GC-MS Analysis of esters of fatty acid present in biodiesel produced from *Cladophora vagabunda*

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**ABSTRACT**

Depletion of petroleum based fuel turns the world’s focus in to finding a new alternative in which biodiesel took major attention. Biodiesel is produced from various sources like waste vegetable oil, animal fat, grease etc. In this, macro algae *Cladophora vagabunda* was studied with different solvent systems such as isopropanol and chloroform-methanol for better yield of biodiesel. Among these solvent system, chloroform-methanol solvent system produced more biodiesel(3.3ml/10gm) than isopropanol solvent system (2.6ml/10gm). Since *Cladophora vagabunda* with chloroform-methanol solvent system produced more biodiesel its esters of fatty acid content was analyzed by using Gas chromatography coupled with mass spectrometer. The results showed that the presence of ethyl palmitate as the dominant ester with percentage composition of 9.36% than methyl palmitate 9.18%. But the overall percentage of methyl ester compound was found to be more (21.66%) than ethyl ester (14.97%). The major fatty acid compounds were also analyzed. These include myristic acid (1.93%), linolenic acid (0.60%) and palmitic acid (9.18%).

**INTRODUCTION**

Energy is one of the most fundamental requirements for human beings. It is a critical factor for social and economic development and a viable commodity that could improve human well being [1]. Because of depleting fossil fuel, an alternate has to be found out to overcome this energy crisis. Hence biofuel technology was developed. Biodiesel is a fuel produced by reacting oil with alcohol using a catalyst [2]. Biodiesel is obtained from animal fats and vegetable oil [3]. So it is an important tool for combating environmental pollution because of its eco friendly nature [4,5]. Many cereals are used to produce biodiesel which is being used as a food. In order to solve this problem biodiesel is derived from animal fats from poultry to produce biodiesel [6, 7]. Jatropha oil is also used to derive biodiesel using lipase catalyst [8].

In addition, scientists are developing certain crops with high oil content just for the production of biodiesel [9, 10] and looking for new sources to produce biodiesel [11]. In recent years algae are also served as a feed stock for the production of biodiesel. India being a peninsula, it has a longer coast line when compared to many other countries. Hence the availability of seaweed is more. About 200 species of seaweeds are available in the Tamil Nadu coast line. There are different types of marine algae (red, brown and green). Marine algae like *Sargassum ilicifolium* and *Kappaphycus alvarezi* has antibacterial activity against pathogen [12], hence being used in food and pharmaceutical industry. The usage of marine algae as food in India is very less. The other species are collected in the beaches and they are treated as a waste. The usage of seaweeds in India is minimal when compared to other oriental countries. Hence there is a vast potential to utilize this raw material for the production of biodiesel. Earlier studies have also indicated the presence of hydrocarbon in algae which is an important parameter for the production of biodiesel.
EXPERIMENTAL SECTION

Collection of samples
The marine algae of *Cladophora vagabunda* was collected from Pulicat lake (Tamil Nadu, India) and washed with water and sun dried for few days to remove moisture which inhibits transesterification process. After complete drying they were crushed into small particles in a mixer to obtain a dry powder.

Extraction of oil from Marine algae
The extraction of oil was done by using Bligh & Dyer method [13] and various solvent systems were used to extract algal oil from seaweed [14]. The powdered samples were soaked in different types of solvent systems such as chloroform-methanol, isopropanol in the ratio of 1:20 (w/v) in a conical flask.

Transesterification Process
Transesterification process was done using methanol and base as catalyst [15,16].

Analysis of fatty acid methyl esters:
Methyl and ethyl esters of fatty acids were analyzed by GC-MS.

RESULTS AND DISCUSSION

Various alternate feed stocks have been analyzed for the maximum yield of diesel. Since algae have potential to produce biodiesel it has been taken for this study. The marine algae *Cladophora vagabunda* with chloroform-methanol solvent system produced more biodiesel (3.3ml/10gm) than isopropanol solvent system (2.6ml/10gm) (Table.1). Hence the chloroform-methanol solvent system was found to be the best solvent system for extracting more biodiesel.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Name of the Sample</th>
<th>Dry weight (gm)</th>
<th>Solvents used</th>
<th>Weight of Biomass (wet weight)</th>
<th>Lipid content (%)</th>
<th>Diesel (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Cladophora vagabunda</em></td>
<td>10</td>
<td>Chloroform-Methanol</td>
<td>10.9</td>
<td>8.1</td>
<td>3.3</td>
</tr>
<tr>
<td>2</td>
<td><em>Cladophora vagabunda</em></td>
<td>10</td>
<td>Isopropanol</td>
<td>11.2</td>
<td>4.5</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Amount of lipid content plays the vital role in the production of biodiesel. High lipid was present in algal oil extracted from *Cladophora vagabunda* with chloroform-methanol solvent system (8.1%) than isopropanol solvent system (4.5%). Hence chloroform-methanol solvent system gave more yield. The quality of the biodiesel depends on the glycerin content [17]. Glycerin content was found to be more in *Cladophora vagabunda* with chloroform-methanol solvent system than isopropanol solvent system (Fig.1). A high content of glycerin can lead to build up in fuel tanks, clogged fuel systems, injector fouling and valve deposits.

![Glycerin content (ml)](image)

Fig.1 (a- *Cladophora vagabunda* with chloroform-methanol solvent system, b- *Cladophora vagabunda* with isopropanol solvent system).
Various specifications that a biodiesel must meet as contained in biodiesel standards are associated with composition and structure of the fatty esters comprising the biodiesel [18]. Some of these specifications that are related to fuel...
The present work is mainly focused on investigating the profile of esters of fatty acid present in the biodiesel, since the ester derived from the alcohol can influence the fuel properties of biodiesel like cetane number viscosity and oxidation stability among others [23]. Fatty acid components of the algal biodiesel were detected by GC-MS for Cladophora vagabunda with chloroform-methanol solvent system since the yield of biodiesel was more in that sample (Fig.2).

GC-MS analysis showed that major fatty acid components in all esters were myristic acid, linoleic acid, palmitic acid, linolenic acid. Formation of ethyl ester during transesterification process was comparatively less than that of formation of methyl ester. This may be because of methoxide radicals is higher than that of ethoxide radicals [24]. Fig.3 shows the sum of the area% of methyl and ethyl ester formation in biodiesel.

CONCLUSION

Seaweeds are the best source of renewable biodiesel that is capable of meeting global crisis for fuel. Hydro carbon content of seaweed are high than plants and their availability also more in Indian coastal line. Hence algae are the best choice for biodiesel production. Further more work may be carried out to characterize the biodiesel extracted from seaweed and the relationship between ester formation and the other important parameters such as viscosity, lubricity and stability.

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REFERENCES

[1] Sokoto MA; Hassan LG; Dangoggo SM; Ahmad and Uba A, Nigerian journal of basic and applied sciences, 2011, 19(1), 81-86.
[9] Cardone M; Mazzoncini M; Menini S; Rocco V; Senatore A; Seggiani M. and Vitolo, Biomass Bioenergy, 2003, 25, 623-63