

## CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

This chapter describes the conclusions and recommendations in the research of the controlled release of furfural-urea complex used as the combination of nematocide and fertilizer.

### 5.1 Conclusions

In this research, the combination of furfural-urea complex and biodegradable polymer, PBSA polymer is introduced as a new to the world product. Biodegradable polymer can perform as both nematocide and fertilizer. Furfural and urea are used in this research to perform a fertilizer function and nematocide function, respectively. The furfural and urea is synthesized through aqueous phase. Two to one ratio of urea to furfural is used in this study. The furfural-urea complex characterized by NMR shows that the molecular structure of furfural-urea complex is that of difurfurilidentriurea or DFTU. Suitable condition to synthesize the complex was conducted as i) to use vacuum dryer as a drying method, ii) Mixing time of urea and furfural and mixing time after adding HCl acids are 15 minutes and 2 hours, respectively, iii) at least 500 ml of water to wash the product. In addition, the thermal stability of DFTU reveals that this product is stable below 140°C before it decomposes under endothermic reaction.

The furfural-urea complex is then combined with a biodegradable polymer in which PBSA is used in this research. To produce a plastic film, 2 different methods are selected in this research. Extrusion method provides a film with uneven film thickness and non-uniform distribution of furfural-urea complex particle. Solvent casting method provides even thickness and better distribution of furfural-urea particles. However, the non-uniform distribution of particles on the polymer film indicates that furfural-urea complex is not easily mixed with PBSA polymer since the film is obviously not homogeneous. The results obtained from FT-IR and ATR suggest that there are small overlap of the peaks between that obtained from furfural-urea complex and that from polymer film. Moreover, the results of both extrusion and solvent casting do not show significant difference in absorbance bands in FT-IR spectrum.

The release of furfural-urea complex is studied by considering only the release rate of furfural since none of urea is absorbed in the UV and visible ranges. The released amount of furfural shows that the release rate of furfural in polymer film is slower than the furfural in only the furfural-urea complex. Moreover, after 4 days the amount of furfural released in only furfural-urea complex is greater than the released amount of furfural within the polymer film.

## 5.2 Recommendations

The furfural-urea complex is not easily mixed with PBSA biodegradable polymer resulting in non-uniform distribution. Other biodegradable should be used instead of PBSA biodegradable polymer in order to produce a polymer film with uniform distribution.

