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Oil Extraction and Production of A Biodiesel Using Vegetable Oil Derived From Algae (*Scenedesmus dimorphus*)

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Abstract

Biodiesel is a biofuel which is projected to substitute diesel oil. The aim of this research is to produce a biodiesel using the oil derived from algae (*Scenedesmus dimorphus*), a fast growing organism. Algae cell wall was ruptured by grinding using the sand, prior to extracting using n-hexane. This method resulted in an

extraction of algae oil (110 ml) from 200 g of biomass. A liter of biodiesel was obtained by reacting algae oil (1.42 Kg/1 liter) with methanol (100 ml).

Keywords : *Scenedesmus dimorphus*, biodiesel, sand, n-hexane.

Introduction

Energy is one of the important things in this globalization era which influences both economic and social life. Petroleum oil products e.g. gasoline, kerosene, diesel oil, aviation oil, etc play an important role in mobilizing global economic which, as a consequence, increasing the global demand of products (Asche *et al.*, 2003). Many efforts have been carried out to meet the global demand of petroleum oil products e.g. exploring some new oil fields, improving the productivity of the oil drilling and refinery facilities, maintaining the distribution of products, etc. However, the largely global exploitation on petroleum oil may cause a global shortage since petroleum oil is a non-renewable natural source. Moreover, the use of petroleum oil products in large scale may cause an increase in the emission of CO_2, in which it may cause a further globally environmental impact, the global warming (Canakci & Van Gerpen, 2003).

For those reasons, some renewable energy e.g. solar energy, wind power, geothermal power, micro-hydro power, tidal power, wave power, biofuel, hydrogen energy, etc have been developed by researchers (Pichler *et al.*, 2014; Han *et al.*,2014; Coskun *et al.*, 2014; Bracken *et al.*, 2014; Tiago Filho *et al.*,2014; Rajaguru *et al.*, 2014). One of renewable energy is biodiesel. Biodiesel is a biofuel which is produced by trans-esterification of vegetable oil and alcohol using a catalyst (Mata *et al.*, 2010). Some feedstock e.g. palm oil, coconut oil, jatropha oil, peanut oil, soybean oil are used to produce biodiesel. However, the productivity of jatropha oil, coconut oil, and palm oil are only 1.500 liter/hectare/year; 2.200 liter/hectare/year; and 5.800 liter/hectare/year, respectively. In this research, a biodiesel was produced using oil derived from a fast growing organism, the algae (*Scenedesmus dimorphus*), in which its productivity may reach 40.000 – 120.000 liter/hectare/year (Wang *et al.*,2013).

Materials and Methods

Material

Fresh algae of species *Scenedesmus dimorphus* was obtained from Institute of Fisheries & Marine research, Jepara, Indonesia. Methanol, n-hexane, phosphic acid, and sodium hydroxide were obtained from Merck KGaA (Darmstadt, Germany). Sand was obtained from a local supplier.

Oil Extraction

About 200 g of algae (*Scenedesmus dimorphus*) and sand (200 g) were added into a mini-grinder for 20 minutes. The mixture was subsequently extracted in a Soxhlet using n-hexane for 30 minutes, prior to purification using phosphic acid (0.1 ml/ml). Sample was analyzed using GC (Gas Chromatography).

Transesterification Process

A concentration of methanol was added into 100 ml of algae oil to obtain a substrate molar ratio (oil/methanol) of 1 : 3. Then, sodium hydroxide (10 ml/ml) was added into the reaction system. The reaction was carried out at 55 °C for 30 minutes and agitated at 1000 rpm.

Analysis

Algae oil concentration was determined according to Lee *et al.*, (2010) using Gas Chromatography (GC). The sample was diluted into Tetrahydrofuran (THF) solution (1 : 1, v/v). An aliquot of sample (850 μL) in THF solution was added into a standard auto-sampler vial and about 350 μL of N_3O-Bis (trimethylsilyl) trifluoroacetamide (BSTFA) was further added into the mixture. Subsequently, the mixture was injected into inlet and nitrogen was flown at a flow rate of 50 mL min^{-1}. The injector and the detector temperatures were set at 280 and 310 °C, respectively.

Result and Discussion

The result shows that about 110 ml of oil was extracted from 200 g of algae (*Scenedesmus dimorphus*) which naturally contains 58% of oil. It is suggested that the sharp properties of sand may rupture the cell wall of algae, so that the oil may be easily released to the outside of cell (Eroglu & Melis, 2010). The extraction of the mixture using n-hexane may further extract the oil which was still existed within cell since n-hexane and the oil are non-polar substance (Poseda-Ureta *et al.*, 2012). Thus, the combinative extraction method of the sand-biomass grinding and the solvent extraction; may extract 95% of oil content from the cell. The transesterification reaction of algae oil (1.42 Kg/1 liter) with methanol (100 ml) resulted in a fatty acid methyl ester (1 liter) and a glycerol (100 ml).

Conclusion

The combinative extraction method of the sand-biomass grinding and the solvent extraction; may extract 95% of oil content from the cell since rupturing the cell wall of algae and extracting the oil existed within the cell.

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