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Production of Biodiesel Using Waste Water Algae

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ABSTRACT

The most common liquid fuel from algae is biodiesel. Fatty Acid Methyl Ester (FAME) or biodiesel is typically produced by a reaction-Transesterification between triglycerides and alcohol (most commonly methanol) at 60–70°C and in the presence of an alkaline or acidic homogeneous catalyst at atmospheric pressure. In addition to triglycerides in the lipid fraction, algae oil also contains a substantial quantity of free fatty acids (FFAS) and some moisture. In the present study the biodiesel was produced by using the algae. The algae were collected from a pond water from Karad, Maharashtra, India. The algae were studied for microscopic observation and was identified as *Pithophora* sp. The yield of the biodiesel was found to be 47.619 ml/100 g of algae. The biodiesel was found to be having green yellowish colour and chemicalodour.

Key words: *Biodiesel, Algae, Renewable fuel, Sustainable fuel.*

Introduction

The world is facing the energy crises and environmental issues in this century due to increased industrialization and overuse of natural resources for energy such as fossil fuels. The burning of fossil fuels generates greenhouse gases which aggravate the global warming. Biodiesel is biodegradable, causes less CO_2 and NO_x emissions. Continuous use of petroleum sourced fuels is now widely recognized as unsustainable because of depleting supplies and the contribution of these fuels to the accumulation of carbon dioxide in the environment. In present situation, global warming effect, depletion in fossil fuel reserves and higher petroleum prices are the main issues driving worldwide interest on the development of alternative renewable, biodegradable and sustainable biofuels (Alptekin, 2008). Biofuels produced from algae are considered to be a potential substitute to replace conventional fossil fuels (Brennan, 2010).

First generation biofuels correspond to those issued from food-based crops (Antizar Ladislao and Turrion-Gomez, 2008). They mainly correspond to ethanol-based fuels obtained from the fermentation of sugars (corn, beet, sugar cane, etc.), vegetable oil-based fuels (raw oil, biodiesel and renewable diesel produced from catalytic hydrodeoxygenation) (Knothe, 2010; Natural Resources Canada, 2011b) from oleaginous plants (colza, palm, canola, etc.) and biogas emitted from raw material or landfills (Naik *et al*., 2010).

Second generation biofuels are the cellulosic-based biofuels obtained from non-food crops materials (wood, leaves, straw, etc.). These biofuels include bioalcohols, bio-oil, 2,5- dimethylfuran (BioDMF), biohydrogen, Fischer-Tropsch diesel, wood diesel (Fatih Demirbas, 2009; Román-Leshkov *et al*., 2007). Third generation biofuels are microorganisms (yeast, fungi) biofuels and algae-based fuels like vegetable oils, bio-oil, jet-fuels, biohydrogen, biodiesel, renewable diesel and many others (Fatih Demirbas, 2009; Nigam and Singh, 2011). Second and 3rd generation biofuels are better than 1st generation biofuels for sustainable development as they are carbon neutral or they reduce atmospheric CO_2 as they are carbon negative (Naik *et al.*, 2010). For example, 1st generation biodiesel (like soybean) only induces a net reduction of GHG emissions by 41% (Hill *et al*., 2006). In comparison, for each tone of microalgal biomass produced, some authors estimate that 1.8 tons of CO2 would be consumed (180% reduction) (Chisti, 2007; Demirbas and Demirbas, 2011).

Materials and Methods

Collection of Algae

One hundred and fifty g of algal biomass (W/W) was collected from pond water of Karad city, Maharashtra, India in a clean bottle.

Study of Morphological Characteristics of Algae

A small amount of algal sample was mounted on glass slide. A drop of water is placed on the mounted algal biomass. Then cover slip was placed over the sample and carefully lowered the cover slip into place using a tooth pick or equivalent. This method will help prevent air bubbles from being trapped under the cover slip. The slide was observed under microscope and Morphological characteristics were studied for identification (Lee, 2018).

Extraction of Biodiesel from Algal biomass

Extraction of oil from algae

Three sets of 50g of Algal mass (W/W) were collected prepared in beakers. Algae were ground with motor and pestle as much as possible. The ground algae were dried for 20 min at 80 °C in an incubator for releasing water. Dry weight of the algal mass was determined. The average dry algal mass per set was 10 g. Ether and n-butyl alcohol (1:1) were mixed at 50 ml amount with the dried ground algae to extract oil. Then the mixture was kept for 24 h at 4 ^{0}C for settling (Brennan, and Owende, 2010).

Evaporation

The supernatants were decanted out and these three oil extracts were evaporated to release n-butyl alcohol and ether solutions using rotary evaporator.

Mixing of catalyst and methanol

The 0.75 g NaOH pellets were mixed with 72 ml methanol and stirred properly for 20 min.

Biodiesel production by Transesterification

The 24 ml mixture of catalyst and methanol was poured into each of the algal oil setsin a conicalflask and heated to 70 ^{0}C for a 3-h on electric shaker at 300 rpm

Settling

After shaking, the solution was kept for 16 h to get settled. The fuel floated in upper layer. The Glycerine and pigments settled faster at the bottom of the flask.

Separation of biodiesel

The biodiesel was separated from sedimentation by separating funnel. The solution was added in the separating funnel. Solution was allowed to settle for few minutes again to separate the solution in layers. After complete separation of layers,the stopper was removed and drained the bottom layer containing glycerine and pigments. Quantity of sediment (glycerine, pigments, etc.) was measured.

Washing

Biodiesel was washed by 5% water for 3 to 4 times until it became clean.

Storage

Biodieselwas measured by using measuring cylinder. The pH was measured and stored at 4 ^{0}C for analysis.

Results and Discussion

Collection of Algal mass: The 150 g algae was collected from pond water and observed under microscope and tentatively identified as strain of *Pithophora sp.* Dry weight of Algal Biomass-taken per set was 10-g from which biodiesel was prepared using methanol-NaoH catalyst mixture.

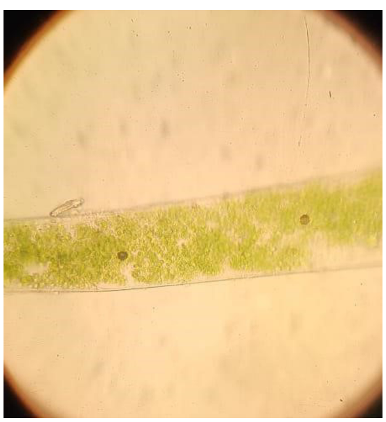
The result of Production of Biodiesel and its properties are presented in Table 1 and Photoplates-1, 2 and 3.

In thethree sets of algae with 10 g each of dry *pithophora* algal biomass, 7-9 ml of Biodiesel and 15-18 ml of glycerine were obtained. Thus the average yield of biodiesel was found to be 80 ml/100 g dryalgae. The oil content (% dry weight) of algae was found to be in the range of 25 to 77%. The oil content of *Pithophora* is found to be equivalent to *Nitzschia* sp. and *Neochlorisoleo abundans* spp. (Deng

Table 1. Biodiesel obtained from *Pithophor*a spp

Sr. No.	Details	Flaskno.1	Flaskno. 2	Flaskno.3
1	Algae used: *Pithophora* species and amount(g)	50-g wet weight and 10-g dry weight	50-g wet weight and 10-g dry weight	50-g wet weight and 10-g dry weight
2	Biodiesel obtained	8mL	7mL	9mL
3	Glycerine obtained	15-mL	18-mL	15-mL
4	Odour of biodiesel	Chemical (Burnt coffee smell)	Chemical (Burnt coffee smell)	Chemical (Burnt coffee smell)
5	Colour	Yellowish green	Yellowish green	Yellowish green
6	pH	acidic	acidic	acidic

Photoplate1. Collection of algae species from lake water



Photoplate 2. Microscopic observation of collected algae *pithophora* spp.

Photoplate 3. Production and separation of biodiesel

et al., 2009; Fatima *et al.,* 2016).

The odour of biodiesel was found to be Chemical (Burnt coffee smell) and Colour of biodiesel was found to be yellowish green.

Conclusion

Algal biofuel is an ideal biofuel candidate which eventually could replace petroleum-based fuel due to several advantages, such as high oil content, high production, less land, etc. For present study the algal mass was collected from a pond water from Karad city, Maharashtra and characterised by microscopic observation *as Pithophora* sp. Algae was used for biodiesel Production. The biodiesel production was carried out by transesterification process. Biodiesel was separated by using separating funnel and collected while the sediment layer was containing glycerine and pigment. Some Physical properties like colour and odour of biodiesel produced were studied.

The yield of the biodiesel was found to be 80 ml/ 100 g of dry algae. The biodiesel was found to be having yellowish green colour and chemical (burnt coffee smell) odour which was same with market available diesel. Three type of the pigment were separated.

Biodiesel could be produced from Algae i.e., *Pithophora* spp. by transesterification process. The algae can be cheap, source for the production of biodiesel. However, more studies should be carried out to explore the algal potential for the productionn of biodiesel.

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Conflict of interest

There is no any conflict of interest. Each author has a contribution in this research and publication work.

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