

# Microalgal Biofuels: A review

Roshni Meghnani

Department of Chemical Engineering (Environmental Engg.), Raipur Institute of Technology, Raipur, India.

## Abstract

Biofuels in this generation is the most important energy source as it plays a major role in environmental protection and sustainability. Microalgae, considered as a potential source of biofuel because of its high growth rate, consumes less water and is cost effective. Various types of biofuels are produced from microalgae such as biodiesel, bio-oil, bio hydrogen and bioethanol. Cultivation system of microalgae is considered as the major part in the biofuel production. Developments in the microalgal cultivation system can enhance the production and will be cost effective.

**Keywords:** Biofuels, microalgae and cultivation.

## INTRODUCTION

Interests in renewable energy sources is growing because of shortage of fossil fuels, global warming and increasing oil price. Biofuels can be considered as the main energy source which can reduce green house gases in developed and developing nations[1]. Various types of sources such as forestry, aquatic and agricultural sources can produce biodiesel, biogas, bio oil and biohydrogen[2]. Biofuels are referred to as solid, liquid or gaseous fuels derived from organic matter. There are generally two categories of biofuels as primary and secondary biofuels. Primary biofuels are used as such whereas secondary biofuels are produced by various process[3].

This review focuses its attention on microalgae, the oldest living organisms that have their primary photosynthetic pigment and lacks covering of cells[4]. Microalgae are unicellular and multicellular photosynthetic microorganisms that have high growth rate and photosynthetic efficiency. Microalgal biomass productivity can be 50 times more than that of fastest growing terrestrial plant known as switchgrass[5,6]. Microalgae is very advantageous for biofuel production as it has high growth rate, consumes less water, tolerates high CO<sub>2</sub> content and potentially more cost effective.

## Microalgal biofuels

Subsequent studies and research developments lead to increased potential of microalgae to fuel production. Different types of biofuels are produced from microalgae such as biodiesel, bioethanol, bio-oil and biohydrogen.

## Biodiesel

Biodiesel can be produced by transesterification process, in which triglycerides reacts with an alcohol with the catalysis of alkali, acids or enzymes[7,8].

## Bio-oil

Processing of biomass at high temperature in the absence of oxygen forms products in three phases as vapour, liquid and solid phase. The liquid phase is a complex mixture known as bio-oil. Bio-oil composition depends on feedstock and the process used[9].

## Production of biodiesel from microalgae

Biomass of microalgae contains three main components as protein, carbohydrate and lipids. The biomass composition of various algae is shown in the table given below:

Table 1. Biomass composition of microalgae based on dry matter [10, 11]

Strain	Protein	Carbohydrate	Lipid
<i>Anabeana cylindrica</i>	43-56	25-30	4-7
<i>Botryococcus Braunii</i>	40	2	33
<i>Chlamydomonas</i>	48	17	21
<i>Chlorella pyrenoidosa</i>	57	26	2
<i>Chlorella vulgaris</i>	41-58	12-17	10-22
<i>Euglena gracilis</i>	39-61	14-18	14-20
<i>Prymnesium parvum</i>	28-45	25-33	22-39
<i>Scenedesmus dimorphus</i>	8-18	21-52	16-40
<i>Spirogyra</i> sp.	6-20	33-64	11-21
<i>Spirulina platensis</i>	42-63	8-14	4-11

Biofuels production from microalgae consists of microalgal cultivation where algae is cultivated, cells are separated from the growth medium and finally lipid is extracted for biodiesel production by transesterification process.

## Cultivation system

Many methods for microalgae cultivation are available as different types of environment are there in different places. Microalgae can be grown in open and closed pond system.

## Open pond system

Microalgae can be grown in open ponds such as lakes, lagoons, ponds. This system is easy to construct and operate. But this system has poor light utilization, requires large land area and evaporative losses. In this open pond system, microalgae cannot be grown under control conditions. This system depends on regional climate conditions and contamination by predators and heterotrophs not allow to use for commercial scale[12].

### Closed pond system

Microalgae can be grown in closed pond system under controlled conditions such as light utilization, less area required and percentage of carbon dioxide. Photobioreactors is a type of closed pond system, used for algae cultivation as it reduces contamination risk, controls temperature and there is no carbon dioxide losses. One disadvantage of this system is that it is difficult to construct, operate and costly. Various different designs of photobioreactors are flat plate and tubular photobioreactors[13].

### Harvesting Method

Various methods can be used for harvesting microalgal biomass such as filtration, flocculation, centrifugation, ultrafiltration etc.

### Extraction

After drying and cell disruption of biomass, lipid can be extracted by expeller oil press, solvent extraction and ultrasound techniques[14].

### Biodiesel production

Extracted microalgae oil can be converted into biodiesel by a process known as transesterification. The transesterification reaction transforms triglycerides into fatty acid alkyl esters in the presence of alcohol and a catalyst with glycerol as a byproduct[15].

### CONCLUSION

Microalgae are a great renewable source of energy. It has a potential to produce biofuels and has rapid growth rate, consumes less water, reduces carbon dioxide, reduces pollution, finally protects the environment. Development in cultivation system and various other process may lead to enhance production and cost effectiveness.

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