UNIVERSITI TEKNIKAL MALAYSIA MELAKA

MICROWAVE EFFECT ON BIODIESEL PRODUCTION FROM HEVEA BRASILIENSIS USING ANADARA GRANOSA SHELL

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Maintenance) with Honours.

by

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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

MICROWAVE EFFECT ON BIODIESEL PRODUCTION FROM HEVEA BRASILIENSIS USING ANADARA GRANOSA

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I hereby, declared this report entitled "Microwave Effect On Biodiesel production From *Hevea Brasiliensis* Using *Anadara Granosa* Shell**"** is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Maintenance) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Tujuan kajian ini adalah untuk mengkaji pengeluaran biodiesel daripada minyak H*evea Brasiliensis* mentah dengan menggunakan pemangkin heterogen melalui kaedah penyinaran gelombang mikro. Potensi menggunakan asid lemak tinggi (FFA) minyak Hevea Brasiliensis (RSO) sebagai bahan bakar biodiesel dengan bantuan heterogen dari sisa *Anadara Granosa* (kerang darah) menggunakan kaedah penyinaran gelombang mikro. Proses esterifikasi-transesterifikasi dua langkah mengurangkan nilai asid RSO daripada 104.7 mgKOH/g jumlah asid total kepada pemangkin 0.46 mgKOH/g. Hasil optimum metil ester asid lemak (FAME) dicapai sehingga 93.47% di bawah keadaan optimum nisbah molar 9:1 methanol, pemangkin pemangkasan 7% berat minyak, 7 minit masa reaksi dan 400watt input kuasa ketuhar gelombang mikro. Semua sifat bahan api dianalisis mencapai standard yang ditetapkan iaitu ASTM D6751.

ABSTRACT

The purpose of this research is to study the biodiesel production from crude *Hevea Brasiliensis* oil by using heterogeneous catalyst via microwave irradiation method. The potential of using high free fatty acids (FFA) of *Hevea Brasiliensis* oil (RSO) as a biodiesel fuels with the aid of heterogeneous from waste *Anadara Granosa* (cockle shell) using microwave irradiation method. The two-step esterification-transesterification process reduces the acid value of RSO from 104.7 mgKOH/g total acid number to catalyst 0.46 mgKOH/g. The optimum yield of fatty acid methyl ester (FAME) was reached up to 93.47% under optimal conditions of 9:1 methanol molar ratio, catalyst loading of 7 wt% oil, 7 minutes of reaction time and 400 watt microwave power input. All fuel properties were analysed according to the ASTM D6751 standard and found within the requirements.

DEDICATION

I dedicate my study to my family and many friends. A special feeling of gratitude to my loving parents, Bakar Mamat and Zaiton Jusoh whose always supporting me with the words of encouragement and push for tenacity ring in my ears.

I also dedicate my study to my final year project supervisor, Madam Mahanum Mohd Zamberi who taught me that is to be passionate and calm in every work I have done

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LIST OF ABBREVIATION

FFA	Free Fatty Acid
RSO	Rubber Seed Oil
NaOH	Sodium Hydroxide
KOH	Potassium Hydroxide
MeOH	Methanol
CaO	Calcium Oxide
$CaCO_3$	Calcium Carbonate
H_2SO_4	Sulphuric Acid
ASTM	American Society of Testing and Materials
%wt	Weight Percentage
℃	Degree Celcius
AV	Acid Value
EN	European Standards
XRF	X Ray Fluorescence
GCMS	Gas Chromatography Mass Spectrometry

CHAPTER 1

INTRODUCTION

1.1 Background

Petroleum is known as the main resource to the energy supply in this world. Most of it are used in machine, car, plane, ship, and many more. However, the usage of this fossil fuels become larger due to the industrial and human growth. This has caused the fossil fuels reserved become decreasing and eventually will be gone. In order to avoid energy from end up just like that, lots of researcher try to find new sources and most of it is renewable energy such as air, water, sunlight, geothermal, and biodiesel. This kind of sources can solve the problem of the fossil fuels from run out.

Biodiesel has the most interest between the researcher all around the world because of the sources is unlimited and used a lot of different kind of raw material as the main sources to produce it. Biodiesel is processed from renewable sources such as vegetable oils and animal fats. The oil from the vegetable oils and animal fats will be extracted get the crude oils. Then the crude oil will passed though the transesterification process. The researcher has used most of edible and non-edible fruits or vegetables as the sources such as jatropha, palm, tallow as well as rubber seed that has a good diversity that can be used as the raw material to produce the biodiesel. The standard used for the quality test of the especially for B100 biodiesel is ASTM D6751 and EN 14124.

The main obstacle to produce the biodiesel product is the biodiesel price is still higher than retail petrol-diesel. Currently, most of the biodiesel is produced from the refined/edible type oils using methanol and an alkaline catalyst. However, large amount of non-edible type oils and fats are available. Ramadhas A.S., (2004), has stated that the difficulty with alkaline-esterification of these oils is that they often contain large amounts of free fatty acids (FFA). In order to reduce the FFA, parameter will be set in order get the better biodiesel production. The next problem to the production of biodiesel is the product commercialization as the biodiesel product cost more than the petrol diesel. Commonly, the higher cost of the biodiesel are influenced by the seasonal crop yield, crop geographic area, local crude petroleum prices, and other factors. For the past years, Malaysia has become one of the big rubber suppliers in the world and the rubber plantation has counted roughly 1,021,540 production has reported in year 2009 with over 120 kilotonne of rubber seeds produced yearly (Muhamad et al. 2013).

1.2 Problem Statement

i. Compared to petroleum fuel, biodiesel is more expensive. To save expenses, every accessible source from everyday lives is used as commodities by the technique of preparing biodiesel.

ii. The production of biodiesel is crucial now days as a backup to the main resource.

iii. The production of the biodiesel using non-edible fruits.

iv. The biodiesel production is not following the standard that has been stated by the international standard

1.3 Objective

i. To prepare and characterize the calcium oxide (CaO) from *Anadara Granosa*(cockle shell) as solid catalyst.

ii. To investigate the influence of microwave energy on heterogeneous catalytic reaction.

iii. To examine the performance of the feedstock characteristics by performing the ASTM D6751.

1.4 Scope

i. To study the microwave effect to the biodiesel production.

ii. To ensure the production of biodiesel is meet the standard of ASTM D7651 test.

iii. The use of *Hevea Brasiliensis* (Rubber Seed) oils as the non-edible oil as the raw material for biodiesel production.

CHAPTER 2

LITERATURE REVIEW

2.1 Biodiesel

Every year, billions of fossil fuels is used as the sources of energy in most of the mechanical machine is this world. Coal, methane, oil, and natural gas also is the main sources for energy and use in most of the sectors. Day by day, the fossil fuels and other non- renewable resources are depleting and eventually will run out. Research and development has be done around three decades ago about the new technology that can reduces the dependability on the non-renewable resources. Green energy comes from natural sources such as sunlight, wind, rain, tides, plants, algae, and geothermal heat. These energy resources is renewable which means they are naturally replenished. The renewable resources also have their own pros and cons where the cons is they generate pollutant such as greenhouse gas which has been contribute as the causes of climax change.

The burning of fossil fuels is a big contributor to increasing the level of Carbon dioxide in the atmosphere, which is directly associated with global warming observed in recent decades. The main features required for an alternative fuel are availability and renewability, or lower dependence on restricted resources accompanied with no or lower pollution. Due to their eco-friendly and nontoxic nature, biodiesel has been attracting increasing interest. Biodiesel is produced from renewable sources such as vegetable oils, micro algae oil, and animal fats. (Mardhiah et al., 2017) stated that the carbon neutral biodegradable, low emission and non-toxic is an example of biodiesel properties that is better on renewable fuels.

First generation of biodiesel are directly related to a biomass that is more than often edible. Example of this first generation biodiesel is sugarcane, corn whey, barley, whey, barley, potato wastes, and sugar beet, olive oil, corn oil, peanut oil, colza oil, cotton oil, sesame oil, sunflower oil, and palm oil. According to (Lee et al.,2013), stated that Brazil is one of the leading countries that used this first generation of biodiesel. Although the production is advantageous in order to reduce the use of fossil fuels, there is a problem occur in long run, which the cost for the feedstock is high and also lead to food and global fluctuations and confusion in food prices in international market.

Then the production of second generation is created in order to avoid the international food price crisis. Second-generation biodiesel is come from they use a non-food feedstock also called as lignocellulosic biomass, such as field crops residues, forest products residues, or fast-growing dedicated energy crops based oil. The example of this second generation feedstock is *Calophyllum inophyllum, Madhuca indica (mahua),Pongamia glabra (koroch seed), Sterculia feotida, Pongamia pinnata (karanja), Hevea brasiliensis (rubber seed), Jatropha curcas, Azadirachta indica (neem), Camelina sativa, Lindseed, Lesquerella fendleri and Nicotiana tabacum*. Milano et al. (2018) stated that second generation biodiesel is verified to have high yield biodiesel, good oxidation stability, and favorable cooling properties. Second generation biodiesel must meet the specification given in ASTM D6751 for United state base and EN 14214 for European union base in order to make this biodiesel is reliable and promising as diesel substitute. Figure show the comparison between petroleum oil, first-generation oil, and second-generation in type of feedstock, advantages, disadvantages, and product. Table 2.1 shows the potential feedstocks for biodiesel for selected countries.

Table 2.1 Comparison between petroleum oil, first-generation biodiesel and second-generation biodiesel (Naik et al., 2010)

	Petroleum fuel	**1st generation**	**2rd generation**
Feedstocks	Crude petroleum	Vegetable oil & corn sugar	Non food, cheep and abundant plant waste biomass (ulgricultural & forest residue, grass, aquatic biomass, and water hyacinth)
Product	Diesel, Petrol, Petrol, Kerosene, and Jet fuel	FAME or Biodisel, Corn ethanol, Sugar alchohol	Hydrotreating oil, Bio-oil, FT oil, Lignocelluosic ethanol, Butanol, Mixed alcohol
Problem	Depletion declining of petroleum reserve, enviroment pollution, economics and ecological problem	Limted feedstocks (Food Vs Fuel), Blended Party with conventional fuel	None
Advantages	None	Enviromental friendly, economic& social security	Not competing with food Advance technology still under development to reduce cost of conversion Enviromental friendly

Table 2.2 Potential feedstock for biodiesel for selected countries (Atabani et al., 2012)

Country	**Feedstock**
United States of America USA	Soybean/waste oil/peanut
Canada	Rapeseed/animal fat/soybeans/yellow grease and tallow/mustard/flax
Mexico	Animal waste/waste oil
Germany	Rapeseed
Italy	Rapeseed/sunflower
France	Rapeseed/sunflower
Spain	Linseed oil/sunflower
Greece	Cottonseed
United Kingdom	Rapeseed/waste cooking oil
Sweden	Rapeseed
Ireland	Frying oil/animal fats
India	Jatropha/*Pongamia Pinnata* (karanja)/soybean/rapeseed/sunflower/peanut
Malaysia	Palm oil
Indonesia	Palm oil/Jatropha/coconut
Singapore	Palm Oil
Philippines	Coconut/jatropha
Japan	Waste cooking oil
Brazil	Soybeans/palm oil/castor/cotton oil

Table 1.3 Example of feedstocks according to the generation of biodiesel production, which in the case is for generation 1st, generation 2nd and 3rd generation.(Bhuiya et al., 2016)

Generation of Biodiesel	Type of Feedstock
Edible oil (1st generation)	Mustard oil, Palm oil, Rapeseed oil, Sunflower oil, Castor oil, Coconut oil, Canola oil, Corn oil, Cottonseed oil, Rice bran oil, Tigernut oil, Radish oil, Sugar apple acid oil, False flax (Camelina sativa), Peanut oil
Non-edible oil (2nd generation)	Jatropha, Pongamia oil, Jojoba oil, Neem oil, Aamla oil, Hemp oil, Macauba coconut oil, Moringa oleifera, Croton megalocarpus, Paradise oil (simaroba glauca), *Pamgium edule*, Rein oil, *Thespesia populnea* seed oil, Yellow Oleander, Sea mango (*cerbera odollam*), Rubber seed oil, Linseed oil
Additional sources (3rd generation)	*Spirulina platensis* algae, Waste, cooking oil, Fish oil, Microalgae, Moroccan waste frying oil, *Mucor circinelloides*, Waste salmon oil, Chicken fat oil, Animal fats, Pig fat oil, Beef tallow oil, Poultry fat oil, Animal fat waste oil

2.2 Raw Material

The biodiesel production process is started with pre treatment of the raw material. The biodiesel yield is depend on the quality of the feedstock or the raw material. Hence, the feedstock play a significant role in order to get a better production of biodiesel. Hassan et al. (2014) stated that rubber seeds are well known to be high volume of oil after extraction than other raw materials. According to (Yanagida et al., 2016), stated that rubber seed oil (RSO) can be exploited in the production of environmentally friendly oil and other industrial application. He also stated that the value of free fatty acid (FFA) acid value will increase over time of the seeds is keeping or storage.

2.2.1 Rubber Seed oil

M.F. Mohajir 2018 stated that rubber oil contains 80 to 90 percent of hydroxyl fatty acid (double bond and hydroxyl group), that enhances lubrication compared to normal vegetable oils make it become the main candidate to become the next option to use after diesel fuel. Acid esterification process is used to reduce the higher Free Fatty Acid (FFA) as the higher grain content in saturated fatty acids. Widayat et al., 2013, found that biodiesel production from rubber seed oil need to undergo two-stage method of esterification reaction followed by transesterification reaction to complete the production. Acid esterification process need to be done before proceed to the transesterification process to reduce the FFA value less than 4%. Widayat et al., 2013, also found that there are currently no significant uses in rubber seed petroleum, and therefore even natural seed production remains underutilized. This research uses filtered petroleum as a feedstock for