# CHAPTER V

# CONCLUSION

1. Encapsulated benzophenone can be prepared by simple coacervation using gelatin and formaldehyde as a coating material and hardening agent, respectively. The optimum concentration of sodium sulphate solution for this technique is 20%w/v. TGA curve presented two decomposition temperatures (Td) of benzophenone and gelatin at 180$^{O}$C and 286$^{O}$C, respectively. In addition, SEM micrograph showed the morphology of encapsulated particle and UV-VIS spectroscopy was employed to confirm the involvement of gelatin in the microencapsulation.

2. Effect of benzophenone to gelatin ratio on preparation of microcapsules was investigated by varying the ratios of benzophenone and gelatin which are 1:0.5, 1:1, and 1:2 (EN1, EN2, and EN3). The size of EN3 microcapsules was larger than EN2 and EN3, respectively. The result from TGA measurement confirmed that EN3 microcapsules had a higher thickness of a coating material than EN2 and EN3, respectively.

3. Effect of amount of hardening agent on preparation of microcapsules was studied by varying amount of formaldehyde, i.e., 1, 2, 4 ml (EN4, EN5, and EN6). The average size of EN4, EN5, and EN6 microcapsules was similar. TGA results indicated that the amount of hardening agent had no effect on the thickness of coating material of microcapsule.

4. The LDPE and LDPE containing additives films were prepared by compression molding. The additives, gelatin, benzophenone, and encapsulated benzophenone were added to LDPE films in a concentration of 0-5% by weight. Tensile strength and elongation at break of LDPE/additives films decreased with increasing amount of additives. Both pure LDPE and LDPE films containing additives with approximately 80 $\pm$ 5 $\mu$m thickness were exposed under outdoor and irradiated in QUV Accelerated Weathering Tester.

5. The degradation of pure LDPE film continuously proceeded after the outdoor and QUV exposure. Carbonyl index slowly increased whereas the tensile properties decreased

upon increasing exposure time, especially under an outdoor exposure test. The weight loss showed no significant change upon increasing exposure time. However, SEM micrograph showed tiny holes at the surface of LDPE film after 145 hours of UVB exposure.

6. The degradation of LDPE/gelatin films increased with an increase of exposure time. 5%gelatin filled LDPE film showed the most photodegradation. Carbonyl index after outdoor and accelerated exposure slightly increased, whereas tensile properties decreased with increasing of exposure time. SEM morphology presented holes on surface at 4 month and 82 hours of sunlight and UVB exposure, respectively. Nevertheless, weight loss of LDPE/gelatin films showed no significant increase under QUV exposure.

7. Benzophenone has a very high influence on photodegradation. The photodegradation of LDPE/benzophenone films increased with increasing exposure time as determined by an increase in carbonyl index as well as a decrease in tensile properties of LDPE/benzophenone films after outdoor and QUV test. SEM morphology showed the degradation after 4 months and 82 hours of sunlight and UVB exposure, respectively, and %weight loss increased as a function of exposure time.

8. Benzophenone to gelatin ratio also had an influence on photodegradation. An increase in carbonyl index as well as a decrease in tensile properties of LDPE/EN1 films showed after the 2$^{nd}$ month and 41 hours of outdoor and QUV test whereas LDPE/EN2 and EN3 films showed an increase in carbonyl index and a decrease in tensile properties after the 3$^{rd}$ month and 61.5 hours of outdoor and QUV test. However, the degradation rate was slower than LDPE/benzophenone. Weight loss of all formula clearly increased at the 4$^{th}$ month of outdoor test. SEM morphology showed an evidence of the degradation which was less than that occurred in the LDPE/benzophenone film. The results indicated that EN3 and EN2 microcapsules can retard the photodegradation more than EN1 microcapsules, compared with the LDPE/benzophenone film.

9. Amount of formaldehyde had no affect on photodegradation rate. An increase of carbonyl index and a decrease of tensile properties of LDPE films containing EN4, EN5, and EN6 microencapsulated particles showed no significant difference among each other. An increase of weight loss of all LDPE/microcapsules films showed similar trend.