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Third Generation Biofuel Production -A Need of the Hour

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Abstract: When we hear the word energy for any machine to work, the first thing that strikes the mind is fuel. It is a crucial element because it produces energy whenever it is burned, making the machine function. Bio-Fuel is a kind of fluid derived from various natural resources such as trees, agricultural waste, etc. Bio-Fuels can be produced from anything that has a colossal of carbon present in it, and it can be replenished immediately. Bio-fuels are now being used vastly around the globe because of its significant advantage that it doesn't produce any toxic chemicals such as carbon monoxides and sulfur. Biofuel's primary usage can be seen in the automobile sector as they blend with the current fuels and decarbonize them, which controls the toxic emissions. Algae is considered to be a non-flowering plant which is found floating on the water. Recently algae have become a center of attraction for the production of biofuel because they are rich in lipids and carbohydrates in their cells, which can help in the production of biofuels. This paper aims at understanding and production of the third-generation biofuel that is through algae by trans-esterification.

Index Terms— algae, biofuel, lipids, trans-esterification

INTRODUCTION

Due to the immense application of fuel, people have forgotten that fuel is only the necessary evil. Even though the fuel is considered to be a necessity, there are numerous drawbacks of using fuel. Fuel, when burnt, leads to the emission of carbon, which is the single highest constituent of Global Warming in the environment. In modern times, due to the growth of industries around the globe, there has been a significant increase in the use of fuels. Since fuel is a natural substance, it is available only in a limited amount and is a Non-renewable energy source. With the current use of 11 Billion tons of Fossil Fuel around the globe, It is believed that the oil deposits can be deserted in the next 53 years. Currently, it is impossible to find an alternative for Fossil fuels because it is a challenge to find something that could produce such a high calorific value and is environment friendly. There have been many studies that involve the use and production of Biofuels. This paper targets at providing an insight into how Bio-fuels can be made from Algae. The use of microalgae can be convenient as an alternative feedstock for next-generation biofuels because certain species of cyanobacteria, chlorella, and Dunaliella contain high amounts of fats and oil. These oils could be extracted, processed, and refined into transportation fuels using currently available technology. Microalgae are the most efficient biological producer of oil due to many reasons which include greater photosynthetic efficiency, greater biomass productivities, a faster growth rate than higher plants (which is also vital in screening step), higher CO2 fixation and O2 production growing in a liquid medium which can be handled easily.

Microalgae can be cultivated in variable climates and non-arable land along with marginal areas inadequate for the agricultural view (e.g., Desert and seashore lands), in non-potable water or even as a wastewater purpose and do not displace food crop cultures, their production is not seasonal and can be harvested daily. The biodiesel produced from microalgae is about 20 fold higher than the yield obtained from the oleaginous plant. Oleaginous plants such as rapeseed, soybean, and sunflower and palm from which oil is produced through a chemical trans-esterification process. It is likewise possible to make biofuel from waste cooking oil through trans-esterification and blended with commercial diesel. The process is economically viable, and biodiesel produced can be fully utilizable without giving a waste as an end product. This did the researches to focus on microalgae for biodiesel production. The properties of microalgae such as density, viscosity, acid value, and almost all physical as well as fuel properties are comparable to those of fuel diesel. The highest growth rate and fatty acid-rich biomass yielding property in less expensive growth conditions of cyanobacteria made the blue-green algae advantageous over the green algae for the production of biodiesel. The characteristic comparison of various industrial wastewater reported that the dairy industry is

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the best suitable source for microalgae cultivation and biodiesel synthesis as it has abundant organic constituents and fats. The integrated cyanobacterial growth with the attached algal culture system in dairy wastewater can reduce the cost of cultivation significantly, as well as it can remove the nutrients from wastewater. The wastewater from the dairy industry is a potentially useful source for microalgae cultivation and biodiesel production by comparing the characteristic features of these industrial wastewaters for BOD, COD, pH, TSS, TDS, organic and inorganic constituents and toxic compounds like chemicals and heavy metals. Therefore, in this paper, we propose an interesting integrated framework, where microalgae can be developed using wastewater from the dairy industry that can help in synthesizing much desired sustainable alternative fuel and in treating the wastewater as well. Algal treatment ponds have the potential to reduce nitrogen and phosphorus nutrients through assimilation into algal biomass, followed by biomass harvesting. Later the oil/fats from microalgae can be trans-esterified to biodiesel using both conventional and novel methods.

REVIEW OF LITERATURE

Lipids or fatty acids are the critical primary components of algal nutritional value [1]. Lipids are storage products with high nutritional value, synthesis, and accumulation by algae is a principal source of energy for invertebrates. Certain strains of microalgae were able to produce up to 60% of their total cellular mass as lipid [2]. Oil content in microalgae can exceed 80% by weight of dry biomass [3]. While the percentages varied with the type of algae, there were algal types that comprised of up to 40% of their overall mass by fatty acids [4]. Many researchers reported about the environmental conditions' influence on the lipid accumulation in algae. The ability of algae to survive or propagate over a wide range of environmental conditions, to a great extent, reflected in the considerable diversity and sometimes unusual pattern of cellular lipids as well as the ability to customize lipid metabolism precisely in response to changes in environmental conditions [5]. Various algal species have been found to grow briskly and produce a substantial amount of triacylglycerol (TAG) or oil; it had long been postulated that algae could be employed as cell factories to produce oils, other lipids for biofuels and other biomaterials [6] [7]; Some microalgae have high oil content and can be induced to produce higher concentrations of lipid e.g., Low nitrogen media, $Fe3+$ concentration, and light intensity. Over the last few decades, it was noticed that many algae and cyanobacterial species, when screened, showed lipid in high content, of which several hundred oleaginous species have been isolated and characterized under laboratory or outdoor culture conditions.

ALGAL BIOFUELS

Algal biofuel Algae can be used to generate energy in several ways. One of the most efficient ways is through the utilization of the algal oils to produce biodiesel. Some algae can produce hydrogen gas under specialized growth conditions. The biomass from alga can also be burned, similar to wood, to generate heat and electricity. Compared with terrestrial crops, which take an entire season to grow and contain a maximum of about 5% dry weight of oil, microalgae multiply and contain high oil content [8]. These oils are very inexpensive compared to edible oils, yet still, alleviate the problems encountered when animal fats or waste oils are used [9] [10]. Renewable energy from biomass is one of the most efficient and effective options among the various other alternative sources of energy currently available. Microalgae have several useful characteristics which enable them to be used in a variety of ways. The high lipid, carbohydrate, and protein contents of many algal species have driven research in a broad spectrum of uses. These vary from food products to biofuels, to use for phycoremediation. The exponential growth of algae under ideal nutrient loads has led to the idea of algae as a phycoremediation tool [11]. Micro algal lipid content can be increased by cells under stress conditions, nutrient starvation, and changing the light and temperature conditions [12]. Several studies affirm that more oil can be obtained from microalgae compared with oilseeds. Enhanced lipid content of algae was reported under nutrient deficiency nitrogen or silicon deficiency [2].

OBJECTIVES

1. To isolate algae Micro and Macro – ASN III, BG11, Himedia-M342.
2. To purify algae – removing contaminants (Dust particles, protozoans, bacteria)
3. To do mass multiplication of algae

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4. To concentrate algal biomass for lipid content – Total lipid extraction 5. To produce biodiesel – Trans-esterification

LIST OF EXPERIMENTS PERFORMED TO SATISFY OBJECTIVES:

1. Inoculation of algae in ASN III, BG11, and M342 broth
2. Isolation of algae by spread plate method
3. Purification by streak plate method (Microalgae), 70% ethanol wash (Macroalgae)
4. Mass multiplication with proper aeration: Parameters pH 7.1, Light intensity 3500 flux, photoperiod 12:12
5. Total lipid extraction
6. Trans-esterification: the presence of NaOH.

PROCEDURE

The micro and macroalgae samples were collected from a lake inside my college and paddy field. Then the sample collected was isolated to separate micro and macroalgae. The samples of fresh and saltwater were obtained from three different commercial sources several. All the samples received were contaminated with microorganisms (i.e., bacteria, fungi, protists) and macro-organisms such as small worms. The algal strains were decontaminated using both solid and liquid media. The microalgae were purified by plating methods and subculturing.

The macroalgae were purified by ethanol wash and separating fresh filaments under sterile conditions. The decontaminated algal strains were then successfully proliferated in batches of roughly 100Litres having densities of 1.4 - 1.9 x 108 cell/mL. Several techniques, such as filtration, centrifugation, flocculation, and freeze-drying, which are generally used for harvesting and drying, were evaluated to dewater the algae cultures effectively. The macroalgae filaments were collected and homogenized with 2:1 methanol chloroform. Total lipid was extracted by treating the homogeneous mixture with 10% NaCl, and the desired lipid content has been collected as supernatant. The lipid was then treated with methanol/NaOH to produce biodiesel.

RESULT

After performing the experiment, it was that with for every 1 liter of densely high algae grown, around 1gm of dry algae could be harvested out of it. After harvesting, the algal oil could be separated from the dry algae using soxhlet extraction with hexane. It was that roughly 0.3 gm of algal oil was recovered from 1 gm of dry algae. In the end, biodiesel was obtained after the transesterification of algal oil with methanol using sodium hydroxide as a catalyst.

CONCLUSSION

After understanding that Bio-Fuel is the need of the hour because of its various advantages such as renewable, reduce carbon emissions, and many more. Biofuel having three generations where the first one is formed by sugar, starch, etc. using conventional methods. The second generation is produced from non-food crops such as stalk of wheat, corn while the third generation biofuel is made out of algae. There is now an immediate need to increase the study and the application of Biofuels as it is rightly said that we have not inherited this earth from our forefathers but borrowed it from the future generation. Therefore it is our responsibility to minimize the use of fossil fuels and gradually shift to biofuels.

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