CHAPTER V1

SUMMARY AND RECOMMENDATIONS

6.1 Summary

Response surface methodology (RSM) model explained the interactions between the parameters (enzyme load, enzyme ratio, substrate molar ratio and reaction time) and the responses (fatty acid composition and free fatty acids) for dual lipase system of acidolysis between palm stearin and oleic acid. Optimization process from RSM plays a key role in determining the optimum condition of the parameters involved and resulted in significants range of parameters by considering factors as cost effective, time consume, labour and product quality. The optimum condition obtained were 10% enzyme load, 5:5 enzyme ratio of lipase Ak towards Lipozyme TL IM, 1:3 substrate molar ratio of palm stearin to oleic acid and 3 hours of reaction time. This study found that enzyme load, enzyme ratio and reaction time plays a vital role in having a higher amount of oleic acid incorporated into palm stearin glycerol bond. While to minimize the amount of free fatty acids from the modified palm stearin, the substrate molar ratio of oleic acid has to be reduced and stick to 1:3.

In this study as well, based on the interesterification degree, the synergistic combination between Lipozyme TL IM and lipase AK does not exceed the effectiveness of Lipozyme TL IM alone in catalyzing the acidolysis reaction. But by prolong the reaction time, which 5 hours and above, the result may improve. Lipase AK work best in longer reaction time however, the idea to shorten the reaction time by combining the lipozyme TL IM to speed up the reaction was not enough. The combinations pull back TL IM effectiveness and slow down its activity. This however, because of the high incorporation of oleic acid and alteration occur was a success, based on the TAG obtained and interesterification degree, high of OOO and POO while decrease in PPP and PPO, the TL IM may enhance lipase AK performance by act as carrier to the lipase AK to work effectively within the short time given reaction (3 h).

The high amount of oleic acid in the modified palm stearin have subsequently reduced the slip melting point from 50.6°C to 46.13°C. The repeatability of the enzymes used in 5 times reactions were not much stable as the slip melting point increased by times of reaction, however, the fifth batch product of reused enzyme, the modified palm stearin still have lower melting point when compared to unmodified palm stearin. This may due to lower in the enzyme effectiveness due to repeated usage as a catalyst. Besides, based on TAG and FAC analysis, the result obtained can explained the lower in melting point of purified modified palm stearin (PMPS). The TAG of OOO and POO (7.33% and 23.97%) increase simultaneously and reduce the PPO and PPP (45.37% and 26.08%). The FAC shows oleic acid percentage increase from 30.80% to 48.55%. These in lined with the result on lower melting point obtained in PMPS.

Overall, the acidolysis reaction between palm stearin and oleic have altered the TAG of palm stearin to rearrange and incorporated more oleic acid to the final product. By using the dual lipase system in the acidolysis reaction, TL IM may enhance the capability of lipase AK to catalyst the reaction in shorter time (3 h). By extending the reaction time (up to 7 h) TL IM and lipase AK may act synergistically to catalyst the reaction where the immobilized enzyme (TL IM) may act as carrier for the free lipase (lipase AK) and incorporation of oleic acid possibly higher. In this reaction, however, high incorporation of oleic acid was successful as the melting point of the final product, PMPS reduced (46.13). This has been supported by a high percentage of OOO and POO as well as a high oleic acid percentage in FAC analysis.

6.2 Recommendations

Findings in this work are directive towards several ideas which requisite further investigations which are some of it listed below:

1. Conduct optimization study by using RSM with other parameters such as stirring speed and reaction temperature besides perform a conventional test to determine optimum range of parameters at a time.
2. Perform acidolysis reaction using a combination of acids MUFA and PUFA to incorporate into the palm stearin and measure the product stability and quality in done in upscale production.

3. For combinations of enzyme used, more enzymes between free and immobilized enzyme should be used to test their behavior, synergistic effect and effectiveness on catalyzing the reactions.
4. Extend the study by making up research and development on new product such as margarines and shortenings by using the modified palm stearin and analyze the stability, shelf life and physicochemical characteristics.