investigate the antibacterial property of chitosan-coated alginate fiber. On the other hand, CM-chitosan and alginate can blend together due to the formation of hydrogen bonding between those two polymer chains. Therefore, blending of alginate and CM-chitosan is also a promising method to introduce antibacterial activity into alginic materials.

In this study, CM-chitosan/alginate blend fiber and chitosan-coated alginate fiber were prepared and characterized for their mechanical properties and morphology. Antibacterial properties against *Escherichia coli* and *Staphylococcus aureus* of the fibers were investigated.