CHAPTER V
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The bacterial cellulose/ sodium alginate/ gelatin (BAG) films and modified BAG films were successful prepared by casting technique. Generally, the composite films shrink in dry state so that plasticizers are used to improve flexibility and resistance to cracking of the films. The composite film with BC/A/G at a ratio of 60/20/20 has superior mechanical properties for both dry and wet states. The SEM images show that sodium alginate and gelatin could penetrate into the nanocellulose fibril networks, fill up of the spaces and coat on the fibril surfaces. The BAG film at a ratio of 60/20/20 displayed good incorporation of sodium alginate and gelatin into the BC fibril network, which forms ribbon-like structure of cellulose fibrils containing gels. Furthermore, the FT-IR revealed the shifts attributed to intermolecular interactions between the hydroxyl group of cellulose, the carboxyl group of sodium alginate and amide group of gelatin. The results indicated that glycerol is a suitable plasticizer for the BAG films. Glycerol is a hydrophilic plasticizer so that it enhanced water absorption capacity and improved elongation at break of the re-swollen films. However, excess glycerol content could attribute to the migration of glycerol. The optimal ratio of glycerol to gelatin was at 2:10 (w/w).

The MBAG film was further modified by the supplement of tannic acid as crosslnking and antimicrobial agent. Currently, the most used crosslinking agents are phenolic compounds due to their safety and moderate cost. The FT-IR revealed hydroxyl groups of tannic acid could form hydrogen bonds with amino group of gelatin as well as increasing amplitudes of free water peaks. These changes were indicative of greater disorder. The interactions between tannic acid and gelatin should be hydrophobic interactions rather than strong hydrogen bonding. Although the tannic acid-gelatin interaction was not strong, it had positive effect on plasticizer properties of the MBAGT films in wet state and helped to increase EB of the re-swollen films. The optimal weight ratio of mg tannic acid to gram gelatin solution was at 10:1.

In order to enhance food quality, prevent food from foodborne pathogens during storage and delay food spoilage, new food packaging films with antimicrobial functions have been developed. The mangosteen ethanolic extract was selected as antimicrobial agent for inhibition growth of foodborne pathogens. The FT-IR spectra of the modified films revealed weakly interactions between the functional groups of the MBAGT film and the mangosteen ethanolic extract compounds. The ethanolic extract contained hydrophobic compounds could filled in the micropores of the films and also coated on cellulose fibrils, resulting in smoother surface of the films. However, the supplement of the mangosteen ethanolic extract might also have interfering effects on the chemical bonds of the films, resulting in a looser film structure. Therefore, the addition of the extract enhanced the thickness as well as the inter-space of the sheet layers of the MBAGTM films. As a result, the WVTR and the OTR of the modified films increased to some extent.

The results of MIC showed that mangosteen ethanolic extracted and tannic acid could inhibit bacteria in food. Mangosteen ethanolic extract possessed at 1.46 mg/ml concentration for *E. coli* and *S. aureus*, and at 0.73 mg/ml concentration for *S. typhimurium* and *L. monocytogenes*. On the other hand, tannic acid possessed at 30 mg/ml concentration for *E. coli*, *S. typhimurium* and *S. aureus*, and at 15 mg/ml concentration for *L. monocytogenes*. The MBC for mangosteen ethanolic extract possessed at 1.46 mg/ml concentration for all bacteria, whereas tannic acid possessed at 30 mg/ml concentration for *E. coli*, *S. typhimurium* and *S. aureus*, and at 15 mg/ml concentration for *L. monocytogenes*. The result of the study on antimicrobial activities of MBAGTM films containing mangosteen ethanolic extract by Disc diffusion method and the study of cumulative release of active compounds, mangosins and phenolic componds from the films revealed that the mangosteen ethanolic extract might not or only slightly released from the MBAGTM films. It was suggested that the accumulation of extract compounds at high concentrations might form agglomerated granules within the cross-linked films and prevented the release of the components.

5.2 Recommendations for future studies

Based on this study, further works for the improvement of the biopolymer composite films are recommended as following.

1. Development of procedure to adjust the film structure in order to control the release rate of the applied active components at optimal level.

2. Application the film for encapsulation of mangosteen ethanolic extract in medicine in order to use as drug carrier or wound dressing.