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Microalgae-An alternative Source for Fossil Fuel

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SUMMARY

Biofuel is the best alternative renewable source to fossil fuel. Among the first, second and third generation biofuel, third generation biofuel offers several advantages and overcomes the disadvantages of first and second generation biofuel. It produces different types of biofuels like Methane, Biodiesel and Bio-hydrogen. Process of Biodiesel production from microalgae involves several steps like selection, cultivation, harvesting and extraction and purification of microalgal species. Nutrients, light, pH, aeration, temperature, salinity are some of the parameters required for growth of microalgae. Process involved in transforming microalgal biomass in to various energy sources are Bio-chemical conversion, Chemical reaction, Thermochemical conversion and direct combustion.

INTRODUCTION

Continuous use of fossil fuel and its exhaustion, rising crude oil prices, Climate change and environment degradation has forced to find alternate energy source. Biofuel from renewable sources is alternative to fossil fuel (Firoz *et al*., 2015). First generation biofuels are made from sugar, starch and vegetable oil. These are edible and requires arable land for its growth which results in less land availability for human and animal food production. Second generation biofuels are produced from lignocellulosic feed stocks to municipal solid wastes (Lee and Lavoie, 2013). But it requires sophisticated and expensive technologies for biofuel production (Dragone *et al*., 2010, Brennan, and Owende , 2010). Due to the disadvantages from first and second generation it paved way for third generation biofuels, which overcomes the disadvantages of first and second generation biofuels (Nigam and Singh, 2011, Dragone *et al*., 2010, Chisti, 2007, Li *et al*., 2008). Third generation Biofuel i.e microalgae are microscopic single celled micro-organisms, found in fresh and saline water. Its growth rate is very high and harvesting cycle of microalgae is very short (Dragone *et al*., 2010, Schenk *et al*, 2008). It can produce 15 to 300 times more biodiesel than traditional crop on area basis (Dragone *et al*., 2010). It produces different types of biofuels like Methane (Spolaore, 2006), Biodiesel (Gavrilescu and, Chisti, 2005) and Bio-hydrogen (Kapdan and Kargi, 2006). Algae require carbondioxide, water sunlight, nutrients like nitrogen, Phosphorous etc to grow (El-Sheekh, and Abomohra, 2016, Neto *et al*, 2019). It has high Lipid content. It does not compete with agricultural food and feed production (Demirbas, 2007). There is no lignin content and less content of hemicelluloses in algal biomass which results in increased hydrolysis and fermentation efficiency (Saqib *et al*., 2013). It has high photosynthetic conversion efficiency. They have the tendency to adapt in adverse conditions. Microalgae converts carbon dioxide in to glucose and glucose is converted to form triglycerides. They are rich in fatty acids such as Linolenic acid, Linoleic acid, Oleic acid, Palmitic acid etc. Important microalgal Species are *Nanochloropsis, Schizochytrium, Botryococcus braunii, Dunaliella, Spirogyra, Cylindrotheca, Nitzschia sp, Crypthecodinium cohnii, Nannochloris, Isochrysis, Monallanthus salina, Tetraselmis sueica, Chlorella sp, Neochloris deoabundans* etc (Mann, 2018).

History:

Near the end of 19th century dilution techniques, agar plates, using tiny pipettes were developed (Pringsheim, 1912). Observations in the nature has revealed that tiny animals feed on microalgal cells. For feeding studies microalgae were required in larger quantities so culture vessel were used for mass cultivation of microalgae. During the 20th century it was the scientific enquiry which helped for the early development of microalgae culture. In Finfish larval rearing and Shell fish farming the larvae and early post–larval stages feed on microalgae (Korringa, 1976, Sttotrup and McEvoy, 2003). Later Molluscan Shellfish sector with scientific reports laid the ground work for microalgal culture practices in use today (Davis and Guillard, 1958; Ukeles, 1976).

Parameters Required for Growth of Microalgae (FAO Website)

- Nutrients: Nutrients like Nitrate and Phosphate (6:1) and silicate is needed.
- Light: 1000 lux is needed for Erlenmeyer flasks, 5000-10000 lux is required for larger volumes. Light may be natural or supplied artificially by fluroscent tubes. Too high light intensity may result in Photo-inhibition and overheating due to both natural and artificial illumination should be avoided. Red light or Blue light from Fluorescent tubes are the most active portions of light spectrum for photosynthesis. The duration of artificial illumination should be minimum of 18 hours of Light per day, although cultivated Phytoplankton develop normally under constant illumination.
- pH: the pH range for most cultured algal species is between 7.0 and 9.0. With the optimum range being 8.2-8.7. In case of high density algal culture, the addition of Carbon dioxide allows to correct for increased pH.
- Aeration: all the cells of algae must be equally exposed to the light and nutrients to prevent sedimentation of the algae. There should be proper gas exchange between the culture medium and the air. Mixing is done by hand for test tubes, Erlenmeyer aerating (bags, tanks) or using paddle wheels and Jet pumps (Ponds). However it should be noted that not all algal species can tolerate vigourous mixing.
- Temperature: most commonly micro-algae tolerate temperatures between 16℃ and 27℃. In the culture vessel, algal cultures, if necessary can be cooled by a flow of Cold water over the surface of the culture vessel or air temperature can be controlled with refrigerated air.
- Salinity: Optimum salinity level for the microalgal cultures is 20-24 gL^{-1}.

Process of Biodiesel Production from Microalgae

It involves following steps like1) selection of Microalgal species, 2) cultivation of Microalgae 3) Harvesting of Microalgae 4) Biomass collection (filtration and drying of Algal biomass 5) Lipid extraction from Algae 6) Biodiesel production from algal extract (Halim *et al*., 2011, Chen *et al* ., 2012).

Biofuel Production from Microalgae Biomass Conversion:

Process involved in transforming microalgal biomass in to various energy sources are Bio-chemical conversion, Chemical reaction, Thermochemical conversion and Direct combustion. In Bio-chemical conversion the algal biomass is converted in to other energy fuel through photobiological H_2 production, alcoholic fermentation and anaerobic digestion. examples for the product formed from photobiological H_2 production is Hydrogen gas, from alcoholic fermentation is Bioethanol, Acetone and Butanol etc. from Anaerobic digestion is Methane and Hydrogen. Thermochemical process involves Gasification, Pyrolysis and Liquefaction. Product formed from gasification is Syngas from Pyrolysis is Bio-oil, Charcoal, Syngas and from Liquefaction is Bio-oil. Product obtained from chemical conversion is Biodiesel through transesterification reaction. In the Direct combustion, algal biomass is converted in to heat or electricity through burning of algal biomass in presence of air (Neto *et al*., 2019).

CONCLUSION

Biofuel derived from Algal biomass is considered to be the best alternative compared to first and second generation biofuel. Disadvantages of algal biofuel is low biomass production and harvesting of biomass which require high energy inputs (Behera *et al*., 2015). High yielding Algae species, advanced production and harvesting methods, advanced drying and oil extraction process makes good supplement of biofuel to the fossil fuels (Firoz *et al*., 2015).

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