# CHAPTER V

# CONCLUSIONS

## 5.1 CONCLUSIONS

Incorporation of whey protein isolate (WPI) significantly altered properties of konjac glucomannan (KGM) film. Lightness and greenness of the blend films significantly increased while yellowness decreased with an incorporating WPI into KGM film ($p \leq 0.05$). Total color difference ($\Delta E$) of WPI and KGM-WPI blend films indicated that these films were not visibly difference to commercial polypropylene. The transparency of the KGM-WPI blend films increased with an increase in the concentration of WPI. Incorporating WPI into matrix of KGM films resulted in significant decrease in tensile strength (TS) and elastic modulus (EM), and significantly increase in %elongation (%E), comparing to pure KGM film ($p \leq 0.05$). The presence of WPI molecules in KGM matrix enhanced water insolubility of the films. However, there was no significant effect of biopolymer content on water vapor permeability of the films ($p > 0.05$). The range of glycerol in this study did not apparently affect properties of the films. Overall, the KGM/WPI blend films exhibited a potential application as edible food films depending on applications. DSC onset temperature of melting of the WPI and blend films were around 157-160 °C and $\Delta H$ ranged from 5.6 J/g to 19.0 J/g. Formulation of the blend films did not significantly affect $T_o$, $T_p$ and $\Delta H$ films ($p > 0.05$.). However, $T_p$ and $\Delta H$ of WPI films were obviously higher than those of the blend films. WPI and blend films with the highest concentration of WPI, 0.4:3.8 (g KGM :g WPI)/ 100 g solution, could be heat sealed at 175 °C. From the microstructure results, there was an incompatibility between KGM and WPI in the film matrix. The formation of smaller clusters of whey protein molecules occurred in the blended film containing greater WPI concentration.

The reduced drying time improved transparency and mechanical strength without impairing overall color, solubility and water vapor barrier properties of the optimized KGM-WPI blend film. This finding indicates that it is possible to employ fast drying condition in order to enable noteworthy faster production speed for commercial scale up without compromising any important properties of the film. The slowly dried film had significantly higher $T_o$ but had significantly lower $\Delta H$ ($p \leq 0.05$). However, there was no significant difference between $T_p$ of the films ($p > 0.05$). From the microstructure results, there were larger WPI clusters in the quickly dried film while the small clusters of WPI dispersed throughout the matrix of films dried at slow drying rate.

Although transparency of KGM-WPI film was significantly increased over storage time ($p \leq 0.05$), total color difference, solubility and water vapor permeability were relatively constant. Although the changes in tensile strength as a result of storage time and temperature were less changed than % elongation and elastic modulus; however, mechanical properties were gradually improved over storage, especially at higher storage temperature. Microstructure of all aged films was relatively similar to that of the freshly prepared film. Overall, the blend film showed better storage stability at lower storage temperature. The storage stability of konjac glucomannan-whey protein isolate blend films demonstrated by this study indicates potential commercial edible packaging use under the appropriate storage conditions.



## 5.2 SUGGESTIONS

The main goal of this research was to study the effect of incorporation of whey protein isolate (WPI), effect of drying rate and storage condition on the physical and mechanical properties of konjac glucomannan (KGM) based films. Although, new knowledge has been developed and many hypotheses were confirmed, many other hypotheses and new ideas arose along the course of experimentation. Below are possible research suggestions that could help to further develop the body of

knowledge necessary in order for the food industry and the consumer to fully benefit from the application of edible KGM-WPI composite film.

- KGM-WPI composite film is a potential good carrier for active ingredients. Investigation of incorporation of antioxidants, antimicrobial agents, nutraceuticals or combinations of functional compounds into the blend film is appropriated.

- Although, KGM-WPI blend film showed good stability during storage, the effects of dried and intermediate moisture food models and storage conditions on stability and integrity of the film should be investigated.

- Other aspects of KGM-WPI film, such as sensory perception of food packaged with KGM-WPI film by consumers should also be explored.