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BIO-OIL FROM MICROWAVE PRETREATED MICROALGAL BIOMASS USING SUPERCRITICAL CARBON DIOXIDE ($SCCO_2$) SYSTEM

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ABSTRACT

Chlorella vulgaris is one of the promising microalgal strains that can produce high yield of bio-oils. *Chlorella vulgaris* has higher growth rate which was 0.9288 day^{-1} compared with *Neochloris oleoabundans* was at 0.7369 day^{-1}. Furthermore, C. vulgaris has high lipid content compared with *N. oleoabundans*. The selected microalga, *C. vulgaris* was pretreated with microwave irradiation prior to extraction using supercritical carbon dioxide ($SCCO_2$). Fourier transform infrared spectroscopy (FTIR) analysis showed microwave irradiation pretreatment does not affect the material composition of *C. vulgaris*. Scanning electron microscopy (SEM) of the microwave irradiation pretreated microalgae showed agglomeration of distortion and rupturing of microalgae cell walls. Optimization of the $SCCO_2$ process parameters (pressure, temperature and CO_2 flow rate) was conducted by using response surface methodology (central composite design, CCD). Two factors significantly affect the extraction yield comprising of temperature and pressure. The maximum percentage of extracted bio-oil from microwave irradiated microalgae biomass was 10.09 % achieved at 4500 psi at temperature 80 ^{o}C. The model equation also predicted the optimum condition for the $SCCO_2$ (without microwave pretreatment) at 70℃, 5676 psi and 7 sL/ min while optimum condition for $SCCO_2$ (microwave irradiation pretreatment) at 63℃, 5948 psi and 10 sL/ min. High amount of saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), α-linolenic acid and palmitoleic acid were found in the extracted oil with microwave irradiation pre-treatment sample. In addition, the polyunsaturated fatty acids (PUFA) content in the microwave irradiation pretreated oil was considerably low and is desirable for biodiesel production

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Nowadays, industrialization and irresponsibly used of natural resources have caused major concerns to global warming issues. According to the environmental protection agency (EPA), global warming is defined as a recent and continuing rise in earth surface temperature. Global warming has occurred when the greenhouse gases (GHGs) comprising of water vapour (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and fluorinated gases are accumulated in the atmosphere.

The combustions from the fossil fuels, agriculture activities, industries and fertilizers have produced large amount of CO_2 productions. If this trend continues, CO_2 emissions are expected to be significantly high in near future. Thus, it is important to neutralize the effect of CO_2 in the atmosphere for sustainable economic growth and to maintain living standards (Rashid, Ur Rehman, Sadiq, Mahmood, & Han, 2014). Many countries and regions had established targets for CO_2 reduction in order to meet the sustainability goals under Kyoto protocol. One of the methods that can be implemented to reduce global warming and the pollution is by replacing fossil fuels with biofuels in transportation as it is one of the major sources of pollutions (Mata, Martins, & Caetano, 2010).

Before the biodiesel was introduced, vegetables oils were used as diesel fuels from time to time. During the 80's, the first international conference on plant and vegetable oils was held to discuss the used of vegetable oils as fuels since it has caused concern among the researchers to use vegetable oils as fuels. The discussions accounting cost of fuel, the effect of vegetable oils on engine performance and durability and fuel preparation specification and additives. Vegetable oils hold a lot of promise as alternative fuels for the diesel engine. However, due to its high viscosities, low volatilities and poor cold flow properties have led to an investigation of various derivatives. Then, fatty acid methyl ester which also known as biodiesel derived from triglycerides by transesterification with methanol have received many attentions (Singh & Singh, 2010).