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# A Review of Production of Biodiesel from Microalgae

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## ABSTRACT

*In regard with climate change issues and limited availability of fossil fuel there is a need of sustainable fuel for transport. Microalgae is an emerging source of biomass for biodiesel that has the prospective to completely displace the fossil fuel. Algae biofuels have significant benefits like less land intensive, can be grown using wastewater and salt water and they are faster in growth and produce high quality of oil. The paper discusses the review of production of biodiesel from microalgae.*

*Keywords: Biodiesel, microalgae, sustainable development.*



## INTRODUCTION

The need of energy is increasing continuously in India, because of development and human population. The main energy sources are coal, oil, natural gas, nuclear and hydro. India produce 2 M kt of CO2 from burning of fossil fuels, manufacturing cement and consumption of solid, liquid and gas fuels from world bank data. The rapid depletion of fossil fuel resources and increasing prices of crude oil, it is significant to search for an alternative fuel. Due to the similar fuel properties biodiesel is an option to substitute diesel [1].

Biodiesel is a biodegradable fuel obtained from non-renewable sources. At present biodiesel is produced by chemically reacting lipids with an alcohol producing fatty acid esters. The commercial sources of biodiesel production is from soybean, canola oil, animal fat, palm oil, corn oil, waste cooking oil [2].

One of the sustainable energy source emerging is Algal biomass. A large scale introduction of algal biomass could contribute to sustainable development [2]. It is an environment friendly, social and economic source of energy. Microalgae has a huge potential as energy crops because of its photosynthetic and heterotrophic organisms.

It has been calculated that, in order a crop such as soybean or palm to yield enough oil capable of replacing petro-diesel completely, a very large percentage of current land available need to be utilized only for biodiesel crop production, which is quite infeasible [3]. Thus biodiesel from microalgae appears to be feasible solution to India. Algae biomass also produce high yield and quality of oil per acre of cultivation. It has been estimated that less than 2-3 percent of total Indian cropping land is sufficient to produce enough biodiesel to replace all petro diesel currently used in country [2]. Microalgae are capable of all year round production, therefore, oil productivity of microalgae exceeds the yields of the best oilseed crops, e.g. biodiesel yield of 12,000 l ha-1 for microalgae compared with 1190 l ha-1 for rapeseed [4]. The paper discusses the review of biodiesel production process from microalgae.

## PRODUCTION OF MICROALGAL BIOMASS

Algae are recognized as one of the oldest life forms [4]. Under natural conditions phototrophic algae absorb sunlight, and assimilate carbon dioxide

from air and nutrients from aquatic habitats [4]. Artificial production of microalgae is possible to replicate and enhance the optimum natural growth conditions. There are three distinct artificial algae production mechanism:

• Phototrophic production: Currently, it is the only method which is technically and economically feasible for large scale production of algal biomass for biofuels. Two major production systems are open raceway ponds and enclosed photobioreactors

• Heterotrophic production: Successfully used for metabolite production but not feasible for biofuel production

• Mixotrophic production: This production method is under experiments and mostly depend on the cultivation conditions.

**Open Pond Production Systems**

They are typically made of a closed loop, oval shaped recirculation channel shown in Figure 1 [4]. Built with concrete or compacted clay. It is the typical biomass production method. In a continuous production cycle, algae broth and nutrients are introduced in front of the paddlewheel and circulated through the loop to the harvest extraction point [4]. The advantages are low energy inputs and easy to clean and maintain. These ponds are subjected to daily and seasonal changes in temperature, need maximum light exposure and have low levels of mixing, light and CO2 utilization.

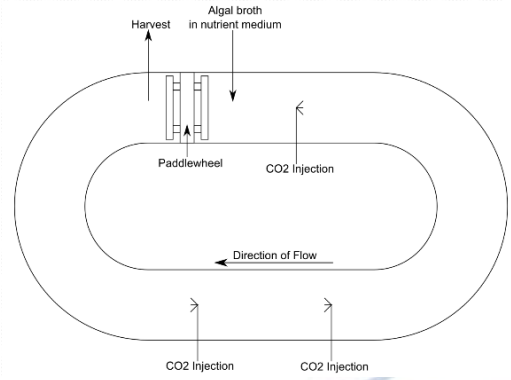


FIGURE1. Open Raceway Pond

**Enclosed Photobioreactors (PBRs)**

These reactors consists of an array of straight glass or plastic tubes. Closed systems include tubular, flat plate or column PBRs, shown in figure 2 [4]. Algae cultures are re-circulated either with a mechanical pump or airlift system. The advantages are less loss of water than ponds, higher surface to volume ratio support higher volumetric cell densities. Some challenges similar to open pond are that it require temperature maintenance, need maximum light exposure and may require periodic cleaning due to biofilm formation.

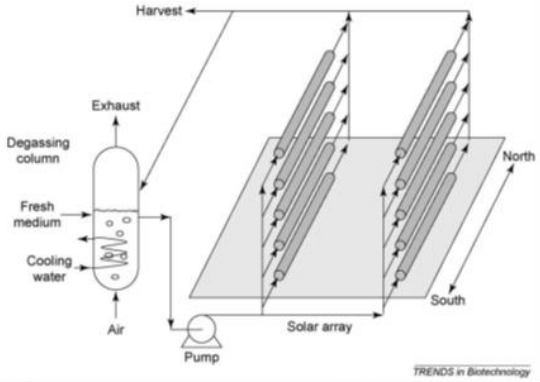


FIGURE2. Photobioreactors

**PROCESS OF BIODIESEL PRODUCTION FROM MICROALGAE**

Figure 3 shows the process involved to produce biodiesel from microalgae [5]. First microalgae is cultivated using the raceway ponds or PBRs. After the microalgae culture is harvested, it is concentrated in a dewatering step. Filtration, centrifugation, pressure dewatering are some of the technologies used for this process [6]. It is then processed in a pre-treatment step to prepare it for lipid extraction by any of these technologies like high-pressure homogenization, bead milling, microwave etc. Lipids are extracted out of the cellular matrices with an extraction solvent during lipid extraction. The methods which are available for the extraction of algal oil are mechanical extraction using hydraulic, enzymatic extraction, chemical extraction through organic solvent, ultrasonic extraction and supercritical extraction using carbon dioxide above its standard temperature and pressure [2]. The lipids are then separated from the cellular debris, extraction solvent and residual water. Finally the lipids are converted to biodiesel in the transesterification step by acid catalyst or alkali catalyst technology.

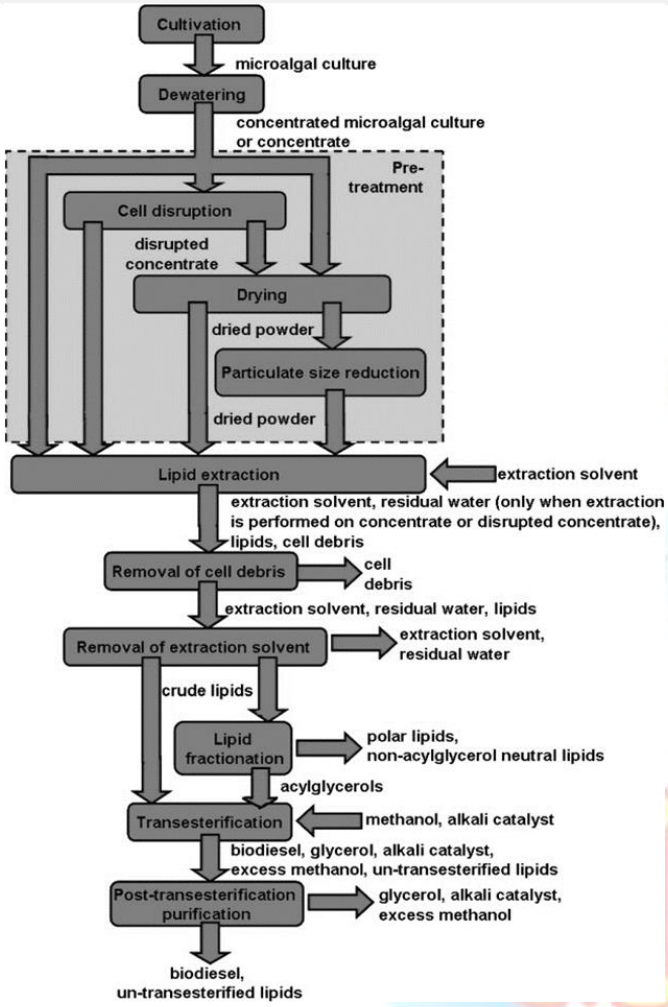


FIGURE3. Downstream processing steps needed to produce biodiesel from microalgae

The current estimates of the cost of microalgae biofuels are very high, which can be reduced if large-scale microalgae production facilities are developed. Biodiesel from microalgae production can be viable, if well-developed growing, harvesting and oil extraction techniques are developed. Apart from biodiesel production, food, fertilizer, pharmaceuticals, antioxidants etc. are number of by-products from microalgae. The paper discussed about microalgae production and extraction of biodiesel from it.

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