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Research Article

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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, chloform-methanol solvent system produced more biodiesel(3.3ml/10gm) than isopropanol solvent system (2.6ml/10gm). Since Cladophora vagabunda with chloform-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 if 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 alvarezii* 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 in to 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.1 Yield of Diesel from *Cladophora vagabunda*

S. No	Name of the Sample	Dry weight (gm)	Solvents used	Weight of Biomass (wet weight)	Lipid content (%)	Diesel (ml)
1	*Cladophora vagabunda*	10	Chloroform-Methanol	10.9	8.1	3.3
2	*Cladophora vagabunda*	10	Isopropanol	11.2	4.5	2.6

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.

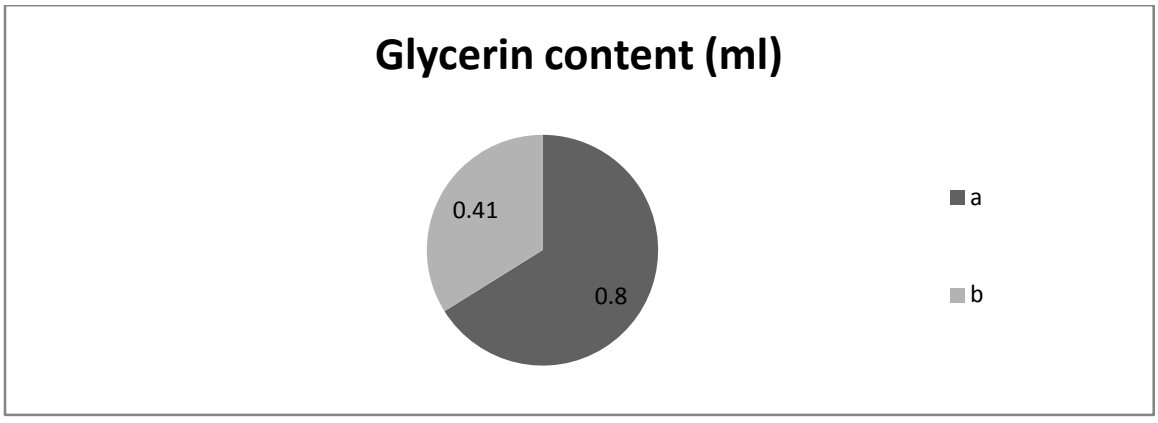
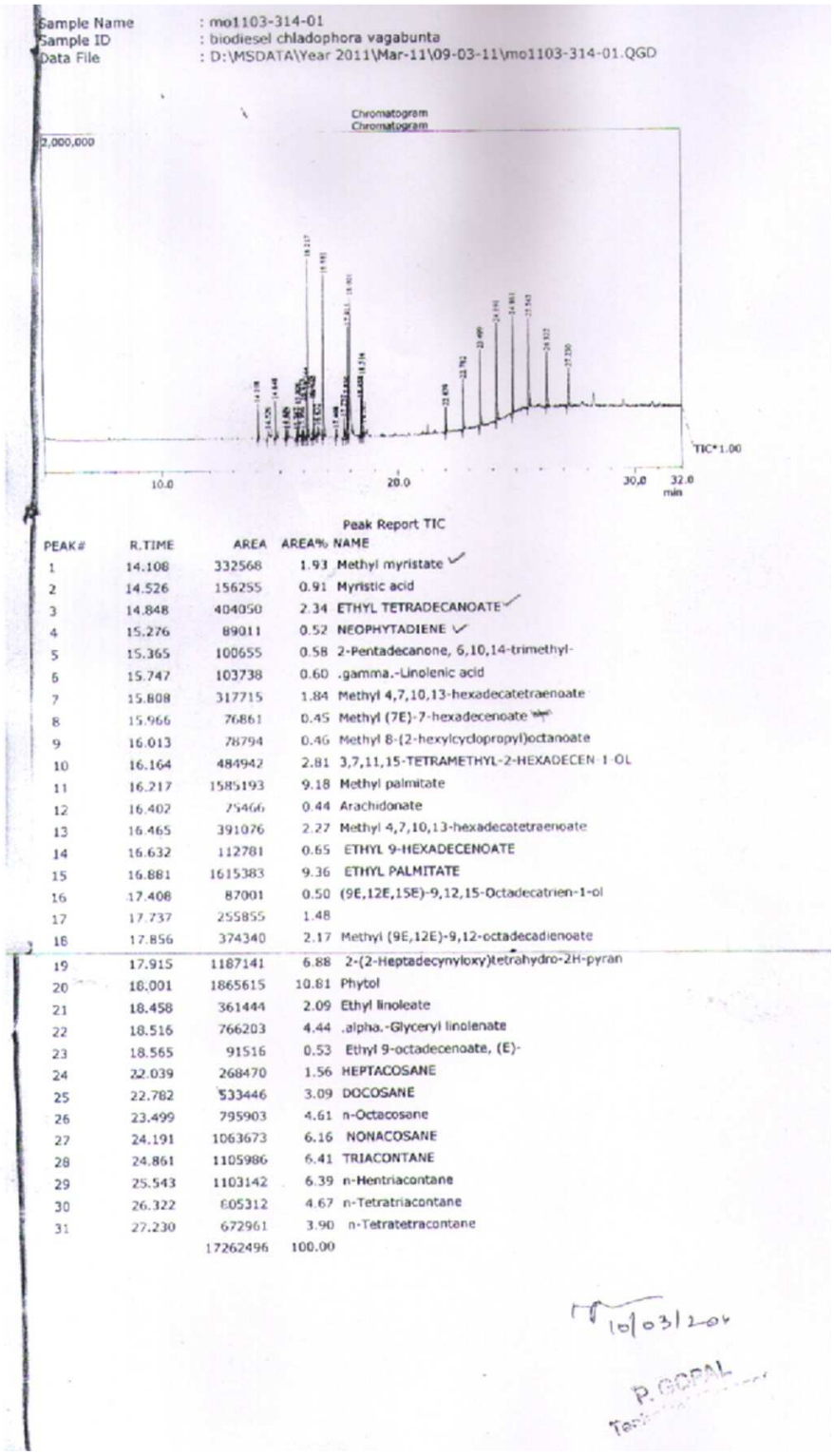


Fig.1 (a- *Cladophora vagabunda* with chloroform-methanol solvent system, b- *Cladophora vagabunda* with isopropanol solvent system).



Peak Report TIC

PEAK#	R.TIME	AREA	AREA%	NAME
1	14.108	332568	1.93	Methyl myristate
2	14.526	156255	0.91	Myristic acid
3	14.848	404050	2.34	ETHYL TETRADECANOATE
4	15.276	89011	0.52	NEOPHYTADIENE
5	15.365	100655	0.58	2-Pentadecanone, 6,10,14-trimethyl-
6	15.747	103738	0.60	.gamma.-Linolenic acid
7	15.808	317715	1.84	Methyl 4,7,10,13-hexadecatetraenoate
8	15.966	76861	0.45	Methyl (7E)-7-hexadecenoate
9	16.013	78794	0.46	Methyl 8-(2-hexylcyclopropyl)octanoate
10	16.164	484942	2.81	3,7,11,15-TETRAMETHYL-2-HEXADECEN-1-OL
11	16.217	1585193	9.18	Methyl palmitate
12	16.402	75466	0.44	Arachidonate
13	16.465	391076	2.27	Methyl 4,7,10,13-hexadecatetraenoate
14	16.632	112781	0.65	ETHYL 9-HEXADECENOATE
15	16.881	1615383	9.36	ETHYL PALMITATE
16	17.408	87001	0.50	(9E,12E,15E)-9,12,15-Octadecatrien-1-ol
17	17.737	255855	1.48	
18	17.856	374340	2.17	Methyl (9E,12E)-9,12-octadecadienoate
19	17.915	1187141	6.88	2-(2-Heptadecynyloxy)tetrahydro-2H-pyran
20	18.001	1865615	10.81	Phytol
21	18.458	361444	2.09	Ethyl linoleate
22	18.516	766203	4.44	.alpha.-Glyceryl linolenate
23	18.565	91516	0.53	Ethyl 9-octadecenoate, (E)-
24	22.039	268470	1.56	HEPTACOSANE
25	22.782	533446	3.09	DOCOSANE
26	23.499	795903	4.61	n-Octacosane
27	24.191	1063673	6.16	NONACOSANE
28	24.861	1105986	6.41	TRIACONTANE
29	25.543	1103142	6.39	n-Hentriacontane
30	26.322	805312	4.67	n-Tetratriacontane
31	27.230	672961	3.90	n-Tetratetracontane
		17262496	100.00	

10/03/2011

P. GOPAL

Fig.2 GC-MS analysis of *Cladophora vagabunda* with chloroform-methanol 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

quality include cetane number, kinematic viscosity, oxidative stability and cold flow properties in the form of cloud and pour points [19, 20, 21, 22]. Other essential properties influenced by fatty acid ester components of biodiesel but not contained in biodiesel standard are exhaust emission, lubricity and heat of combustion [22].

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.

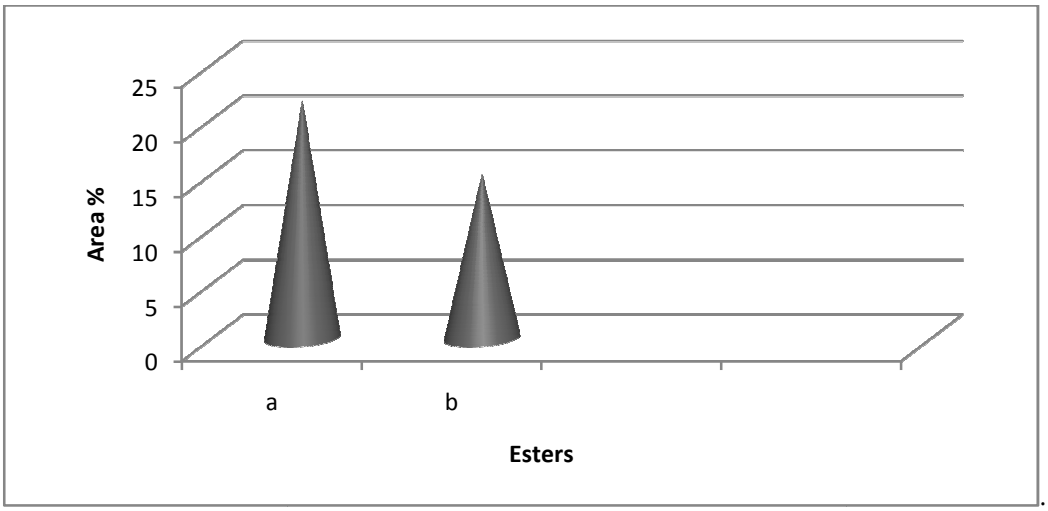


Fig.3 Analysis of esters of fatty acid in biodiesel (a- methyl ester, b- ethyl ester).

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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