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Transesterification of Algal Oil to Produce Algal Biodiesel

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ABSTRACT

The role of fossil fuels in modern economy is quite vital. The decreasing fossil fuel resources cause both insufficiency in providing demand and increase in prices and it triggers the structural change in energy production and resources. In this context, the innovations in encouraging the use of renewable energy sources will make it possible to manage the passage from an unsustainable structure to a more sustainable structure. The necessary conditions for the world oil supply can be said to enter into a new era with the increasing demand pressure. In this study naturally occurring fresh water algal samples were collected from different sites of Shivamogga. Algae were identified as Spirogyra spp, and Oedogoniumspp and they were inoculated into the selective media, which favor the growth of algae oil was extracted from dried algal samples and pH were analyzed. These results indicate that biodiesel can be produced from Spirogyra spp, and Oedogonium spp.

KEYWORDS: *Biodiesel, transesterification, Spirogyra spp., Oedogonium spp. glycerin, biomass.*

I. Introduction

The world is about to face the predicament in energy sources. The consumption of fossil fuels and the available energy sources are the main problems needed to be solved. This critical situation that the world is about to face is a threat to modern human existence. Energy crisis will arise when there will not be enough energy sources to survive the demands of the world as the demand for energy increases.

Algae are an important raw material for many industries i.e. from medicine to fertilizer and from fodder to food. Algae are the feedstock for many industrial productions like alginate derivatives, carrageenan and agar-agar but they are also widely consumed as food in many countries. Some macroalgae are nutritionally very much valuable they are consumed with fresh or dried vegetables, salads, or as ingredients in a wide variety of cooked foods. Some known algae contain significant quantities of vitamins, protein, minerals and lipids. In algae the nutrient content may vary from species to species, from one geographical location to the other, one season to the other or even due to humidity as well as temperature.

Transesterification or alcoholysis is the reaction of a lipid with an alcohol to form esters and a by-product, glycerol. This reaction actually converts highly viscous raw lipid/oil into low molecular weight molecules in the form of fatty acid alkyl esters which can be used as an alternative fuel for diesel engines. Biodiesel is a term used to describe "fuel comprised of monoalkyl esters of long-chain fatty acids that are derived from vegetable oils or animal fats"

The demand for energy is increasing day by day due to the rapid growth in population and industrial development. The basic sources of energy are petroleum, natural gas, coal. The continued use of petroleum sources fuels is now widely recognized as unsustainable because of the depletion supplies and the contribution of these fuels to the accumulation of carbon dioxide in the environment leading to increase of global warming. Biodiesel from oil crops, waste cooking oil and animal fat cannot realistically satisfy even a small fraction of the existing demand for transport fuels. Recent researchers involved not only the existing renewable sources available from land plants, but also those coming from aquatic systems. The idea of using algae as a source of fuel is not new, 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.

Biodiesel is an excellent substitute for conventional diesel fuel because of being renewable, nontoxic and biodegradable. It consists of mono-alkyl esters usually produced from renewable feed stocks. Macroalgae are a potential alternative source for the conventional feed stocks and algal oil is suitable for esterification/transesterification reaction of biodiesel production. The recent renewable source of algal oil that could meet the global demand for transport fuels. The rapid replication and high percentage of oil present in many species of algae, reaching about 80% of their biomass, are some of these advantages. Also, unlike other plants, algae do not require large areas for cultivation, and can be up to 20 times more productive per unit area than the top oilseed crops.

Biodiesel is produced through different techniques such as direct/oil blends, micro emulsion, pyrolysis and transesterification. However, the most notable way to produce biodiesel fuel is through transesterification reaction. Transesterification is the reaction of triglycerides to fatty acid alkyl esters and low molecular weight alcohols such as methanol and ethanol in the presence of catalyst.

II. Methodology

Collection of algal Samples:

The samples were collected from freshwater bodies of Shivamogga region, and they were brought to the Department of Botany and Seed Technology, Sahyadri Science College, Kuvempu University, Shivamogga, The algal samples were identified as shown in Table.1

Place of Collection	Name of Algae
Kachinakatte pond	*Oedogoniumspp*
Nagara pond	*Spirogyra spp*
Devaranasipura pond	*Oedogoniumspp*
Waterlogged area near Mandli, O.T. Road, Shivamogga.	*Spirogyra spp* + *Zygnemaspp*
Waterlogged area near Sagar	*Spirogyra spp*

Table.1

Isolation and culture of algal samples:

Once the algae were identified, they were inoculated into the selective media, which favor the growth of algae. In case of more than one alga in a sample, serial dilution was performed followed to obtain uni-algal cultures [4]. The samples were cultured in BG-11 media [6] at 27-300C, for 21 days.

Harvesting:

The algal culture was filtered with the help of filter paper then weighed separately. Then the filtrate was dried in Hot Air oven at 800C for 3hrs.

Oil extraction:

The dried algae were ground with motor and pestle as much as possible. The ground algae were dried for 20 min at 80°C in a incubator for releasing water. Hexane and ether solution (1:1 vol) were mixed with the dried ground algae to extract oil. Then the mixture was kept for 24h for settling. Then the biomass was collected after filtration and weighted.

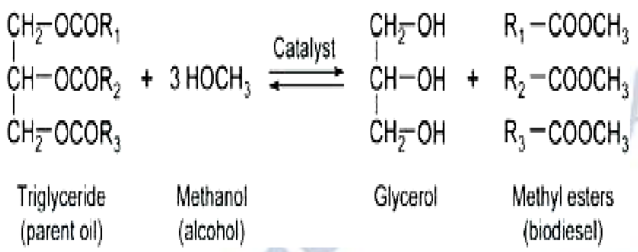
Evaporation:

The extracted oil was evaporated in vaccum to release hexane and ether solutions using rotary evaporator, and 0.25g NaOH was mixed with 24ml methanol and stirred properly for 20 min.

Biodiesel production:

The mixture of catalyst and methanol was poured into the algal oil in a conical flask. The following reaction and steps were followed.

Transesterification:



The conical flask containing solution was shaken for 3h by rotatory shaker at 300rpm. After shaking the solution was kept for 16h to settle the biodiesel and sediment layers clearly. The biodiesel was separated from sedimentation by flask separator carefully. Quantity of sediment was measured. Biodiesel was washed by 5% water until it was become clean. Biodiesel was dried by using dryer and finally kept under the running fan for 12h. And measured by using measuring cylinder; pH was measured by using pH strips and stored for analysis.

III. RESULTS

The investigations were carried out to isolate and growth prospecting of fresh water algae for biodiesel production. The result shows that the biodiesel can produced from fresh water algae Oedogonium spp. and Spirogyra spp., Algae are simple autotrophic organisms and from simple inorganic molecules such as carbon dioxide they produce complex organic compounds using energy from light or inorganic chemical reactions. Although algae grows at a fast rate and good producers of lipids in comparison to other oil sources.

Samples	% of Algal oil (w/w)	Density g/cm³	Viscosity (mm²/sec)	pH
Oedogonium spp.,	19.82	0.889	4.9	7
Spirogyra spp.,	16.78	0.886	4.4	7

IV.DISCUSSION

Lipids extracted from Oedogonium spp., and Spirogyra spp., were used for the biodiesel production. Biodiesel is produced with a process known as transesterification. Biodiesel produced using Oedogonium spp., and Spirogyra spp., as lipid source. Glycerol is a byproduct of biodiesel production and it can be used in food industries, pharmaceutical industries and cosmetic industries. Amount of glycerol produced using the lipids of respective algal samples was recorded and the comparison between the two algal species showed the lipid extracted from Oedogonium spp., was the best feed for glycerol production. Biomass is also a byproduct of algal sample and it can be used as a fertilizer or fodder.

The result showed 16.78 to 19.82 % amount of oil in both algal samples, and also the Density of algal oil matches the density ranges of a biofuels given by EN 14214 and ISO 15607, and the viscosity range given by EN14214 and ISO 15607 is 3.5 – 5.0mm2/s, thus our result matches to these standards.

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