

## CHAPTER V

### CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Conclusions

The study showed that the palm fatty acid and palm stearin could be used as a material for producing methyl ester. The effect of the parameters for the esterification and transesterification of palm fatty acid and palm stearin was investigated. The production of methyl ester from low-cost, high FFA feed stocks is investigated in the present study. It is found that the feedstocks with high FFAs could not be transesterification with the commercially available alkaline catalyst transesterification process. The reason is alkaline catalysts react with the FFAs to form soap.

5.1.1 When the transesterification reaction of triglyceride with methanol was carried out in a batch reactor by using potassium hydroxide as a catalyst, the concentration of methyl ester (wt%) does not change with reaction time. Thus, the appropriate reaction time is 40-60 min, which makes the concentration of methyl ester 80%. The optimum condition is considered most appropriate at 60 min because the reaction is equilibrium.

5.2.2 The esterification reaction of free fatty acid with methanol is done by using sulfuric acid as catalyst. The chose to be tested reaction time is 60 min because it is the same duration as palm stearin in transesterification. A long time is spent on the reaction of esterification because these reactions are slowly when acid catalyst is used.

5.2.3 For the one using potassium hydroxide (KOH) as catalyst, the optimum conditions were 300% mol excess of methanol from its stoichiometric ratio, 1.0% KOH, 60 min and 60°C which gave maximum concentration of methyl ester 94.44%

5.2.4 For the one using sulfuric acid ( $H_2SO_4$ ) as catalyst, the optimum conditions were 300% mol excess of methanol from its stoichiometric ratio, 1.0%  $H_2SO_4$ , 60 min and  $60^\circ C$  which gave maximum concentration of methyl ester 55.73%

5.2.5 From the experiment, it proves that acid catalyst is compatible with free fatty acid reactant. When increased acid catalyst and excess methanol occurs to be seen, the concentration of methyl ester is increased. The optimized variables are high methanol/oil and high acid catalyst at high temperature for a long time.

5.2.6 From the experiment at high free fatty acid feedstocks is to be used as base catalyst to deliberately form soap from the free fatty acid. The soap is recovered, the oil dried, and then used in a conventional base catalyzed system.

## **5.2 RECOMMENDATIONS**

5.2.1 Since acid catalysis is relatively fast for converting the free fatty acid to methyl ester, it is used as a pretreatment for the high free fatty acid feedstocks. Then, when the free fatty acid level has been reduced to 0.5%, or lower, an alkali catalyst is added to convert the triglycerides to methyl esters. This process can convert high free fatty acid feedstocks quickly and effectively.

5.2.2 Glycerol by-product of the reaction can be purified or transformed into higher value products for uses as raw materials in the chemical industry.