

CHAPTER 4

CONCLUSION

Preparation of SF hydrogels with different gel formers, e.g. CP, PL, HPMC have been accomplished in order to improve some physical properties of the SF film which was hard and brittle. When the gel formers were added, it was found that the SF hydrogels obtained were more flexible and tougher. The characterization of the prepared SF hydrogels provided the following results.

The FTIR spectra revealed that each prepared hydrogel evidently had intermolecular linkage through H-bonding between the molecules of SF-CP-TEA, SF-PL and SF-HPMC. These results suggested that the conformational change of SF from random coil to β -sheet structure was accelerated by addition of gel formers due to the intermolecular hydrogen bonds between SF and gel formers. In addition, the conformation of the SF protein in the hydrogels was changed from random coil to β -sheet like that happened when the SF film was soaked in the EtOH.

Thermal calorimetry reveals the existence of relatively low temperature thermal transitions (T_g and T_m) in treated SF and SF hydrogel blends with gel formers. These transitions disappear entirely upon EtOH treatment due to the formation of β -crystals. Thermal gravimetric analysis also provides evidence to indicate the formation of the β -sheet structure generally that promotes the improved thermal stability of pure SF and SF-containing blends at elevated temperatures. Crystallization of SF likewise enhances the mechanical properties of SF hydrogels.

The blend strategy developed here and used elsewhere to produce physically cross-linked, thermally responsive SF hydrogels is based on the crystallizable attributes of SF and is sufficiently general to be extended to blends of SF with synthetic polymers. The large endothermic peak is appeared due to the effect of moisture. More importantly, the endothermic peaks of blended SF hydrogels become broader than that the powder of materials because of the effect of gel formers addition. The results confirm that the SF hydrogels prepared from different gel formers have enough β -sheet content, which makes these hydrogels water-stable.

The results from morphological study using SEM demonstrated that the addition of gel former caused a thicker and smoother layer of the hydrogel film. After immersing in EtOH, the SF and SF-gel former hydrogel films became even smoother and more orderly arranged in layer. The nature of layer formation of the hydrogel with each gel former is quite different depending on the property and structure of each component involved. For example, PL which has a straight chain conformation and highly order and crystallinity, once it is mixed with SF, the hydrogel formed will have a smoother cross sectional layer compared to other hydrogels.

Another important property of the hydrogel is the ability to swell in water. It was found that the SF films without gel former had low water swelling ability, but when all three gel formers were added, the swelling ability apparently increased and varied with the concentration of the gel formers. The water swelling ratio of SF/CP hydrogel appeared to be the highest using the lowest concentration of the gel former. The preparation of SF/CP hydrogel was different from the others because

triethanolamine (TEA) was introduced as a neutralizer to assist on being a better gel former of CP. When it was soaked in water, the SF network would stretch out and formed a larger network, thus more water molecules could be accommodated inside the network causing more swelling.

As the hydrogel swelled, the SF protein would be released and could be monitored with UV-VIS measurement. It was found that the SF protein was released most from the SF/PL hydrogel. This is because the PL molecules itself form an umbrella structure of PPO and PEO which is a characteristic feature of PL and this umbrella-like structure can surround water molecules efficiently. Once it is blended with SF, the cross-linking can occur through H-bonding. When the SF/PL hydrogel was immersed in water, the stretching of the network to accommodate water molecules would cause the decrease of intermolecular attraction between SF and PL, thus the SF protein was released. However as more PL concentration was introduced to the hydrogel formation, less protein release occurred due to a denser network formation that allowed less water to penetrate.

From all the experiments carried out, it can be concluded that the blending occurred between SF and gel formers is very compatible and help improve the physical properties of SF. In addition, the result from this study will also provide guidelines on selection of other gel formers to be applied appropriately for different needs.