CHAPTER V

CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

The main objectives of the present work were to develop a new carrier by using adsorbed lipase on $CaCO_3$ followed by entrapment in calcium alginate matrix (CRLAE), for application in biodiesel production. In this work, the suitable preparation condition of $CaCO_3$-lipase (CRLA) was at 5% (wt) *C. rugosa* lipase adsorbed on $CaCO_3$ with the ratio of 1:2, and stirred at 4°C for 90 min. The CRLAE carrier preparation was by the entrapment of CRLA in calcium alginate bead. The condition for the bead formation was by using 1% (w/v) Na-alginate to form beads with a diameter of 1.7 mm. It was found that the water or buffer levels in the carrier significantly affected the lipase catalyzed reaction. The immobilized lipase in CRLAE bead filled with the buffer showed significantly higher activity than that of the one without the buffer for about ten folds. From the study of the effect of bead size, it could be concluded that the intraparticle diffusion resistance over the calcium alginate bead could cause a decrease in the rate of reaction. The optimal temperature for both free and immobilized enzymes were at 50°C. However, the immobilized lipase showed good thermal resistance than the free enzyme.

For the biodiesel production, the optimal conditions were at the molar ratio of ethanol to purified palm oil of 9:1 or at the molar ratio of ethanol to palm fatty acid of 3:1 using 5% wt (by oil) lipase, controlled at temperature 50°C, 250 rpm and reaction time 24 h, with the yields of ethyl ester at 83% from purified palm oil and at 16% from palm fatty acid, respectively. In addition, the substitute of palm fatty acid as a substrate in the ratio of 30% palms fatty acid: 70% palm oil at the addition time of 24 h (total reaction time of 48 h) yielded approximately 81.2 - 84.1% ethyl ester by the free lipase, whereas the biodiesel production by the immobilized lipase in CRLE, CRLA and CRLAE resulted in ethyl ester yields of about 74.2% 57.6% and 42.7% respectively. The results from the reuse of the immobilized enzymes revealed the significantly decrease of ethyl ester yield from the 1st run to the 3rd run.

5.2 Recommendation

5.2.1 In an effort to develop a high performance immobilized lipase carrier for biodiesel production from palm oil or palm fatty acid, other types and shapes of immobilized supports should be studied.

5.2.2 To avoid serious degradation of lipase activity in the presence of high concentration of ethanol, the strategy for continuous ethanol feeding should be developed.

5.2.3 The effect of water content in a solvent-free system should be investigated.