

POTENTIAL OF GREEN ENERGY GENERATION OF RIVER KHARKAI AT JAMSHEDPUR, JHARKHAND

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Abstract- Algal biomass is considered as best option for clean and green energy due to its fastest growth, sink for pollutants. This study deals with biofuel production from the algal biomass collected from River Kharkai at Jamshedpur, Jharkhand processed under laboratory. *Chlorella vulgaris*, *Chlamydomonas reinhardtii*, *Botryococcus braunii*, *Scenedesmus* sp., *Microcystis aeruginosa*, *Nitzschia* sp., *Cladophora* sp., *Porphyridium cruentum*, *Zygnema* sp., *Spirogyra* sp., *Synechococcus* sp are the major algal species recorded during study period that have biofuel generation capacity. An amount of 0.865 g dry wt m⁻² algal biomass collected from the site. Soxhlet extraction method having chloroform: methanol (2:1) was used for Lipid extraction. 21.87% of lipid was extracted from collected algal biomass. Extracted lipids were further hydrolyzed for release of fermentable sugar by trans-esterification and single step acid hydrolysis process. These fermentable sugars converted into an amount of 56.76% bioethanol which shows the green energy potential of River Kharkai.

Keywords: Algal Biomass, Green Energy, Bioethanol, River Kharkai.

1. INTRODUCTION

Sustainable world are stepping towards the production of green energy sources because fossil fuels creating load of CO₂ and harmful gases in atmosphere and these non renewable energy resources going to be exhaust in future [1]. Biomass is the answer for clean environment and energy sustainability [2]. One of most prominent biomass source which catches the attention of researcher throughout world is Algal biofuel because algal biomass supplied about 25% of global energy requirement [3]. Algal biomass has potential to produce a wide range of value-added products like biofuel, biofertilizer, bioactive compounds [2]. Algae have several advantages over other green sources like enormous biodiversity, fast growth rate, ability to grow in wastewater or wasteland, and act as sink for air pollutants [4-5]. All these advantages make the algal biomass an economically viable and an eligible candidate for the sustainable production of biofuel and green energy. Algae can form dense floating mats on water surfaces that make it suitable for cost-efficient biomass harvesting. Therefore, present study conducted to study the potential of green energy generated by algal biomass collected from River Kharkai, an tributary of Subarnarekha River, Jharkhand. This study has three specific objectives:

- Water quality of River Kharkai
- Extraction of lipids from harvested algal biomass.
- Conversion of the lipid extracted algal biomass into Bioethanol via fermentable sugars

2. MATERIALS AND METHODS

Water samples and algal biomass were collected from River Kharkai near Adityapur Bridge, Jamshedpur, Jharkhand (Latitude 22.7892°N; Longitude 86.1742° E) from November- February 2020 during winter season when the growth is high as water is less turbulent. Standard Method followed for collection and testing [6-7]. Lipid extraction of algal biomass was done using Bligh and Dyer method [8] commonly called soxhlet method. Transesterification of extracted lipids into fatty acid methyl esters (FAMES) done by methanolic sulphuric acid method [9]. Single step hydrolysis method used for acid hydrolysis. Acid hydrolysis product was used for sugar analysis by using fermentation process carried out for 7 days at 32°C with pH 5. The fermented Product used for determination of Bioethanol concentration by using potassium dichromate method [10].

3. RESULT AND DISCUSSION

3.1 Water Quality and Algal Biomass

Changes in water quality of aquatic ecosystems have a substantial impact on the species that live within them. Seasonal variations in these parameters have an important role in the distribution and composition of freshwater biota [7] [11]. Water quality of River Kharkai was reported in Table 3.1. Dissolved oxygen decides ecological health of a fluvial ecosystem and protects aquatic life [7]. Dissolved oxygen was found 7.81 mg.L⁻¹ and pH was observed 7.62 during study period. Alkaline water promotes high primary productivity [7]. Chlorophyceae has been recorded as the most dominant group in River Kharkai (Fig.1) followed by Bacillariophyceae and Cyanophyceae. Chlorophyceae is one of best algal group for biofuel production [12]. *Chlorella vulgaris*, *Chlamydomonas reinhardtii*, *Botryococcus braunii*, *Scenedesmus* sp., *Microcystis aeruginosa*, *Nitzschia* sp., *Cladophora* sp., *Porphyridium cruentum*, *Zygnema* sp., *Spirogyra* sp., *Synechococcus* sp are the some major algal species were found during study period that have biofuel generation capacity. The oil content potential of these algal species was given in Table 3.2. An amount of total 0.865 g dry wt m⁻² of algal biomass harvested from River Kharkai for estimation of green energy potential.

Table-3.1 Water quality of River Kharkai

Parameters	(Mean ± SD)
Water Temperature (°C)	14.58 ± 1.75
Transparency (m)	0.16±0.12
Conductivity (mS.cm ⁻¹)	0.56±0.03
Turbidity (NTU)	40.52±23.12
pH	7.62±0.14
Dissolved Oxygen (mg.L ⁻¹)	7.81±1.12
Alkalinity (mg.L ⁻¹)	60.23±8.05
Chlorides (mg.L ⁻¹)	13.47±1.56
Nitrates (mg.L ⁻¹)	0.10±0.06
Phosphates (mg.L ⁻¹)	0.06±0.04

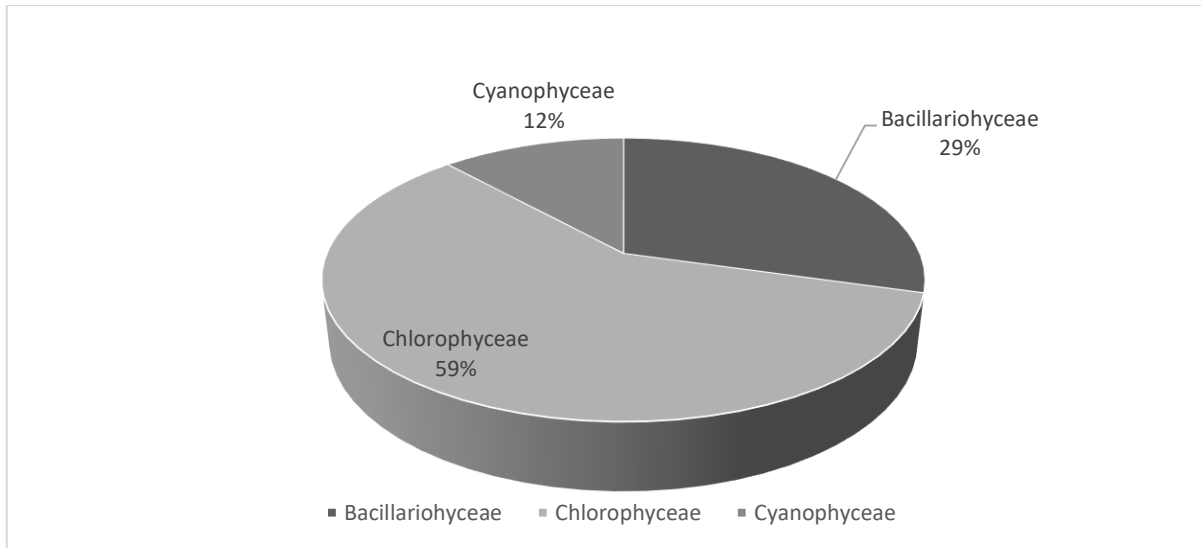


Fig. 3.1 Algal diversity of River Kharkai

Table-3.2 Oil content of harvested Algal species on dry weight basis

Algal species	Oil content (% dry weight)	Reference
<i>Chlorella vulgaris</i>	28–32	[13]
<i>Chlamydomonas reinhardtii</i>	21	[14]
<i>Botryococcus braunii</i>	29-75	[13]
<i>Scenedesmus sp.</i>	45	[13]
<i>Microcystis aeruginosa</i>	30	[15]
<i>Nitzschia sp.</i>	45–47	[13]
<i>Cladophora sp.</i>	3.5	[14]
<i>Porphyridium cruentum</i>	9-14	[14]
<i>Zygnema sp.</i>	8.3	[15]
<i>Spirogyra sp.</i>	11-21	[13]
<i>Synechococcus sp.</i>	11	[14]

3.2 Fatty acid methyl esters (FAMES), Lipids, Sugar and Ethanol Production

Triglyceride (extracted lipids) was converted into Fatty acid methyl esters (Fig.3.2). An amount of total 21.87 % of lipid was obtained from the collected algal biomass. The FAMES were analyzed using gas chromatography-mass spectroscopy (GC-MS) (Fig. 3) showed that major fatty acids that was obtained were saturated fatty acid (C16:0, C16:1, C18:0, C18:1, C18:2 and C18:3). Saturated Fatty acids (C16:1; C18:1 and C18:2) are considered to have major agent for algal biofuel production [13] [16]. 90% of biofuel produced from C16 – C18 Fatty acid groups [17]. Major compositions of fatty acid methyl esters were given in Table 3.3.

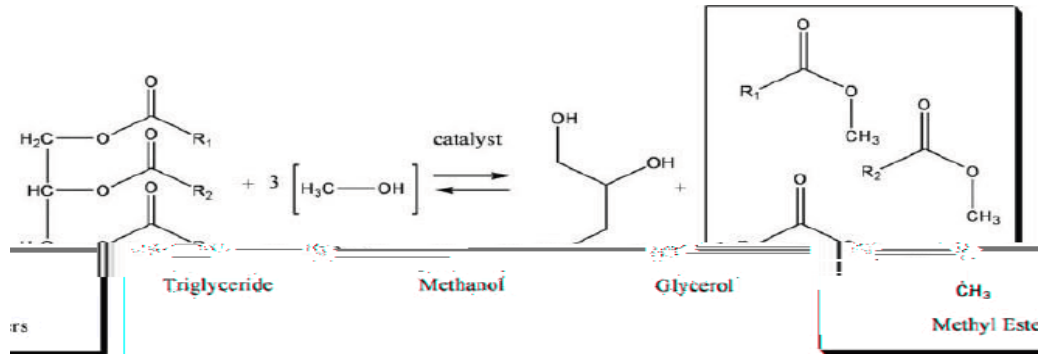


Fig. 3.2 Trans-esterification Process

Table-3.1 Major Fatty acid composition obtained during transesterification

Fatty Acid Methyl Ester	Form	Mass%
Palmitic acid methyl ester	C16:0	8
Palmitoleic acid methyl ester	C16:1	20
Stearic acid methyl ester	C18:0	5
Oleic acid methyl ester	C18:1	30
Linoleic acid methyl ester	C18:2	15
Linolenic acid methyl ester	C18:3	10
Total Esters		88 %

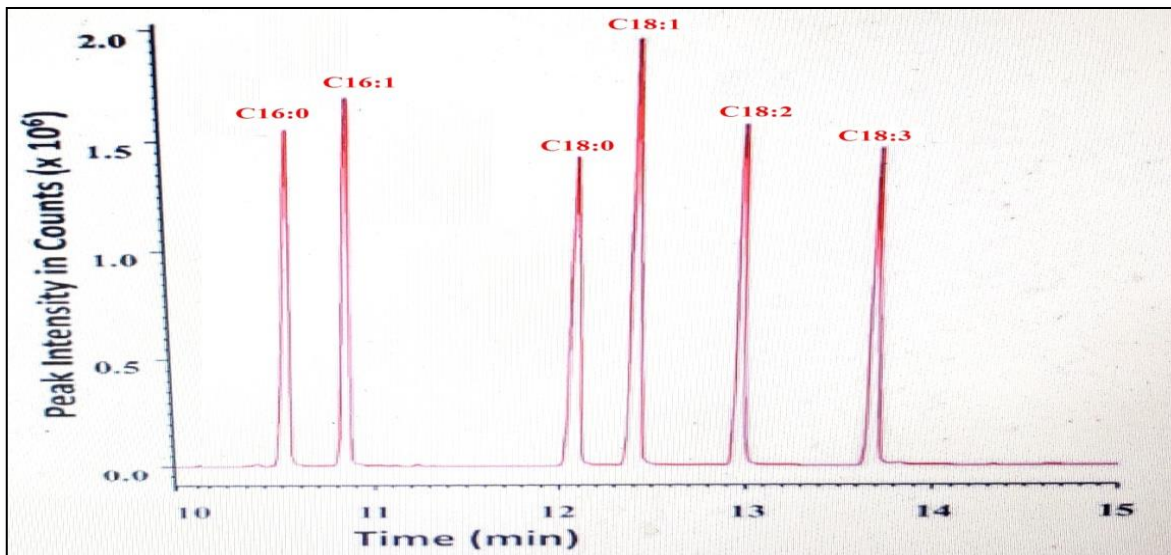


Fig. 3.3 GC-MS analysis of Fatty Acid Methyl Esters (FAMES)

3.3 Fermentable sugar and Bioethanol

Single step hydrolysis method used for acid hydrolysis for the release of fermentable sugar. One-step acid hydrolysis method provides best results as compared to two-step approach for different biomass [18]. H₂SO₄ and HCl used for single step acid hydrolysis process. H₂SO₄ and HCl are powerful agents involve in hydrolysis of cellulose [19]. An amount of 38.5 % sugar obtained from acid hydrolysis of extracted lipids obtained from dry algal biomass collected during study period. Sugar further utilized under fermentation process to produce bioethanol. Hence, total yield of bioethanol was recorded 56.75 % from total collected algal biomass

CONCLUSION

This paper deals with the concept of green energy generation from algal biomass to promote environmental sustainability. The total 56.75% of bioethanol was recorded from the harvested 0.865 g dry wt m⁻² algal biomass. Algal biomass can play an important role in solving the problem between renewable and non-renewable energy sources in the near future. Algae also serve as better feedstock for many bioactive compounds. Algae considered as boon for River Kharkai because they act as sink for pollutants and treat the wastewater. Alkaline nature of water promotes algal growth. This study revealed that River Kharkai has immense potential of green energy generation and provides a base line data for future study.

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