

## CHAPTER 5 CONCLUSION AND RECOMMENDATIONS

### 5.1 Conclusion

The effect of Kraft lignin on rheological and functional properties of fish protein-based biomaterial was studied. Fish protein powder plasticized with 30% glycerol was blended with 0-70% Kraft lignin and thermal molded. Then, properties of plasticized fish protein/ Kraft lignin biomaterial were determined.

Viscosity of plasticized fish protein/ Kraft lignin blends with 0-70% Kraft lignin was determined by capillary rheometer. The addition of Kraft lignin resulted in a decrease of shear viscosity. In addition, storage modulus in rubbery state of biomaterials determined by DMA showed the same the trend as the shear viscosity. The addition of Kraft lignin decreased the storage modulus in rubbery state at processing temperature. Moreover,  $\tan \delta$  peak height increased with Kraft lignin content which showed liquidlike nature of biomaterial. This might be because Kraft lignin has low molecular weight compared to protein or Kraft lignin interfered protein aggregation. The addition of Kraft lignin increased  $T_g$  of materials until the content of lignin reached to 30 wt%. It may be associated with cross linking of plasticized fish protein/ Kraft lignin biomaterial. However, FTIR spectra showed no new chemical bond between fish protein and Kraft lignin.

The effect of radical scavenging properties of Kraft lignin on protein aggregation was investigated. Addition of Kraft lignin increased protein solubility in SDS. This might be because Kraft lignin interfered protein aggregation. However, the no changes in protein molecular weight in studied range investigated by SDS-PAGE was observed. In addition, free radical scavenging effect between fish protein and Kraft lignin measured by ESR spectroscopy was not observed.

For functional properties, the addition of Kraft lignin in range of 10-40% Kraft lignin can improve mechanical properties of biomaterial. When Kraft lignin was the major component in biomaterial (50-70% Kraft lignin) Young's modulus and tensile strength of biomaterial decreased because of hard brittle property of Kraft lignin. Moreover, the

hydrophobic nature of Kraft lignin effectively reduced the water absorption of the biomaterial.

From this study, it may be concluded that Kraft lignin is an alternative to enlarge the protein thermal processing window. Kraft lignin not only improved the rheological properties of protein by decreasing the viscosity at high processing temperature, but also improved functional properties in terms of mechanical properties and water absorption of fish protein materials. These fish protein-based biomaterial may be used as packaging materials (sheet, container, flower pot) to substitute petroleum-based materials.

## **5.2 Recommendation**

Plasticized fish protein/ Kraft lignin biomaterial prepared by the extrusion or injection should be studied in order to confirm the possibility of Kraft lignin on the processability improvement of protein-based materials.