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DIRECT TRANSESTERIFICATION WITHOUT CATALYST OF MICROALGAE WITH AN AIDED OF ULTRASONIC TREATMENT IN BIODIESEL PRODUCTION

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Abstract

Microalgae have protracted as a sustainable and renewable biomass feedstock with high lipid content to produce alternative biofuels in future. This paper describes a process for producing biodiesel from microalgae; Tetraspora sp. was cultivated in Research Laboratory, UiTM Bukit Besi. After drying process, the biomass then had undergone direct- transesterification process to produce biodiesel as Fatty acid methyl ester (FAME). The FAME obtained from non-catalytic transesterification method of individual FAME components mostly consists of maximum average FAME (biodiesel) yield of 70.58±1.54% with the effect of ultrasonic treatment; 5, 10, 15, 20 minutes followed by 5 minutes homogenization of dried tetraspora species without catalyst on fatty acid methyl ester (FAME) percentage. The direct transesterification process without catalyst was also produced the average percentage of FAME of 43.70±3.43, 5.34±2.28 and 57.63±2.22 percent. The results revealed that tetraspora sp. can be produced via ultrasonic treatment on yield of Fatty Acid Methyl Ester (FAME) percentage without catalyst and be able for biodiesel production.

Keywords: Microalgae; Direct transesterification; Ultrasonic; Fatty acid methyl ester (FAME); Biodiesel.

1.0 INTRODUCTION

Transformation of natural resources as alternative bio crude- raw material especially in biofuel industry is much-awaited due to the growing world population; increasing the demand for fossil fuel and commodities. Therefore, sustainable and environmental friendly resources for energy and food are required to support for huge population in the future of years [1]. As a result, a substitute biofuel which can be produced from biomass sources that is also known as third generation biofuel from plants, aquatic plant and organic waste have lead in reducing the world's dependence on fossil fuel and could recycle of carbon dioxide gas via photosynthesis process which aid in reduce carbon footprint production[2].

Microalgae, a vast group of rude, mostly aquatic and chlorophyll-bearing plants without specific tissues and organs such as roots, stems, leaves and flowers as the plant. They are found in abundance with more than 30000 species and their growth rates are fast as well. There are three primarily components for algae to grow: sunlight, carbon-dioxide and water [3]. Photosynthesis is an important bio-chemical process in which plants, algae, and some bacteria convert the energy of sunlight to chemical energy. Different types of algae grow in different environments and nutritional requirements [4].

The research was studied on sunflower seed oil that is applied in-situ (direct) transesterification with several advantages of transesterification process of the oil entrenched in the superficial structure which might improve the total yield of the fatty acid alkyl ester. Moreover, this process can be excluding in application of solvent such as hexane for extraction in conventional step as refer to the figure 1. In addition, it also can avoid reducing of yielded oil due to different in solubility of solvent (hexane) and triglyceride [5].

The objective of this research is to determine the ultrasonic effect on yield of Fatty Acid Methyl Ester (FAME) percentage without catalyst in microalgae; tetraspora sp. that was cultivated in a batch aquatic open system in Laboratory research, UiTM Bukit Besi, Terengganu in Malaysia to be applied as renewable biofuel feedstock.

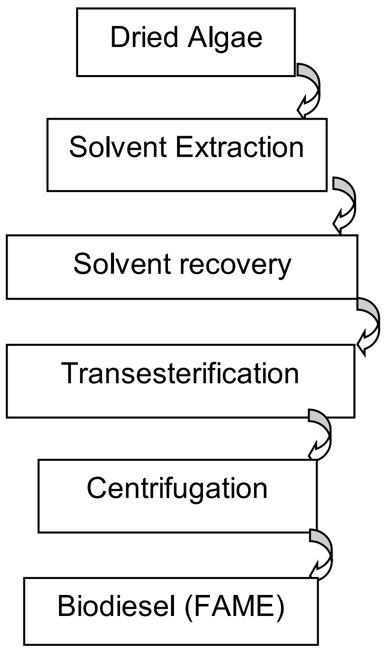

Figure 1: Conventional transesterification

2.0 METHODOLOGY

2.1 Material and Method

A green microalgae (chlorophyta) strain, namely tetraspora sp., was obtained from local Sungai Sura water flows outside Universiti Teknologi Mara, Sura Hujung in Dungun, Terengganu, Malaysia. The direct transesterification of algae biomass process as shown in figure 2.

Effect on Ultrasonic- aided with high speed homogenizer

The dried algae powder, 0.10 gram was weighted, and then transferred into 20 ml methanol. The samples mixture then was treated in ultrasonic (name)for 5, 10, 15 and 20 minutes. Then, the treated samples were homogenized with an Ultra Turrax tissue homogenizer (Ika Works, Wilmington, NC) at 10 000 rpm.

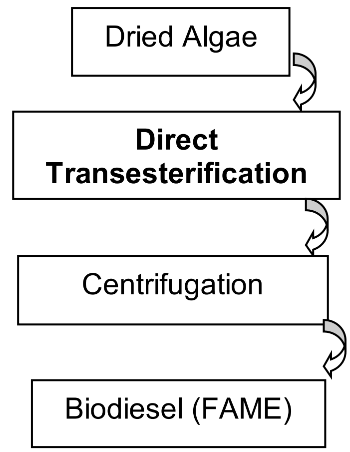

Figure 2: Direct transesterification

Direct transesterification reaction was carried out in a water bath at 60 °C. Further, the samples were centrifuged at 3500 rpm for 15 min and the supernatant was collected using 5 ml syringe. Finally, 1 microliter of supernatant from the mixture was collected and transferred into the vial for fatty acid methyl ester (FAME or biodiesel) products determined by GCMS quantified.

Fatty acid methyl ester (FAME) analysis

The FAMEs yield of transesterification product was determined using a Gas Chromatography (Shimadzu, GCMS-QP 2010 Ultra, Japan), fitted with BP5M FAME capillary column (30 m x 0.25 mm ID 0.25 µm), flame ionization detector (FID) and equipped with autoinjector (QP2010- Shimadzu,). GCMS was identified and quantified the present

FAMEs. Helium and zero air were used as the carrier gases with a split ratio of 10:1. The oven initial temperature was 50°C for 6 minutes, then increase 10°C per/ minute to 150°C, and maintained for 30 minutes. Both the injector and the detector were set at 250°C.

3.0 RESULTS AND DISCUSSION

Effect of Ultrasonic-aided and homogenizer

Table 1 Biodiesel yield in this studied, the biodiesel was extracted from the algal biomass through direct transesterification. Through this method that resulted the maximum average FAME (biodiesel) yield of 70.58±1.54% with the effect of ultrasonic treatment; 5, 10, 15, 20 minutes followed by 5 minutes homogenization of dried tetraspora species without catalyst on fatty acid methyl ester (FAME) percentage. The direct transesterification process without catalyst was also produced the average percentage of FAME of 43.70±3.43, 5.34±2.28 and 57.63±2.22 percent respectively as shown in table 1. The duplicate data were collected in production of FAME percent.

Ultrasonic (UT)(minutes)	Average FAME (%)
UT 5 min	70.58±1.54
UT 10 min	43.70±3.43
UT 15 min	5.34±2.28
UT 20 min	57.63±2.22

Table 1: Effect of ultrasonic-aided and homogenizer on FAME production

From the figure 3 is illustrate the effect of ultrasonic-aided and homogenizer shows the higher percentage of FAME; 74.44±7.06 with reaction time 5 minutes of ultrasonic treatment followed by 5 minutes homogenizer, speed of 10000 rpm at temperature of 60°C without catalyst in formation of FAME (fatty acid methyl ester) via direct transesterification process. Meanwhile, reaction time in 1o, 15, and 20 reaction time of ultrasonic treatment was indicated decreasing formation FAME percentage of 39.13±9.89, 5.34±2.28 and 57.66±2.26 respectively.

The application of liquid surrounding the microalgae cells breakdown and impart kinetic energy to the local cells inducing disruption via elevated shear stresses to the cell walls, combined with a momentary and highly localised extreme temperature rise, ruptured the agitation actively encourages cell contents out of the cell wall encapsulation [6].

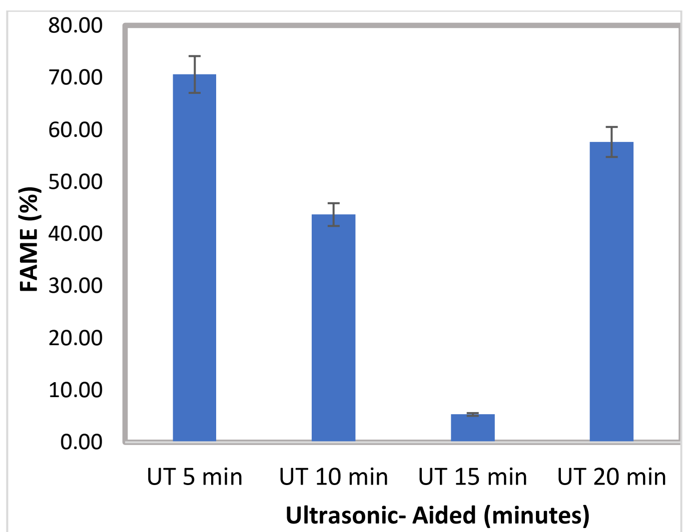

Figure 3: Effect of Ultrasonic-aided and homogenizer on FAME production of Tetraspora sp.

The ultrasonic mixing improves mass transfer and reaction kinetics leading to faster transesterification and higher yield with formation of small cavitation bubbles in the liquids which causing sonochemical effects in liquids the phenomenon of acoustic cavitation. The sonochemical effects to chemical reactions and processes include increase in reaction speed [7].

The application of ultrasound in lipase catalysed direct transesterification to reduce the reaction time and the results confirmed that the ultrasound increased the yield and reduced the reaction time considerably. Thus, it appears that ultrasound treatment effectively accelerates the production of methyl esters regardless of the type of catalysts and substrates used. The mechanism of sonication reaction involves the formation of microbubbles ranges of 4 to 300 lm in diameter in which the unsymmetrical collapse of bubbles at an interface of solid and solvent (more than 200 lm) produces micro jets at high speed more than100 m/s toward solid surfaces. The immediate collapse of bubbles is also responsible for strong shock waves that might be up to 103 MPa. This violent movement of cavitation bubbles is defined as micro-convection and results in extremely strong shear forces. This influences the activity of substance present in the reaction leading to an increase in product formation in a short duration [8].

4.0 CONCLUSION

The FAME obtained from direct transesterification without catalyst with aided ultrasonic treatment (5 minutes) was determined of70.58±1.54% higher yield of (FAME) biodiesel. This result was evidenced that some forces such as ultrasonic vibrations and high pressure homogenization method provided the mechanism of ultrasonic cell disruption result the emitting in acoustic cavitation that can disrupt cells in manufacturing of FAME (biodiesel) [9]

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