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Experimentation in procuring and characterizing Biofuel Obtained from Micro Algae from Sewage Treatment Plant and Municipal Waste

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Abstract : Concerns over energy shortage and environmental influence have led to improvements in renewable energy sources. Microalgae are potential energy carriers. Their biomass productivity is 5 – 30 times higher than other biomass. Algae exploit various nutrients present in wastewater such as local municipal wastes, diary, food processing industry, textile industry, pharmaceutical industry which are opulent in nutrients namely, nitrogen and phosphorus, and produce energy rich biomass. Additionally, they utilize CO_2 for photosynthesis and thereby contribute to CO_2 redressal. This work represents a review of the availability of wastewaters as per different sectors. The quantity of nutrients within the easy reach of micro algae for their growth is reviewed for different sources. In the end, the economy generation from this process of, treating waste water and production of biofuel, is computed.
Keywords : Alternate Fuels, Microalgae, Renewable Energy, Wastewater, Algal biomass.

1. Introduction

Demand for energy continues to rise as the world population increases, for the economically upcoming nations. Relying on fossil fuels for long term is not a viable option because of its limited availability and environmental concerns [1]. An immediate best alternative for fossil fuels are renewable energies because they are eco-friendly compared to fossil fuels. Biodiesel and Bioethanol are commercially available renewable fuels. Microalgae can be said as a new generation biofuel as they do not compete with food and feed crops and can be cultured in seawater, brackish water, and in wastewater. Microalgae can be considered as better alternative for fuel production due to its photosynthetic efficiency, growth rate, area - specific yield and higher tolerance level of CO_2. Various processes involved are strain selection, cultivation, harvesting, dewatering, and conversion to fuel [2]. Integrating algae cultivation with wastewater treatment will be of mutual benefit for both algae cultivation and wastewater management. Also, it is economically beneficial and eco-friendly. The nutrients necessary for algae cultivation can be obtained from wastewater and wastewater can be treated naturally without any chemicals. The biofuel produced and treated waste water is unhazardous to the nature [3]. In addition, significantly it reduces the burden on the people involved in managing these processes. For example, nitrogen and phosphorous, which are the main nutrients for algal cultivation, present is the different wastewaters can be used for algae cultivation, which in turn gives natural remedy for water treatment and decreases the capital involved in treating the wastewater.

2. Importance of Algae and Categorizing Waste Water

Microalgae can be said as a new generation biofuel as they do not compete with food and feed crops and can be cultured in seawater, brackish water, and in wastewater. Microalgae can be considered as better alternative for fuel production due to its photosynthetic efficiency, growth rate, area - specific yield and higher tolerance level of CO_2. Various processes involved are strain selection, cultivation, harvesting, dewatering, and conversion to fuel.

Demand for energy continues to rise as the world population increases, for the economically upcoming nations. Relying on fossil fuels for long term is not a viable option because of its limited availability and environmental concerns [4]. An immediate best alternative for fossil fuels are renewable energies because they are eco-friendly compared to fossil fuels.Biodiesel and Bioethanol are commercially available renewable fuels.

Integrating algae cultivation with wastewater treatment will be of mutual benefit for both algae cultivation and wastewater management. Also, it is economically beneficial and eco-friendly. The nutrients necessary for algae cultivation can be obtained from wastewater and wastewater can be treated naturally without any chemicals [5]. The biofuel produced and treated wastewater is unhazardous to the nature. In addition, significantly it reduces the burden on the people involved in managing these processes. For example, nitrogen and phosphorous, which are the main nutrients for algal cultivation, present is the different wastewaters can be used for algae cultivation, which in turn gives natural remedy for water treatment and decreases the capital involved in treating the wastewater [6]. An alga requires supply of inorganic nutrients, sufficient light and advantageous temperatures for its growth. Inorganic nutrients include nitrogen, phosphorous and carbon. The water also renders hydrogen and oxygen. They also require many other elements like silica, calcium, magnesium, sodium, potassium, iron, manganese, zinc, copper and cobalt in trace amounts (collectively referred as micronutrients). Nutritional need differs from species to species [7].

Table 1: Categorization of Waste Water

Types	Constituents
• Domestic • Institutions • Industrial • Septic tank • Wash water • Discarded water	• Microbes like Pathogenic bacteria, virus and worms eggs. • Biodegradable materials. • Other organic materials like, Detergents, pesticides, fat, oil and grease, colouring, solvents, phenols, cyanide. • Nutrients like nitrogen, phosphorus, ammonium. • Metals like Hg, Pb, Cd, Cr, Cu, Ni. • Other inorganic materials. • Odour (and taste).

3. Methodology

Raw dairy wastewater was collected from the cattle shed. The DWW is filtered initially using cotton filter. The second level filtering is done using what-man filter paper of 11micron pore size, to obtain cultivation grade dairy waste water. The purpose of filtering is to obtain dust and particles free nutrient rich solution for cultivation. The obtained Municipal waste was autoclaved at 121 ˚C and 1 atm pressure. Autoclave is done to kill the bacteria’s present in the sample, which may hinder the growth of the algae.

Fig 1. Sample of STP water & Municipal Water

Sample Preparation: A measured quantity of 1000ml MSW is taken in a conical flask. 40ml of mother culture algae named chlorella vulgaris is added to the MSW sample.

Fig 2. Sample Prepared with Algae

4. Cultivation, Growth and Extraction

The sample is kept under outdoor condition and no artificial light was provided. The sample was aerated using aquarium pump for 10 hours every day to supply CO_2.

1. UV spectrophotometer is used to know the growth of the algae and the curve is plotted as per the readings obtained.
2. As the biomass / algae concentration increases in the culture medium, more amount of light is absorbed.
3. Nutrition is the factor which determines the growth rate. If the nutrition is readily available to algae, more will be the growth in short duration.
4. In the below graph it is observed that Dairy waste water has more nutrition concentration as compared to the STP plant.

Algal Extraction

1. Aluminium potassium sulphate also known as potash alum is added to the culture.
2. This separates algal biomass from the water.
3. Water is removed using pipette.
4. The water is further removed from the biomass through centrifuge.
5. The wet biomass is extracted and dried in the oven.
6. Finally, the weight of the biomass is calculated.

a. 1 litre Dairy waste water yielded 1.970gms of Algae in 30days.

b. 1 litre STP water yielded 0.516gms of Algae in 30days.

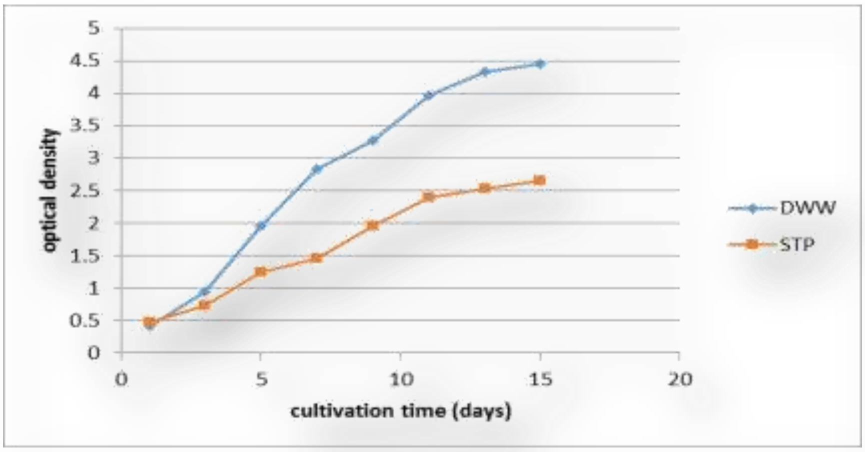

Fig 3. MSW waste water has more nutrition concentration as compared to the STP water

Lipid Extraction

Lipid was extracted using Folch extraction method.

1. The biomass (0.25mg) is dissolved and homogenised with 5ml chloroform/methanol (2/1) and swirled for 30 seconds.
2. The whole mixture is agitated for 15 to 20 minutes at room temperature.
3. The homogenate is then centrifuged to separate the cell debris from the liquid phase.
4. Solvent has been washed by 0.9 % NaCl solution and is centrifuged at around 3000 rpm for 5 minutes to achieve the separation of two phases.
5. Lower layer with chloroform and lipid is collected in a 20 ml glass vial and dried at 65°C and the lipid content is calculated gravimetrically.

MSW

Dry weight of test tube in grams	14.144
Weight of test tube with oil in grams	14.306
Weight of oil produced in grams	14.306 – 14.144 = 0.162 g = 162 mg

STP

Dry weight of test tube in grams	16.027
Weight of test tube with oil in grams	16.076
Weight of oil produced in grams	16.027 – 16.076 = 0.049 g = 49 mg

5. Observations& Calculation

Gas Chromatograph

Table 2: Content Table

Sl. No.	Fatty acid methyl ester	Carbon No	Molecular weight	% wt.
1	Methyl Deconate	C_{10}	186.297	0.1663
2	Methyl Myristate	C_{14}	242.405	0.3945
3	Methyl palmitate	C_{16}	270.459	29.776
4	Methyl Stearate	C_{18}	298.513	4.7909
5	Methyl oleate	$C_{18.1}$	296.513	27.957
6	Methyl linoleate	$C_{18.2}$	280.486	30.13
7	Methyl linolenate	$C_{18.3}$	292.513	4.936

6. Results

Saponification Value

Saponification value indicates average molecular weight of the triacylglycerol’s in the sample.Saponification value is inversely related to the average molecular weight of the fatty acids in the oil fractions. High saponification values are due to high proportion of shorter carbon chain lengths of the fatty acids.The smaller the saponification values the longer the average fatty acid chain.

SV = 560 x [0.1663/186.297 + 0.3945/242.405 + 29.776/270.459 + 4.7909/298.513 + 27.957/296.513 + 30.13/280.486 + 4.936/292.513]

= 194.457

Iodine Value

The iodine value gives the degree of unsaturation. High iodine value indicates high unsaturation and oils with low-IV are more saturated with fewer double-bonds.

IV = 254 x [(27.957 x 1/296.513) + (30.13 x 2/280.486) + (4.936 x 3/292.513)]

= 91.377

Comparison

Properties	**SV**	**IV**	**Heating Value (MJ/Kg)**
Chlorella Vulgaris	194.457	91.376	33597
JatrophaCurcus	195.09	100.29	39628

7. Conclusion

Microalgae are a congregation of microorganisms.Microalgae are a potential sustainable energy resource. They have been explored for the generation of various biofuels including biodiesel, bio-oil, bio-syngas, and bio-hydrogen. Microalgal biofuel generation is conceivably practical.The experimental study suggestedmicroalgae as an agency for wastewater treatment and also for the production of oil. Few essentials factors pertaining to algal biomass growth and productivity were highly variable according to the medium of culture, CO_2 availability and exposure to sunlight. Microalgal cultivating can be combined with flue gas CO_2 relief and wastewater treatment. Microalgae can create a huge assortment of novel bio-products with wide applications in drug, sustenance, and corrective businesses. The growth rate of algae is high in the dairy wastewater than the STP water since there is greater availability of nutrients like nitrogen and phosphorous.Consolidating microalgal cultivating and the generation of biofuels utilizing biorefinery methodology is relied upon to significantly improve the general cost-viability of the biofuel from microalgae approach.

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