CHAPTER I

INTRODUCTION

1.1 Motivation

Due to the consecutive shortage of petrol and diesel, the bottlenecks in transportation along with the economical and industrial activities dislocation have been obviously resulted. In addition, the dramatically increase of fuel price with an unstoppable consumption significantly bring about the feasibility exploration of diesel substitution with an alternative fuel which can be produced inbound on a massive scale to a commercial utilization. In general, biodiesel is an alternative to petroleum-based diesel fuel made from renewable resources such as vegetable oils or animal fats. It is one of the possible candidates to replace fossil fuels as the world's primary transport energy source, because it is a renewable fuel that can replace petroleum-diesel in current engines and can be transported and sold using today's infrastructure. From the Ministry of Energy annual record, it was found that diesel occupied the most consumed fuel with the consumption rate of 55 millions liter per day and biodiesel cunsumption rate is growing up to 1.2 million liter per day. For decades, the development of biodiesel has been progressed continuously. Tremendous of research topics have done covered either new ideas or methods of choosing plants as a source of biodiesel, biodiesel extraction technologies and biodiesel quality improvements. Moreover, the investment supporting fund, research supporting fund and knowledge sharing from government sector, educational sectors and public agencies to develop the biodiesel production technologies have become more apparent, therefore, it could be obviously seen that biodesel have become more important alternative nowadays and in the future as well [online]. Available from : http://www.tmc.nstda.or.th/th/index.php?option=comcontent&task=view&id=212&Itemid=60 [January 4, 2009].

In general, the selection of plant type as a source of biodiesel may be effective in the commercial and economical aspects. Chhetri et al. (2007) reported that as the biodiesel is produced from edible plant oils and animal fats, there have been concerns that biodiesel feedstock may compete with food supply in the long-term. Hence, the recent focus is to find oil bearing plants that produce non-edible oils as the feedstock for biodiesel production. Furthermore, the non-edible vegetable oil of *Jatropha curcas* L. has the requisite potential of providing a promising and commercially viable alternative to diesel as it has the desirable physio-chemical and performance characteristics comparable to diesel to facilitate continuing to run the machine without necessitating much change in design. There have been proved that biodiesel from *Jatropha curcas* L. has higher flash point and cetane number compare to diesel (Manurung, 2007). Moreover, Kandpal and Madan (1995) claimed that the absence of sulphur dioxide (SO_2) in exhaust from diesel engines run on *Jatropha curcas* L. oil shows that the oil may have a less adverse impact on the environment. Recently, Nick Chambers (2009) published the news that Air New Zealand becomes the first airline to test a 50/50 blend of second generation Jatropha biodiesel and standard A1 jet fuel in a Boeing 747-400 passenger jet. The company has hailed the test as a milestone for commercial aviation. The flight lasted two hours and ran one of the plane's Rolls-Royce engines on the Jatropha biodiesel blend. Air New Zealand has previously stated that they want to become the world's most sustainable airline and hopes that by 2013, 10% of its flights will be powered by biofuel blends such as the Jatropha biodiesel blend used in this test flight [online]. Avilable from: http://gas2.org /2008/12/30/first-commercial-jet-flight-using-jatropha-biodiesel-a-success/ [January 10,2009].

Theoritically, the *Jatropha curcas* L. is a multipurpose and drought resistant large shrub or small tree. Since Jatropha has been brought from its native of tropical America, the plants have been thriving around with more than 150 species in sub-tropical regions of the world and can be grown in areas of low rainfall and problematical sites. Jatropha is easy to establish, grows relatively quickly and is hardy. Being drought tolerant, it can be used to reclaim eroded areas, be grown as a boundary fence or live hedge in the arid/semi-arid areas. *Jatropha curcas* L. grows almost anywhere, even on gravelly, sandy and saline soils. It can also thrive on the poorest stony soil and grow in the crevices of rocks. The wood and fruit of Jatropha can be used for numerous purposes including fuel. The seeds of Jatropha contains (50% by weight) viscous oil, which can be used for manufacture of candles and soap, in the cosmetics industry, for cooking and lighting by itself or as a diesel/paraffin substitute or extender. When Jatropha seeds are crushed, the resulting Jatropha oil can be processed to produce a high-quality biodiesel that can be used in a standard diesel car, while its residue (press cake) can also be processed used as biomass feedstock to power electricity plants or used as fertilizer as it contains nitrogen, phosphorous and potassium. Other benefit is, the plant yields more than four times as much fuel per hectare as soybean, and more than ten times that of maize (corn). A hectare of Jatropha produces 1,892 litres of fuel [online]. Available from : http:// www.technologyreview.com/Energy /17940/?a=f [November 15, 2008]. Besides utilizing as biodiesel, Jatropha is expected to be potentially applicable in oleochemical production. Nevertheless, it is important to be noted that the detoxification of phorbol esters which is considered as the main toxic in Jatropha oil is necessary because it has high possibility of exposure and harm to the human if Jatropha oil is applied into the oleochemical products without detoxification.

Secondly, to investigate biodiesel extraction technology may affect the higher oil yield. There are several methods of vegetable oil extraction for various usage, for instant, cold pressed, expeller pressed, carbon dioxide extraction, and solvent extraction. Recently, Jatropha seeds are processed mostly artisanally in small local plants. The oil is recovered from the seeds with mechanical expellers that are able to extract 70 -75% of the oil. As a by-product, partially deoiled Jatropha meal with ± 10% residual oil is obtained. Due to the presence of toxins (phorbol esters), this product cannot be used as animal feed. Because of its highly containment of crude protein concentration, the Jatropha meal seems to have some potential as bio-fertilizer or can also be used as biomass for energy production. The animal feed from Jatropha meal will only be applicable after an appropriate detoxification. However, higher oil yields can be obtained either via a full or double mechanical pressing or via pre-pressing followed by a solvent extraction. Pilot scale trials have shown that more than 90% of the Jatropha oil can be extracted from Jatropha seeds by combined pre-pressing of partially dehulled seeds followed by a solvent extraction of the pressed cake (Jatropha World, 2008). The solvent extraction using hexane, a conventional solvent for oil extraction, is served as the conventional method as highly oil yield can be obtained. Furthermore, it is reported that hexane extraction is considered to be economical only at a large-scale production of biodiesel; however, this extraction technique is not recommended due to its harmful chemical characteristics toward the environment and human health. Naksuk (2006) mentioned that hexane is volatile solvent and classified as a hazardous air pollutants (HAPs) by US Environmental Protection Agency, moreover, the major source of hexane leakage to the environment is oil extraction plant. It is approximately 0.7 kg of hexane per ton vegetable oil produced released into the environment. The human acute effects in case of inhalation which is the most common exposure pathway are dermatitis and irritation of the eyes and throat [online]. Available from : http://www.epa.gov/ttn/atw/hlthef/hexane.html [May 28,2008].

To response an alternative, the use of mixed surfactants aqueous-based solution system is introduced to enhance higher oil yield as well as to detoxify Jatropha oil which could be main advantages of this system. The other benefits of this system are considered as being environmental friendly solvent and biodegradable so it does not cause environmental and human health impacts in a long term. To utilize this method, microemulsion system is introduced as a key role because microemulsion provides very essential characteristics of low interfacial tension; therefore, they can enhance the extraction of oil from the seed meals. Nevertheless, the other property of microemulsion is providing high solubilization which is not desired for the system. Thus, to design an essential system for Jatropha oil extraction, it needs to find an optimum proportion of mixed surfactants aqueous-based solution to minimize interfacial tension as well as minimizing solubilization.

1.2 Objectives

The main objective of this study was to investigate the oil extraction method using mixed surfactants aqueous-based solution in order to eliminate phorbol esters from extracted oil. The specific objectives are:

1. To investigate optimum conditions for oil extraction using mixed surfactants aqueous-based solutions.

2. To evaluate the extraction efficiency of Jatropha oil compare to other conventional extraction method.
3. To determine quality of Jatropha oil.
4. To determine phorbol esters presented in extracted oil.

1.3 Hypothesis

Mixed surfactants aqueous-based solution is able to extract oil from Jatropha kernels as well as to eliminate phorbol esters from the extracted oil.

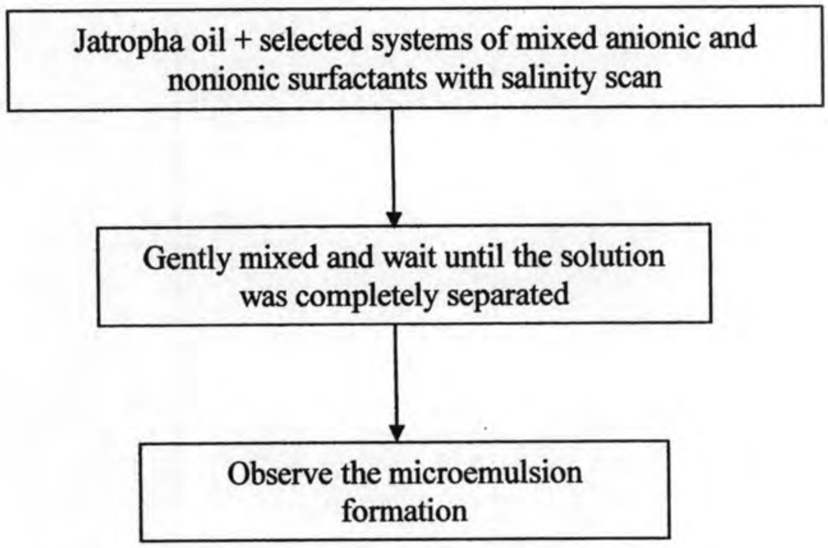
1.4 Scopes of the study

The main focus of the study was an investigation of using mixed surfactants aqueous-based solution for Jatropha seed oil extraction. The desired system was the surfactant solution that able to form microemulsion with Jatropha oil. Then optimum conditions for oil extraction were evaluated and the quality of oils obtained from the selected systems were determined. In addition, this study also focused on the elimination of phorbol esters exists in excess oil phase by this introduced method.

The study was divided into 4 phases as follows:

First phase: Microemulsion formation and phase study

This phase investigated the surfactant systems that are able to form microemulsion with Jatropha oil for surfactant selection for the next phase on oil extraction from Jatropha kernels. Both single surfactant and mixed surfactants system were evaluated for microemulsion formation. The two most suitable systems were then selected for the next experimental phase. Microemulsion formation and phase study were determined according to these following steps.



Second phase: Jatropha oil extraction

After appropriate systems were found, in this phase, the next investigation was to find the optimum conditions to obtain the highest oil yield. The parameters of concern were illustrated as follows:

- Variation of contact time
- Variation of solid liquid ratios

Moreover, the Jatropha oil extraction efficiency of re-extraction and re-use of mixed surfactants aqueous-based solution were also investigated.

Third phase: Oil quality determination

In this study, the oil quality defined by these following parameters:

- Water content
- Fatty acid composition
- Surfactant remaining in an aqueous phase

Fourth phase: Phorbol esters determination

To develop the method for determination of phorbol esters in extracted oil and surfactant aqueous phase. This phase included the extraction procedure and the analysis of phorbol esters by HPLC. In this study, phorbol esters were referred as TPA which is the main compound found in Jatropha seeds and it is only the compound produced as a standard for phorbol esters.

Figure 1.1 and 1.2 show overall of experimental procedure diagram.

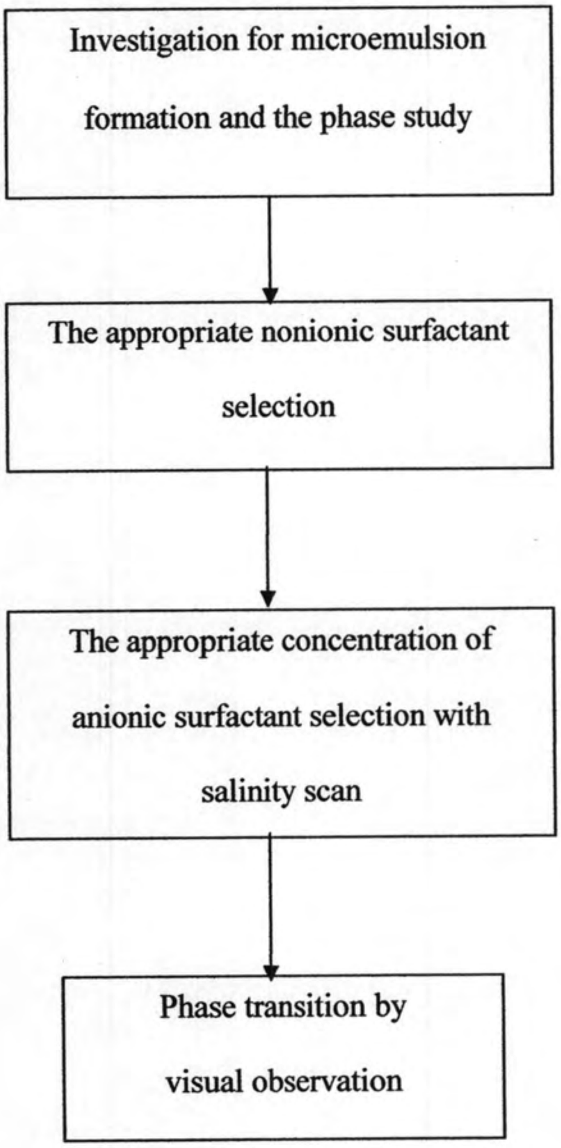


Figure 1.1 Flow chart of the step for the microemulsion and phase behavior study

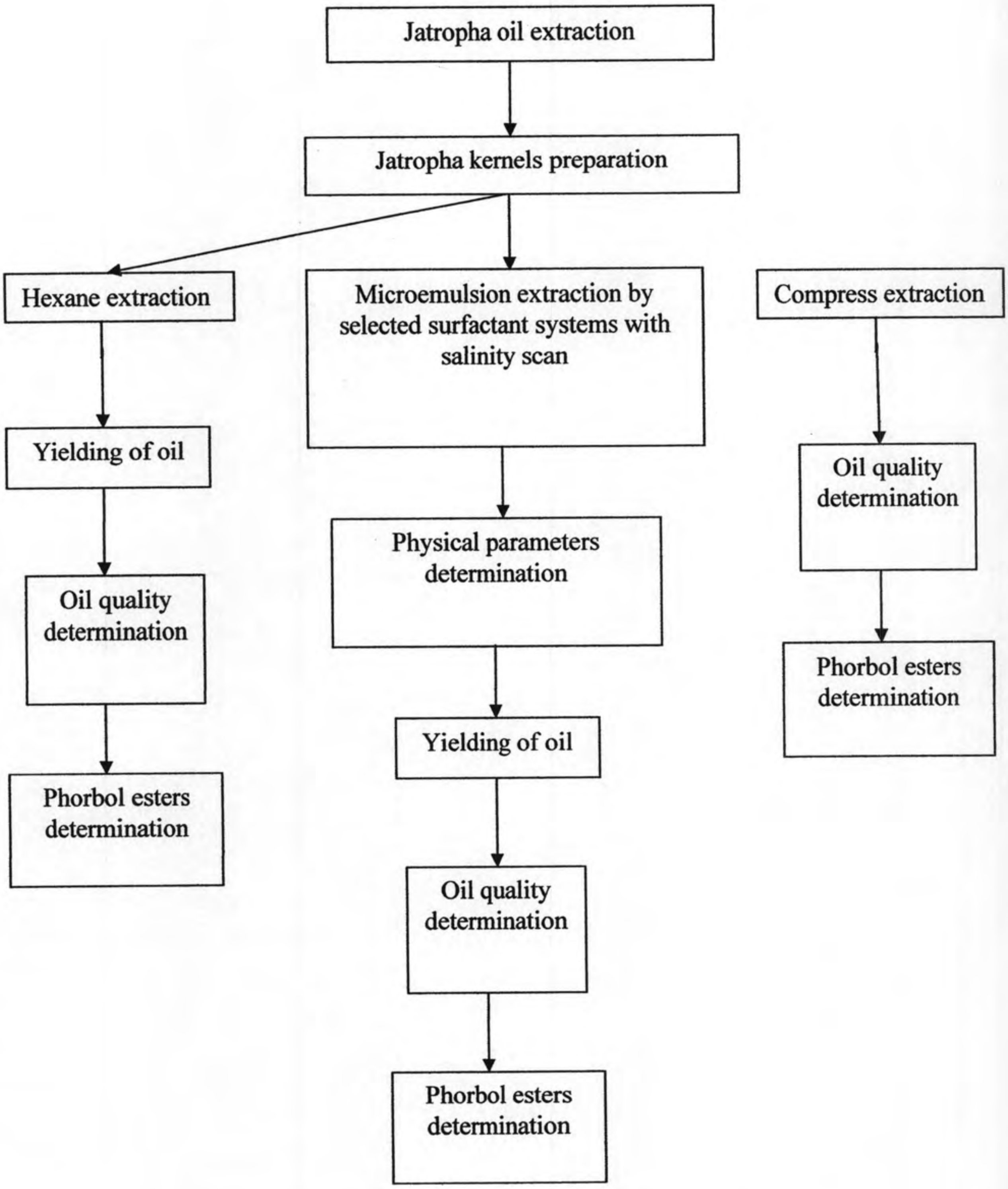


Figure 1.2 Flow chart of the step for the oil extraction study, oil quality and phorbol esters determination

1.5 Expected outcomes from this study

The mixing surfactants aqueous-based solution can enhance the oil from Jatropha; therefore, it can be a new alternative of environmental friendly oil extraction method. Moreover, it can eliminate phorbol ester, which classified as toxic substance, from the extracted oil for further utilization of the oil in the oleochemical industry.