CHAPTER VII
CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

In this research work, smart alginate-based wound dressings were successfully developed using the wet spinning process. Incorporation of the other natural polymeric as well as the synthetic substances was used to complement the properties of the final products. In order to improve the mechanical properties and include the ability to promote tissue reconstruction of neat alginate fiber, chitin whisker, a nanofibrilla chitin prepared by acid hydrolysis of the chitin from shrimp shells was used as filler in alginate wet-spun fibers. Incorporation of a low amount of the whiskers in the nanocomposite fibers improved both the mechanical and the thermal properties of the fibers as well as accelerated the biodegradation process of the fibers in the presence of lysozyme. Antimicrobial property was introduced to alginate-based fibers by coating alginate fibers with silver particles or mixing alginate aqueous solution with chitosan whiskers suspension before spinning. The occurrence of silver nanoparticles can be achieved by using small proportion of the silver coated on the fibers. Moreover, at these compositions, the good distribution of silver nanoparticles was observed resulting in the enhancement of the mechanical properties of the fibers. Chitosan whiskers were prepared by deacetylation of chitin whiskers. Study on the mechanical properties of the neat and chitosan whisker-alginate nanocomposite fibers revealed that, the embedded chitosan whiskers lead the nanocomposite fibers to increase in the tensile strength but lowering the elongation at break. The accumulative release amount of chitosan whiskers is dependent on the initial chitosan whisker contents in the fibers. Release data also indicated the influence of erosion of polymer matrix on chitosan whiskers released from the nanocomposite fibers. Both silver-coated alginate fibers and chitosan whisker-alginate nanocomposite fibers show antibacterial efficacy against both gram-positive *Staphylococcus aureus* and gram-negative *Escherichia coli*. Lastly, a novel method of using chitosan in the form of an emulsion was proposed in order to overcome the major problem associated with the production of alginate/chitosan hybridized fibers

by wet spinning which is the formation of gels due to ionic interactions of the oppositely-charged molecules of alginate and chitosan when these two polymers are directly mixed. Such an emulsion was prepared by adding the primary emulsion of olive oil in a sodium dodecyl sulphate (SDS) aqueous solution into chitosan-citrate complex. The complexation of chitosan with citric acid is the key of this method. By this way, chitosan can be mixed in alginate fiber up to 10% w/w of chitosan based on the weight of alginate. The alginate/chitosan hybridized fibers showed spotty features of the chitosan-citrate complex micelles on the surface and the inside of the hybridized fibers. At the lowest content of incorporated chitosan (i.e., 0.5% w/w chitosan), both the tenacity and the elongation at break of the obtained chitosan-spotted alginate fibers were the greatest. Further increase in the chitosan content resulted in a monotonous decrease in the property values. Preliminary studies demonstrated that the obtained chitosan-spotted alginate fibers showed great promises as carriers for drug delivery.

7.2 Recommendations

In this research work, the results indicated the good compositions between the alginate and other substances (i.e. chitin whiskers, silver particles, chitosan whiskers, and chitosan emulsion) in order to get alginate-based wet spun fibers with a suitable homogeneity, mechanical properties, and antibacterial activities. However, study on other variations in the spinning conditions such as size of nozzle, bath length, and take-up speed was not conducted. The effect of these variations should therefore be further investigated in order to obtain the optimal spinning conditions that would give an alginate-based wet spun fiber with the best properties.

In addition, the potential for use of the obtained alginate-based wet spun fibers as wound dressing or skin regeneration applications should be further investigated *in vivo* or in an animal study.