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Review Article

Biodiesel: A Most Feasible Option Produced from Microalgae over Petro-Diesel

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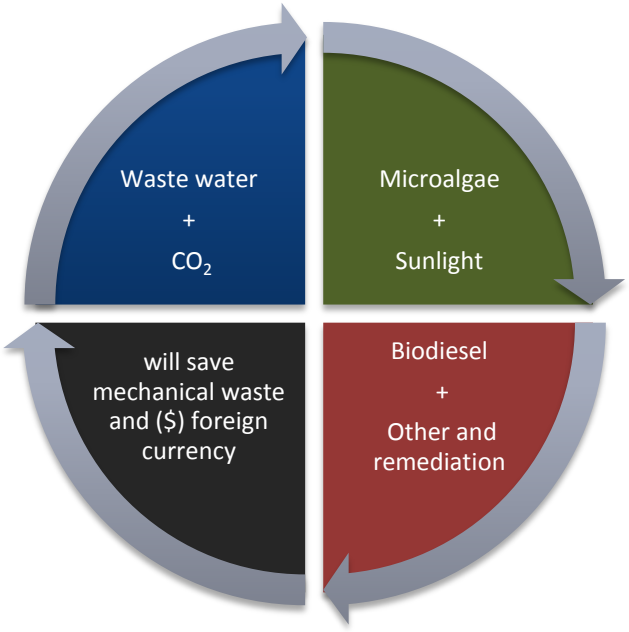
Abstract
Due to continuous use of present source (fossil fuel) mainly cause the pollution to the environment and also negative effect on availability of the oil reservoirs necessitates developing renewable fuels to replace petroleum-based fuels. Investigation of feasibility of biodiesel produced from microalgae. One of the main challenges in algal oil is the poor quality that is efficiency of the biodiesel, which is mainly, depends upon the fatty acid in algal-oil. Algal biodiesel having property for efficiency, which is produced from biomass of microalgae to produce lipids, which is key factor for production of biodiesel in large amounts and within short periods of time with zero net carbon dioxide (CO_2) emission.
Indeed, Algal biodiesel can be considered as a potential source of renewable energy with no limitation like hydro or nuclear power relies on their sources.
Keywords: *Microalgae, biodiesel, bioremediation, clearer and renewable hydrocarbon fuel, fatty acids.*

Graphical Abstract



Introduction

Contribution of by-products of fossil fuels combustion like carbon dioxide, is recognised internationally a major cause[1,3] to change incessantly our global climate and yet now consumption of fossil fuel is predicted to grow incessantly[2,4]. This explains why although improvements in the recovery of traditional fossil fuels, more attention needs to be paid to the search for clean and viable alternative renewable energy resources like biodiesel with the prospect of minimizing increases in atmospheric CO_2 by recycling carbon from the atmosphere[5-7].

There are several sources and methods by which the current requirement & / or future requirement of our energy, specifically fuel for transport system can be fulfilled[8].

On the basis of clean or green energy the top source is the electricity generated by hydro-power plant, not nuclear power plant because it has its own, number of consequences and various precautions to take although, we all know that, for hydroelectricity the need of continuous water[9] and also the water amount for it must be maintained and for current uses hydroelectricity unbaled to fulfil it, so it is very tedious task but if so, hydroelectricity is generated in enough amount then there is no need of think elsewhere and if we consider that they can produce such amount of energy than there is also a problem, problem of continuous supply of water for daily need of fuels plus, water has already a lot of responsibility of daily home uses and industries[10] also, so water must be regulated in that area too, and moreover that we need to make very big structure like dam to generate the electricity which also to be utilised by industries and home purposes and all this works are done by clean water customarily[11].

Therefore water and human both are doing their best work in today's scenario and utilises most of the part of it.

Now remaining part of hydro energy is the waste water and its management, where on the one hand it is a biggest rising problem and has no use and, on the other hand it causes the different problems like diseases in regular intervals of seasons[12].

Here if suitable microalgae is used than microalgae does not only clean the waste and polluted water but also by using microalgae in the presence of sunlight and harmful CO_2 from environment but also produces the very raw material for biodiesel [13].

But why to use the biodiesel instead of liquid hydrogen (H_2) which is more clean fuel and beneficial to the environment, because

- Waste water (in running condition)
- Produced water is not daily useable
- A common man has to spend again in their vehicles and government too somehow.
- There must be need to change the engine
- Installing of its (H_2) fuel canters costly too.
- And existing machines and vehicles based on petrochemicals are useless to everyone and government too [8,10,14].

Hence all these conditions are favourable for the recommendation of biodiesel production but production of biodiesel itself is very challenging task at commercial level.

Biodiesel is currently produced from vegetable oils[15]. Estimates suggest that less than 6% of the food land of the USA can provide all its transport fuel needs if devoted to algal culture. Fortunately, oil crops cannot sustainably provide sufficient biodiesel to displace conventional transport fuels furthermore creates problem of land for food which force us to choose either food or fuel. The facility of the economic fuel is, in the demand list of everyone but first we need food, not fuel over the food; this also concerns to microalgae indeed[5].

The production of biofuel by using the photosynthetic microalgae is a striking hope since, like plants, they harness light energy to synthesize organic molecules with the help of water and polluted air as carbon source, but their cultivation does not require agricultural terra firma. Moreover, distinct heterotrophic micro-organisms (e.g., *Escherichia coli* or yeast), their growth does not require a crop-derived feedstock such as

sucrose. This cultivation can also include the remediation of waste streams, such as carbon dioxide rich power station exhaust gases and nutrient containing wastewater effluent[16].

Oil or lipid produced by the algae is found in many varieties but, not all of them are suitable for production of biodiesel. Conservatively, the neutral triglycerides are only lipids, used to make biodiesel; however, all algal lipids can be used to make diesel with the help of existing chemistry [17,18].

Microalgae are photosynthetic microorganisms which exist as individual cells or chains of cells [19, 20]. Microalgae live in saline, marine, waste or freshwater environments and convert sunlight, carbon dioxide and water to algal biomass [19,21-24].

There are some advantages which makes microalgae as important source of biofuel, like:

- Can grow rapidly than other plants due to their micro structure.
- Their solar energy conversion efficiency is higher than other terrestrial plants due to their simple structure.
- Oil yield is approximately 30 times more than the terrestrial oil seed plants.
- Can grow on non-arable land.
- Can grow in waste, marine, fresh and saline water.
- Microalgae able to use waste CO_2 sources, thereby, potentially mitigating the release of GHGs (greenhouse gas) into the atmosphere.
- Cultivation consumes less water than land crops.
- Also gives us other valve added product for food and pharmaceutical.
- Microalgae derived biofuel/ biodiesel is clean and renewable energy source [22, 25-30].

Governments of diverse countries including the US, Italy, China, Germany, and India have been funds now a days for biofuel projects. For illustration, the US alone has announced a spur package of US$100 billion to develop clean, alternative, and renewable technologies. Various reports emphasize that, algae derived biofuel can reduce CO_2 emissions by 50% as compared to the petrochemical fuels[31].

For biodiesel production microalgae strain must possesstwo essential key features:

1. High biomass productivity
2. Adaptation to regional climatic conditions

Production of biodiesel

Biodiesel can be define as a concolorous mixture of fatty acid methyl esters (FAMEs), which is formed by processin transesterification of triglycerides with the help of alkyl acceptors likewise methanol in the presence of NaOH, KOH or lipase as a catalyst.

Methanolysis of triglyceride, is an equilibrium reaction in which surfeit amount of methanol added because in this reaction it takes six moles of methanol for each mole of triglyceride [32, 33].

In the current scenario, biodiesel is largely produced through terrestrial plant and in recent times, microalgae are being measured as best feedstock production for biodiesel, because of having non-toxic and exceedingly biodegradable property [34-36].

Production of lipid for biodiesel can be obtained in extensive amounts from ample cultivation of microalgae. As signify, in some reports, the microalgae yield for lipid per hectare is about 58,700 l/ha, which is approximately ten times larger than those from terrestrial crops [21].

The three main components of algal biomass are carbohydrates, proteins, and natural oil or lipid which is stored form of energy by living organisms. Algal biomass contents about 40 percent of a fatty acids, which can be transformed into biodiesel after extraction[1].

The oil produced from each algal species is mixed with a blend of catalysts such as sodium hydroxide and an alcohol such as methanol. This process is called Transesterification[1].

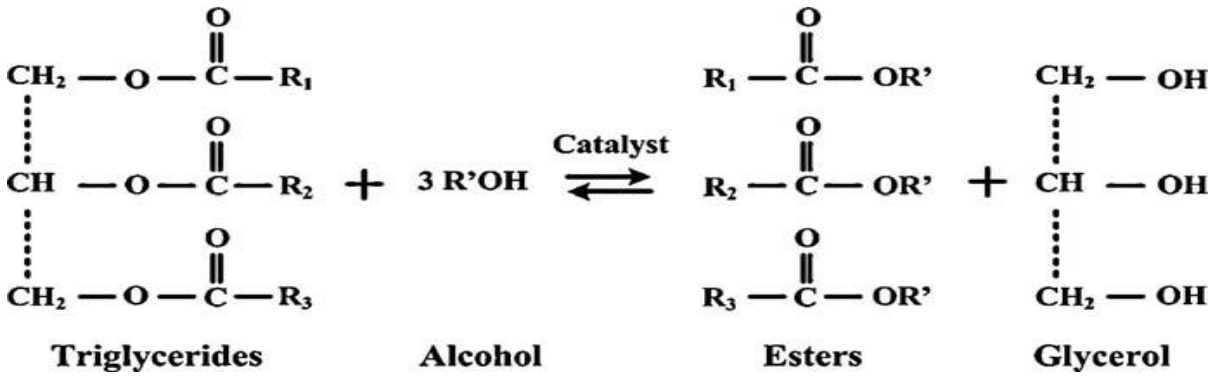


Figure - Transesterification of triglycerides (overall reaction)[37]

The algal biodiesel can be obtained after removing glycerol and other valuable products[1].

Long chain fatty acid (C16 – C20) can be transesterified with short chain alcohols to form fatty acid esters that are well suited to diesel combustion [2].

Conclusion

This review suggest that the current and upcoming future needs of energy can be easily fulfilled with the help of microalgal biodiesel production and suitable algae is much better option instead of the other conventional sources like coal, petrochemicals, hydro-electricity, nuclear excreta or liquid hydrogen either.

With the help of suitable amount of fatty acid in biodiesel it is very easy to replace the petro diesel and there is still hope that more and more amount of fatty acid (C16- C20) unsaturated will be produced or either easy and economically converted to usable fatty acid with regards to biodiesel which also free the public from the pressure of price hike on day today basis and also empower to the national economy and less the dependency on fuel import.

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