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Production of Biodiesel from Green Alga *Oedogonium capillare*

Tosin Victor Adegoke[1, *], Adeleke Osho[2], Ogedegbe Gloria Palmer[1], Oloruntoba Ademola Olodun[1], Adeola Tolulope Adeyelu[1]

[1]Department of Microbiology, The Federal University of Technology, Akure, Nigeria

[2]Department of Microbiology, Redeemer's University, Ede, Nigeria

Email address:
tosinadegoke64@yahoo.com (T. V. Adegoke)
[*]Corresponding author

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Abstract: The production of biodiesel from green alga *Oedogonium capillare* was investigated. The result shows that biodiesel can be obtained from green alga *Oedogonium capillare.* The algal oil obtained from the *Oedogonium capillare* was 8.18 % using n-hexane as the solvent extraction. The algal oil was converted into biodiesel and the percentage yield of the biodiesel obtained from the *Oedogonium capillare* oil was 100 % in the course of the research. The biodiesel was found to be almost neutral in nature because the pH was 7.1. *Oedogonium capillare* can serve as source of energy and considerable amount of biodiesel can be produced from algae. The global dependence on the nonrenewable energy sources (i.e. fossil fuels) is leading us towards the worldwide energy insecurity. Algae have many reasons why they could be consider as one of the most perfect choices for biodiesel production. A constant rising worldwide demand of motor and power generation fuels together with environmental concern has made us to turn on towards natural and pollution free fuel i.e. biofuel which can be gotten from *Oedogonium capillare*. Biofuels are quite adequate to provide an alternative to fossil fuels and can also reduce total CO_2 emissions. *Oedogonium capillare* can produce biodiesel which is biodegradable, less CO_2 and NO_x emission. Increasing number of population, advanced technology and economics growth somehow has caused energy depletion. Algae have important potential as an alternative energy source. Therefore, lipids-secreting microalgae are promising alternatives for the production of renewable biofuel.

Keywords: Production, Algae, *Oedogonium capillare*, Algal Oil, Biodiesel, Energy

1. Introduction

Bioenergy is one of the most important component of mitigating greenhouse gas emission and substitute of fossil fuels [1]. The need of energy is increasing continuously, because of increase in industrialization and population. The basic sources of energy are petroleum, natural gas, coal, hydro and nuclear [2]. Petroleum diesel is also a major source of greenhouse gas. It is also a major source of other air contaminants including NO_X, SO_X, CO, particulate matter and volatile organic compound [3].

A constant rising worldwide demand of motor and power generation fuels together with environmental concern has made us to turn on towards natural and pollution free fuel i.e. biofuel. A wide variety of terrestrial biomass feed stock have been identified as suitable candidates for future source of biofuel production such as corn, cotton, soya bean, mustard seed, sunflower, *Jatropa* and oil palm *etc*. Recently, microalgae have also been considered as a group that might play an important role in biofuel development and environmental protection. Biodiesel has attracted attention during the past few years as a renewable and environmentally friendly fuel because of diminishing petroleum reserves and the deleterious environmental consequences of exhaust gases from petroleum diesel [4].

Biodiesel is a non-toxic and biodegradable alternative fuel that is obtained from renewable sources. Biodiesel fuel can be prepared from waste cooking oil such as palm oil, soybean, canola, rice bran, sunflower, coconut, corn oil, fish oil, chicken fat and algae [5].

Fuel production from biomass is getting more importance these days due to scarcity, pollutants emission and increase in cost of conventional fossil fuels [6].

Algae have the potential to produce more oil per acre than any other feedstock being used to make biodiesel. The fact that oxygenic photosynthetic microalgae have the ability to accumulate abundant lipids intracellularly has been regularly exploited for the production of food additives and biofuel. Biodiesel generation from microalgal biomass is especially well researched since most oleaginous microalgae store easily accessible lipids in membranes and lipid droplets. Biodiesel is a nontoxic and biodegradable alternative fuel that is obtained by the transesterification of triglyceride oil with monohydric alcohols [7].

Biodiesel can be produced from microalgae through reactive extraction ("*in situ* transesterification") or a two-step transesterification. In a two-step transesterification, pre-extracted oil from microalgae can be converted into fatty acid methyl ester (FAME) ("biodiesel") with alkalised or acidified methanol. Alternatively, algal fatty acid methyl ester (FAME) can be produced via *in situ* transesterification by contacting the algal biomass directly with an alcohol containing a catalyst [8-10].

Algae can have between 20-80 % of oil by weight of dry mass [11]. Algae have much faster growth-rates than terrestrial crops. The per unit area yield of oil from algae is estimated to be from 20,000 to 80,000 L per acre, per year; this is 7–31 times greater than the next best crop, palm oil [12]. The calculations made by Chisti [13] clearly demonstrated the strong scenario for algal biofuels.

The idea of using algae as a source of fuel is not new [14], but it is now being taken seriously because of the increasing price of petroleum and more significantly, the emerging concern about global warming that is associated with burning fossil fuels [15].

The aim of this study was to examine the production of biodiesel from green alga *Oedogonium capillare.*

2. Materials and Methods

2.1. Collection of Oedogonium capillare

The algae sample was collected with a spoon type net from reservoir in Mini campus at the Olabisi Onabanjo University, Ago-Iwoye, Ogun State and was identified by Dr. Sobowale of Plant and Applied Zoology department and collaborated by Dr. (Mrs.) Adesalu of the Botany and Microbiology department, University of Lagos (UNILAG), Lagos Nigeria.

2.2. Algal Oil Extraction

Oedogonium capillare was ground with mortar and pestle as much as possible. Twenty-Two gram of the dried ground *Oedogonium capillare* was used for the oil extraction using Soxhlet extractor. In the soxhlet extractor, 250 ml of n-hexane were measured into the round bottom flask, the algae were placed in the thimble and blocked at both end with white laboratory wool and with water running through the condenser. The whole set up was placed on a water bath at 100°C for 6 hours.

2.3. Evaporation of the Alga Oil

The extracted oil obtained from green alga *Oedogonium capillare* was evaporated to release the n-hexane by using rotary evaporator.

2.4. Biodiesel Production

The algal oil obtained from green alga *Oedogonium capillare* was mixed with 100 ml of methanol and 6.25 ml of concentrated H_2SO_4 as catalyst to undergo acidic transesterification at 60°C on water bath for 90 minutes. The initial product (glycerine and methyl esther) was left to settle for 10 hours and separated using a glass separating funnel to remove the glycerine as by-product. Biodiesel was washed by 5 % v/w water until it become clean. Biodiesel was dried by using dryer and finally kept under the running fan for 6 hours.

2.5. Determination of pH of the Biodiesel

The pH of the biodiesel obtained from green alga *Oedogonium capillare* was carried out using pHep-pocket-sized pH meter

2.6. Statistical Analysis of Data Obtained

All experiments were carried out in triplicate and data obtained were subjected to analysis using Microsoft Excel 2010.

3. Results

Table 1. *Quantity of Extracted Algae Oil from Oedogonium capillare.*

Alga	Dry weight (g)	Extracted Algae oil (g)	Yield of the Algae oil (%)
Oedogonium capillare	22	1.8	8.18

Table 1 shows the percentage yield of extracted algal oil from *Oedogonium capillare.* It was observed that 8.18 % of algal oil was extracted from 22 g of dried weight of *Oedogonium capillare* which yield 1.8 g of algae oil in the course of the research

Table 2. *Quantity of the Oedogonium capillare Biodiesel Oil.*

Alga	Dry weight (g)	Extracted Algae oil (g)	Biodiesel oil obtained from the algal oil (g)	Yield of biodiesel (%)
Oedogonium capillare	22	1.8	1.8	100

Table 2 shows the percentage yield of the *Oedogonium capillare* biodiesel oil. It was observed that 100 % of biodiesel oil was extracted from the *Oedogonium capillare* in the course of the research. One-point-eight gram of biodiesel oil was obtained from 1.8 gram of the extracted algae oil which leads to 100 % yield of biodiesel

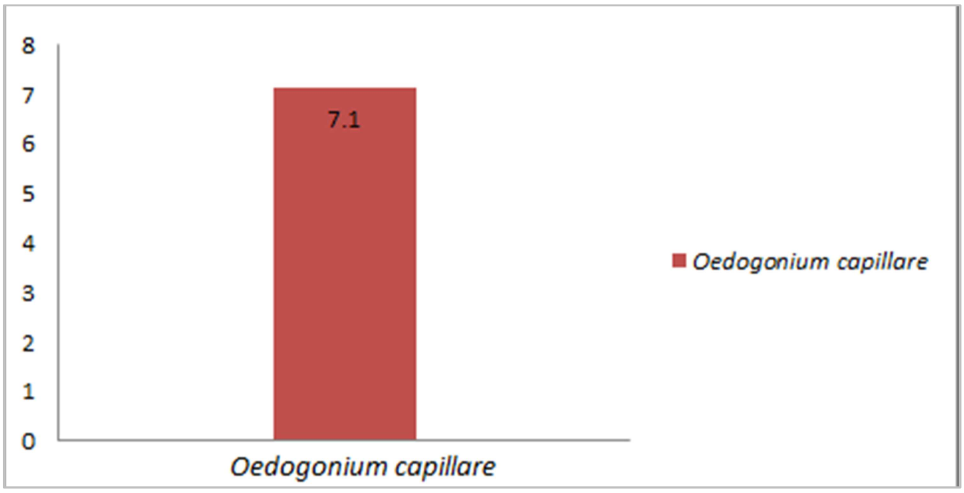

Figure 1. *Shows the pH of biodiesel obtain from Oedogonium capillare.*

The pH of the biodiesel was presented in Figure 1. The pH of the biodiesel obtained from *Oedogonium capillare* was found to be 7.1 in the course of the research using pHep-pocket-sized pH meter.

4. Discussion

The aim of the study was to present production of biodiesel from green alga *Oedogonium capillare.* The result shows that biodiesel can be produced from *Oedogonium capillare*. The algal oil obtained from the *Oedogonium capillare* was 8.18 %. Vincecate [16] observed that seaweed contain 5.50 % oil which differs from the 8.18 % of the algal oil obtained from the *Oedogonium capillare* in this research and may be as a result of the habitat, location, seasonal variation, environmental factors etc. Algae have long been recognized as potentially good sources for biofuel production because of their relatively high oil content and rapid biomass production. Biodiesel production directly depends on the oil content of microalgae and its efficiency. The amount of oil each strain of the algae produced varies widely. So that, even the process and culturing systems are selected perfectly, time and other related factors plays an important role [17]. The oil content of algae can be high as over 70 % with oil levels of 20 % to 50 % being reasonably common, but more typically 10 to 30 % when grown under nutrient replete conditions [18, 19]. The NREL study found oil yields in certain species up to 60 %, but maximum productivity levels were found at lower oil contents [20]. Miao and Wu [21] reported that hexane as the most widely used solvent for the extraction of oil from micro and macro algae.

Johnson made a study on *Schizochytrium limacinum* microalgae species. He converted this algal oil to biodiesel with acidic transesterification and he achieved 82.6 % of biodiesel yield [22]. The percentage yield of the biodiesel obtained from the *Oedogonium capillare* oil was 100 % in the course of the research.

The global biodiesel market is estimated to reach 37 billion gallons by 2016, growing at an average annual growth of 42 %, being Europe the major biodiesel market for the next decade or so, closely followed by US market [23]. In order to meet these rapid expansion in biodiesel production capacity, observed not only in develop countries but also in developing countries such as China, Brasil, Argentina, Indonesia and Malaysia, other oil sources, especially non edible oils, need to be explored [24]. Microalgae seems to be the only source of renewable biodiesel that has the potential to completely displace petroleum-derived transport fuels without the controversial argument “food for fuel” and to reach the 2003 Biofuels Directive target, achieving more than a 35 % minimum greenhouse gas savings (this value represents the diminishing impact of oleaginous crops including the land use change) [13, 25, 26].

The biodiesel was found to be almost neutral in nature because the pH was 7.1. The result of pH of *Oedogonium* sp observed by Khola and Ghazala [27] was a little bit higher than 7.1 observed in the course of the study.

5. Conclusion

This study has been able to prove that biodiesel can be produce from *Oedogonium capillare* which can serve as source of energy and that considerable amount of biodiesel can be produced from algae. Algae have important potential as an alternative energy source. Technical experience and technological development are required in order to increase the yield of biodiesel oil from algae.

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