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The study on biodiesel production from Algae sources - An overview

G. Anbarasu*, A. T. NavinPrasad

Department of Mechanical Engineering, Sri Ramakrishna Engineering College, India.

Corresponding author: *G. Anbarasu, Department of Mechanical Engineering, Sri Ramakrishna Engineering College, India.

Abstract

In this world, biodiesel is one of the renewable resources of energy which will helps to reduce the dependence on the limited economy resources. At present, research work is going towards biodiesel to replace petroleum diesel. Biodiesel can be used either directly or blended with diesel fuel to reduce the dependence fossil fuels and environmental degradation. The alternative fuels like biodiesel is considered as a best substitute fuel for internal combustion engines. This paper reviews the biodiesel production from algae, cultivation, harvesting, and processing of algae. For production of microalgae biofuels Dairy farm wastewaters are potential resources. The main aim of this study was conducted to produce algae from dairy farm treated wastewater and algal biodiesel production. Algal fuel is an alternative to fossil fuel that uses algae from natural deposits. Micro algal lipids are the oils of the future for sustainable biodiesel production.

Keywords: Microalgae**,** Harvesting, Algal oil, Transesterification, Biodiesel, Properties

Introduction

Biodieselis an alternative fuel from various resources of energy such as vegetable oils, animal fats and algae which could be edible or non-edible. Production of biodiesel from renewable energy is being increasingly understood that biofuels from first generation, which is produced from food crops and mostly oil seeds are limited. Due to this concern, second generation non-food feedstock's leads to interest in developing biofuels from microalgae, which has greatest potential opportunities in the future. This paper reviews the current status of biodiesel production from microalgae, including their cultivation, harvesting, and processing of microalgae. In this paper biodiesel production from microalgae species are compared with other available biodiesel feedstock's. The design of microalgae production units is described, which gives an overview of the development of algae, potential applications and products from microalgae.

The bio fuel production from renewable sources should be environmental and economic sustainability. Due to rapid growth rate, greenhouse gas fixation ability (net zero emission balance) and high production capacity of lipids (fat) of microalgae, it is considered as an ideal third generation biofuel feedstock. It can be grown on non-arable land and saline water and does not compete with food crops. The biofuels classification is shown in Fig. 1.

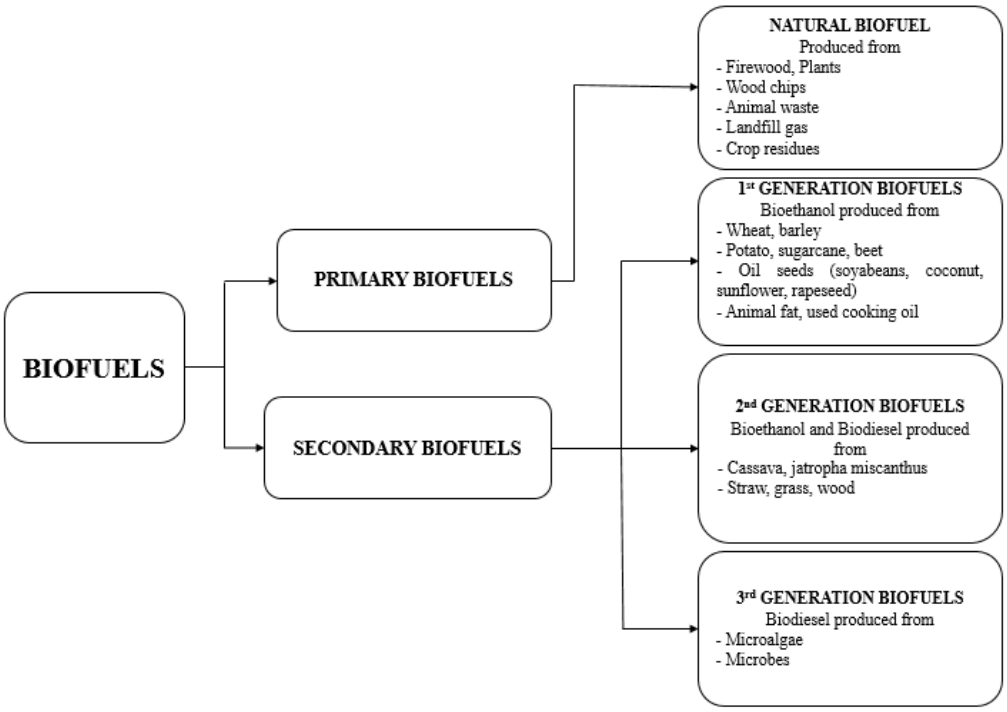

Figure 1: Biofuel production sources [2].

The first generation biofuels contain notable economic, environmental and political concern and it requires more arable agricultural lands resulting in reduced lands for human and animal food production for the massproduction of biofuel. The responsible for environmental degradation is due to production of first generation biofuels. Researchers considered first generation biofuels are not viable and they focused on second generation biofuels. Later on research, second generation biofuels result that is not use for commercial due to its high expensive and not profitable. Then the researchers focused on third generation biofuels. The microalgae are the main component of third generation biofuels. It is considered as alternative renewable energy resource for biofuel production which overcomes the disadvantages of first and second generation biofuels. Microalgae can produce different types of renewable biofuels which includes methane, biodiesel and bio-hydrogen. The microalgae can produce 15 to 300 times more biodiesel than traditional crop on area basis. The microalgae harvesting cycle of is very short and growth rate is very high. For microalgae biomass production there is no need high quality agricultural land.

Different species of microalgae

Microalgae are naturally found in fresh water and marine environment and it is a single-cell microscopic organisms. In this world, microalgae are more than 300,000 species. Comparing to higher plants, microalgae are more efficient converters of solar energy. The cells of microalgae can grow in aqueous suspension and they have more efficient access to water, CO_2, and other nutrients.

Biomass production of microalgal

Microalgal biomass production is more expensive than growing crops. Microalgae growth by photosynthetic requires light, CO_2, water and inorganic salts. For most microalgae growth, the temperature generally ranges between 20°C to 30°C.

From available sunlight, despite daily and seasonal variations in natural light intensities will reduce the cost of biofuel production.

Table 1: Oil contents of microalgae [2,8].

S. no	Name of microalgae	(% dry wt)
1.	Botryococcusbraunii	25–75
2.	Chlorella sp.	28–32
3.	Crypthecodiniumcohnii	20
4.	Cylindrotheca sp.	16–37
5.	Dunaliellaprimolecta	23
6.	Isochrysis sp.	25–33
7.	Monallanthussalina	20
8.	Nannochloris sp.	20–35
9.	Nannochloropsis sp.	31–68
10.	Neochlorisoleoabundans	35–54
11.	Nitzschia sp.	45–47
12.	Phaeodactylumtricornutum	20–30
13.	Schizochytrium sp.	50–77
14.	Tetraselmissueica	15–23

In various aquatic environments, microalgae are grown such as fresh and marine water, municipal waste waters, industrial waste waters and animal waste waters because it contains some amounts of carbon may be organic or inorganic, N such as urea, ammonium or nitrate, and P and also other trace elements. For growing marine microalgae, commercial nitrate and phosphate fertilizers and a few other micronutrients are commonly supplemented with sea water and used. Comparing waste waters with fresh and marine waters, its chemical and physical properties are unique. Using wastewaters, it has high capability for mass production of algal biomass for biofuel and other applications. Based on cultivation of algae from wastewater it has to face many uncertainties and challenges such as variation of wastewater composition due to source, infrastructure, weather conditions, and pre-treatment methods, improper nutrient ratios, high turbidity, etc.

Microalgae can be cultivated in different ways. The two widely used cultivation systems are

a) Suspended cultures, including open ponds and closed reactors, and

b) Immobilized cultures, including matrix immobilized systems and biofilms.

For large scale production systems of algae, high rate algal ponds or raceway ponds are the most commonly used, because they are open and shallow with paddle wheel to provide circulation of the algae and nutrients. Raceway ponds are relatively difficult to operate and inexpensive to build, but for various reasons it will often suffer low productivity. For large scale production of algae, tubular photo bioreactors are used, which is the only type of closed systems.

The sub-classification of photoreactor system:

a) Vertical photo reactor,

b) Flat or horizontal photo reactor, and

c) Helical photo reactor.

The helical photoreactor is considered the easiest to scale up production. For better pH and temperature control, better protection against culture contamination, better mixing, less evaporative loss and higher cell densities, tubular photo bioreactors are commonly used. On comparing tubular photo bioreactors with open ponds, tubular photo bioreactors are much better, but each system has relative advantages and disadvantages.

Harvesting methods for algae

For harvesting algae various methods were used such as chemical based, mechanical based,biological based and electrical based operations. The algae cell size is very small and hence pre-treatment chemical flocculation isperformed to increase the particle size of algae before using flotation method to harvest the algae. In mechanical

based process for recovering suspended algae, centrifugation process is used which is more reliable and rapid method for harvesting. The negative charge properties of algalcells are used for separating the cells by electrical based method and these cells concentrated by the movement in an electric field.

The microalgae biomass can be converted into energy sources by number of ways which include:

a) Biochemicalconversion,
b) Chemical reaction,
c) Direct combustion, and
d) Thermo chemical conversion.

Process for production of biofuels from microalgae

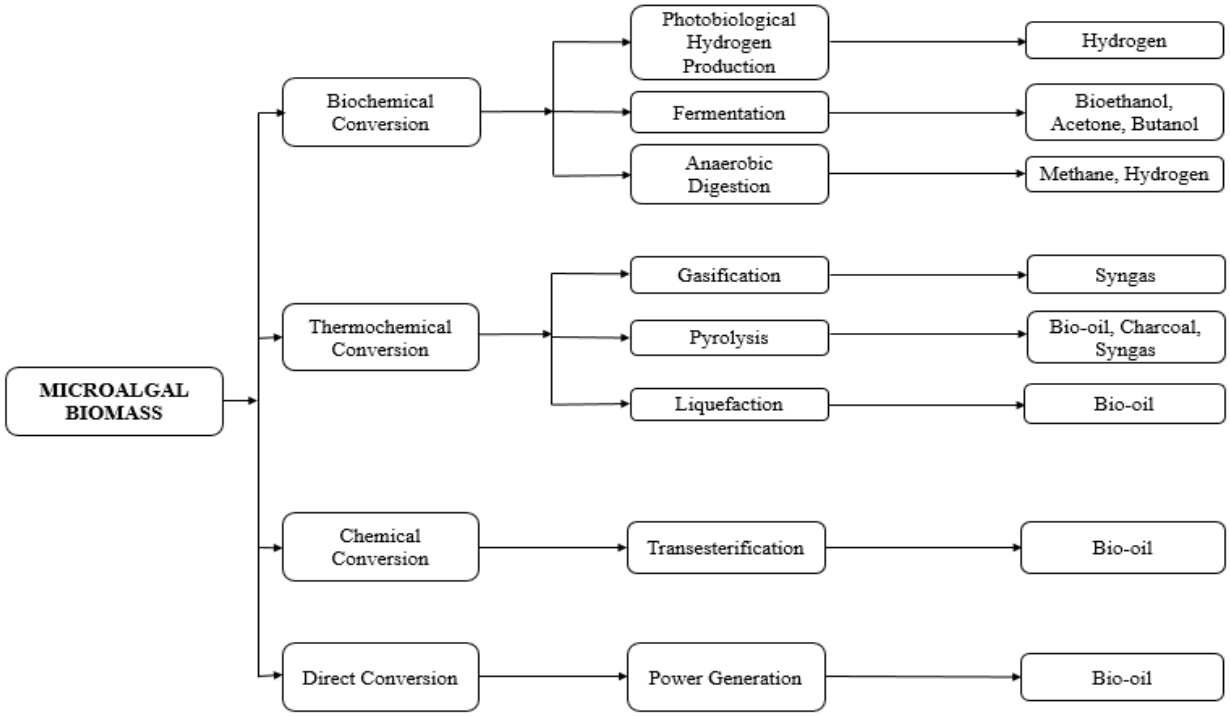

Figure 2: Biofuel production processes from microalgae biomass [2].

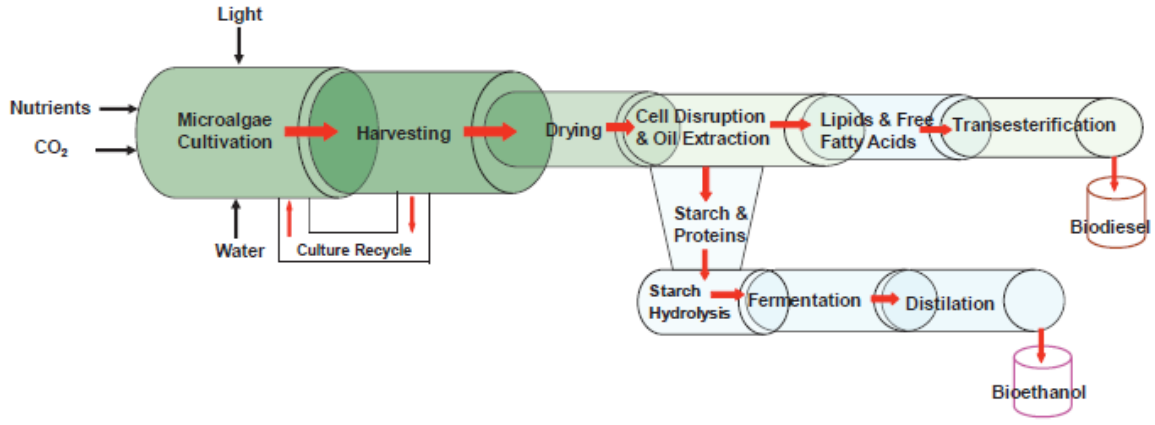

Figure 3: Biodiesel and Bioethanol production processes from microalgae [2].

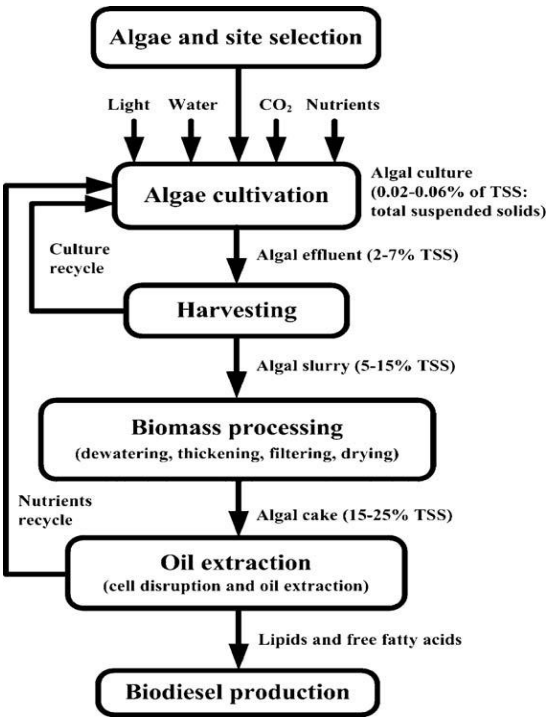

Figure 4: Microalgal biodiesel value chain stages [9].

Fuel properties

Table 2 shows the typical properties of produced biodiesel as compared to diesel. It is essential to study the properties of produced biodiesel for engine use, storage handling and safety.

Conclusion

Biodiesel is a one promising environment-friendly alternative fuel due to renewable energy nature and clean burning characteristics. In this paper, production of algae, biodiesel from algae sources, its properties were discussed. This study indicates that there is a great potential for wastewater-based algal biofuel production. The waste water-based algal biofuel could offer significant benefit in GHG control. Biodiesel production from algae is better, because of its availability and low cost. This study proves that biodiesel can be produced from microalgae and can be used as renewable energy. Many researchers reported that microalgae might better for higher biodiesel production, because of its availability and low cost. Our results prove that biodiesel can be produced from microalgae. This study reported that for higher biodiesel production, microalgae might better. The price of biodiesel from algae will be lower than the price of conventional diesel fuel in the near future due to linear increase in the price of conventional diesel fuel with the increase in its demand and limited supply.

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Table 2: Comparison of fuel properties of Algal Biodiesel to Diesel fuel [3].

S. no	Fuel properties	Unit	Diesel	Algal biodiesel
1.	Density@15°C	kg/m3	848	863.7
2.	Kinematic Viscosity@40°C	cSt	1.3-4.1	12.4
3.	Calorific value	MJ/kg	42.52	45.63
4.	Cetane number	-	40 to 55	70
5.	Flash Point	°C	60 to 80	189

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