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Research Article

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Production of Biodiesel from *Chaetomorpha antennina* and *Gracilaria corticata*

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ABSTRACT

Biofuels are wide range of fuels which are derived from biomass. Biofuels are gaining increases public and scientific attention. Marine algae also known as seaweed are the multicellular plants having potential role in biodiesel production. In this study, Chaetomorpha antennina and Gracilaria corticata were collected from Covelong (East coast of Tamil Nadu) and their diesel content was estimated using different solvent system. Among these species, Chaetomorpha antennina with chloroform-ethanol system produced more diesel content (2.4ml/10gm) than Chaetomorpha antennina with chloroform-methanol solvent system (2.1ml/10gm). Similarly Gracilaria corticata with hexane-ether solvent system produced more biodiesel (2ml/10gm) than Gracilaria corticata with benzene solvent (1.8ml/10gm). The formation of fatty acids of methyl and ethyl esters were also analyzed by GC-MS. GC-MS analysis revealed that the formation of methyl esters was more than the formation of ethyl ester.

Keywords: Biodiesel, *Chaetomorpha antennina*, *Gracilaria corticata*, Methyl and ethyl ester.

INTRODUCTION

The term biofuel covers solid biomass, liquid fuels and various biogases. Biodiesel is made from vegetable oils, animal fats, recycled greases, plant materials by transesterification process using base catalyst to enhance maximum conversion of lipid to diesel. Petroleum fuel is now recognized as unsustainable because of decrease in supplies and their Cox emission. Bioenergy is one of the important key to mitigate green house gas emissions and substitute of fossil fuels [1]. Biodiesel is biodegradable and has less CO_x emission to the environment. It is an alternate fuel for diesel engines is increasing significantly due to depletion of fossil fuels. Biodiesel is produced by chemically reacting a vegetable oil or animal fat with short chain alcohol such as methanol, ethanol or butanol as a catalyst [2, 3]. It is an important tool for combating environmental degradation because of its eco friendly nature and easy portability [4]. Certain crops with high oil content are used for the production of biodiesel [5, 6]. Biodiesel from sunflower oil is highly unsaturated and this makes it very prone to oxidation which can cause the fuel to become acidic form leading to the formation of insoluble gums and sediments that can plug fuel filter [7]. Apart from waste vegetable oil, animal fat, seeds of *Jatropha curcas* are also used for the production of biodiesel [8]. It is also activated by lipase catalyst for the yield of biodiesel [9]. Micro algae are also serving as different types of renewable biofuels. These include biodiesel derived from algal oil [10, 11, 12,13].

An innovative biodiesel production was carried out in North Eastern Spain with *Galicia*. It is a region with wide diversity of marine algae and has a deeply rooted seafaring tradition [14]. Shay had reported that algae are one of the best feed stocks for the production of biodiesel [15]. It can produce 250 times the amount of oil per acre as soya beans. Producing biodiesel from algae may be the only way to bring out enough automotive fuel to replace current gasoline usage. Algae can produce 7 to 31 times greater oil than palm oil. It is very simple to extract oil from algae [16]. 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 [17], 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 *Gracilaria corticata* and *Chaetomorpha antennina* were collected from Covelong (Eastern coast of 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 [18] and various solvent systems were used to extract algal oil from seaweed [19]. The powdered samples were soaked in different types of solvent systems such as chloroform-methanol, chloroform-ethanol, benzene, hexane-ether, in the ratio of 1:20 (w/v) in a conical flask.

Transesterification Process

Transesterification process was done using methanol and base as catalyst [20, 21].

Analysis of fatty acid methyl esters

Methyl and ethyl esters of fatty acids were analyzed by GC-MS.

RESULTS AND DISCUSSION

There has been a worldwide search for an alternate fuel to meet the demands of growing world population. 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 Chaetomorpha *antennina* with chloroform-ethanol system produced more diesel (2.4ml/10gm) than *Chaetomorpha antennina* with chloroform-methanol solvent system (2.1ml/10gm). Similarly Gracilaria *corticata* with hexane-ether solvent system produced more biodiesel (2ml/10gm) than *Gracilaria corticata* with benzene solvent (1.8ml/10gm). (Table.1).

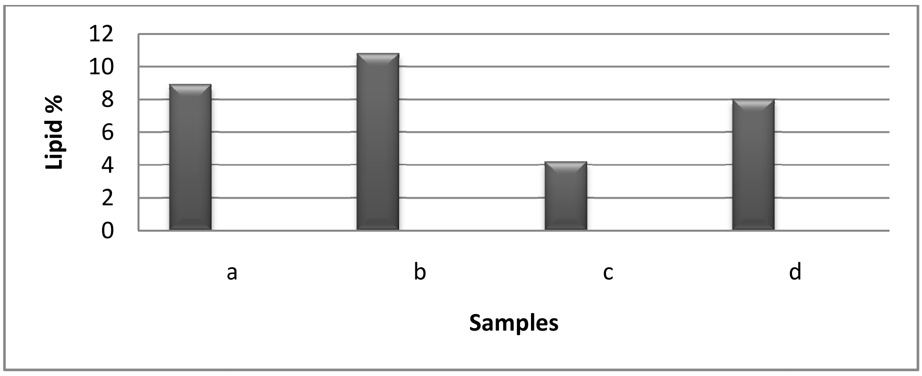
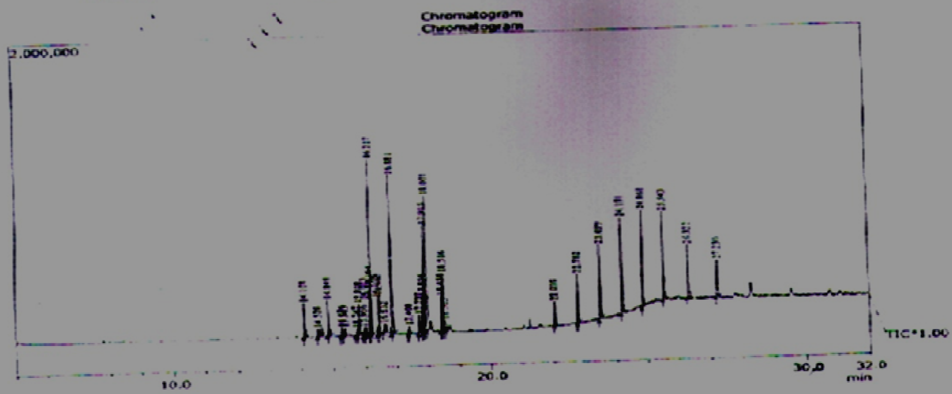


Fig.1 Lipid% of the samples (a- *Chaetomorpha attennina* with chloroform-methanol solvent system, b-*Chaetomorpha attennina* with chloroform-ethanol system, c-*Gracilaria corticata* with benzene solvent system, d- *Gracilaria corticata* with hexane-ether solvent system).

Sample Name : mo1103-314-02

Sample ID : biodiesel chaetomorpha atennina

Data file : D:\MSDATA\Year2011\Mar-11\09-03-11\mo1103-314-02.QGD



Peak Report TIC

PEAK#	R.TIME	AREA	AREA%	NAME
1	13.100	302660	1.05	Methyl myristate
2	14.005	145200	0.9	Myristic acid
3	13.848	303040	1.3	ETHYL TETRADECANOATE
4	14.200	79001	0.4	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	[illegible]	0.45	Methyl (7E)-7-hexadecenoate
9	16.015	[illegible]	0.46	Methyl 8-(2-hexylcyclopropyl)octanoate
10	16.164	[illegible]	2.81	3,7,11,15-TETRAMETHYL-2-HEXADECEN-1-OL
11	16.217	[illegible]	9.18	Methyl palmitate
12	16.402	75466	0.44	Arachidonate
13	16.465	391026	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	24.915	100673	5.1	n-Hentriacontane
30	25.499	1002131	5.4	n-Tetratriacontane
31	26.203	57904	3.1	n-Tetratetracontane
		17262496	100.00	

Fig.2 GC-MS Analysis of biodiesel from *Chaetomorpha antennina*

Amount of lipid content plays the vital role in the production of biodiesel. Fig.1 shows the lipid% of both the samples. High lipid was present in algal oil extracted from *Chaetomorpha antennina* with Chlorofrom-ethanol solvent system (10.8%), than *Chaetomorpha antennina* with chloroform-methanol system (8.9%) and *Gracilaria corticata* with hexane-ether solvent system has more lipid content (8%) than *Gracilaria corticata* with benzene solvent system (4.2%). Hence the yield of biodiesel was more in *Chaetomorpha antennina* with Chlorofrom-ethanol solvent system and less in *Gracilaria corticata* with benzene solvent system. After extracting biodiesel, the weight of biomass was more in *Gracilaria corticata* with benzene solvent system (11gm) and less was found in *Chaetomorpha antennina* with Chlorofrom-methanol solvent system (9.67gm) (Table.1).

Table.1 Analysis of Macroalgae

S. No	Name of the Sample	Dry weight (gm)	Solvents used	Weight of Biomass (wet weight)	Diesel (ml)
1	*Chaetomorpha antennina*	10	Chloroform-Methanol	9.67	2.1
2	*Chaetomorpha antennina*	10	Chloroform-Ethanol	10.11	2.4
3	*Gracilaria corticata*	10	Benzene	11	1.8
4	*Gracilaria corticata*	10	Hexane-Ether	10.9	2

Fatty acid components of the algal biodiesel were detected by GC-MS for *Chaetomorpha antennina* with chloroform-ethanol 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 [22]. Fig.3 shows the sum of the area% of methyl and ethyl ester formation in biodiesel.

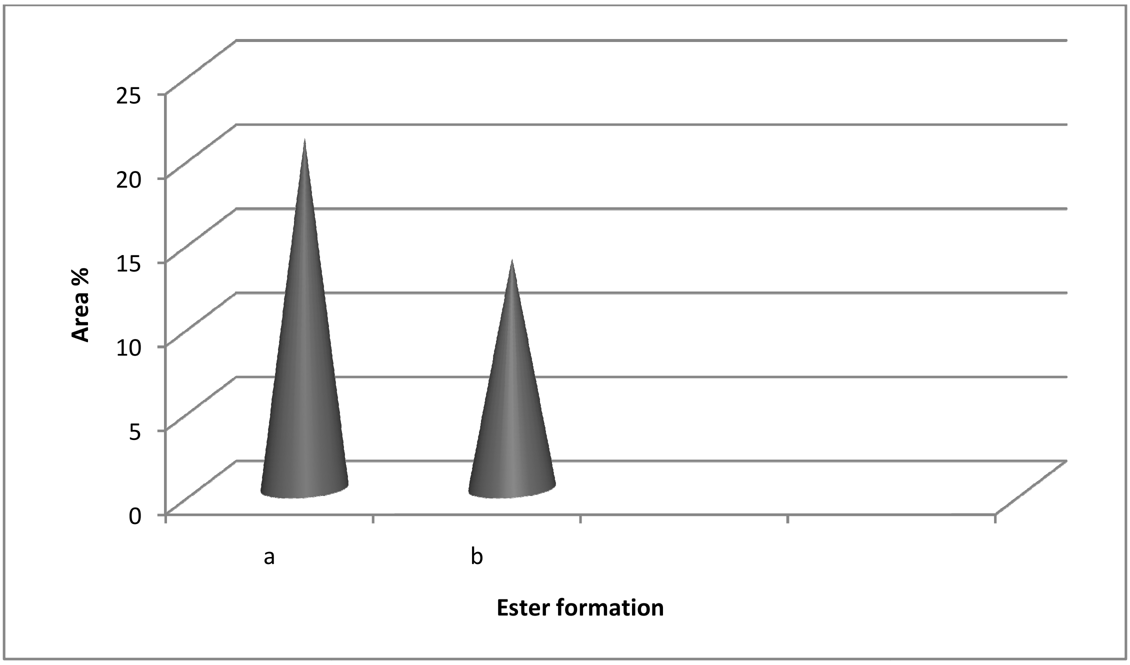


Fig.3 Analysis of ester formation in biodiesel (a- Methyl ester, b- Ethyl ester).

CONCLUSION

Macroalgae are the best source of renewable biodiesel that is capable of meeting global crisis for fuel. Like plants, macroalgae synthesize oil using sunlight but their hydrocarbon content is more 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.

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