

REVIEW ARTICLE

Fuels from Algae: A Review

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ABSTRACT:

Biofuel is an effective fuel which is non-polluting and biodegradable with less emissions of greenhouse gases. There are many sources for the biofuel production. In recent, algae has ensured to be the suitable sources for biofuel production. This approach may solve many problems that arises from air pollution. Many common species of algae are used in this fuel production. The fuel produced from algae serves as the better alternative for other depleting fossil fuels. The biomass from algae are used to produce algal oil and the biofuel are extracted from the algal oil by several extraction processes.

KEYWORDS: Biofuel, biomass, transesterification, microalgae, fossil fuel.

INTRODUCTION:

In recent days, Bio energy is one of the developing alternatives of fossil fuels. The need for bio energy is to mitigate green house gases and the global economy requires an eco-friendly source for producing energy^[1,2]. As the usage of fossil fuels are rapidly depleting natural resources. Fossil fuels emits oxides of carbon, nitrogen, sulphur which affects the atmosphere and causes other harmful effects to the living organisms. There may be many reasons like rapid industrialisation, increasing population for explosion of our natural resources. So bio energy serves as an alternative to this and leads to the sustainable development in the environment^[3]. The fossil fuels are contributing to global warming, not renewable and unsustainable and there is a scarcity of fossil fuels. These all paved the way for production of biofuels. Biofuels obtained from algae has the aptness to make the concentration of carbon dioxide stable in our atmosphere. The sources for bio energy are renewable and non-toxic. The biomass is of renewable sources so there will be a constant supply of energy^[4].

Biomass can produce heat and electricity. There are several plant sources available for biofuel generation^[5]. Biofuels are derived from vegetable oils or animal fats. Common sources are soyabean, palm, canola, sunflower, rice bran, algal oil. Among them algal oil serves as the better sources^[6] and leads for the production of fuels for transportation^[7]. Algal oil is extracted from both micro and macro algae in simpler methods^[8]. Mainly biodiesel is produced widely among other fuels from algae^[9].

Algae are the fastest growing plants and are the polyphetic group with higher photosynthetic efficiency. Algal species are widely distributed in this environment and has huge economic importance. Algae contributes upto 40% for global carbon fixation^[10]. They can significantly produce valuable products from many waste streams, so the importance of algae is increasing in the research field. In future there will be a huge need for algae and their valuable products^[11]. They has the ability to convert into energy as in the form of fuels and gases^[12]. Algae are of interest in fuel production because they are renewable^[13,14]. As of now there were many advanced techniques have been developed^[15].

IMPORTANCE OF BIOFUELS:

Biofuels are derived renewable biological sources of energy and it plays a major role in the field of transportation^[16]. They are produced by transesterification process. Common types of biofuel are biodiesel, bioethanol, biofuel gasoline, bioethers, biogas, syngas, vegetable oil etc. Among these bioethanol has been a emerging fuel for many purposes. It can be cultivated from both macro and micro algae and even from algal metabolites^[17,18]. There were several ways have been formulated to increase the efficiency of biofuels^[19].

Based on their production process they are divided as first generation and second generation biofuels etc^[11,20].The main need for the production of biofuel is to reduce the levels of particulates that creates air pollution and to sort out the demand of fossil fuels like petroleum, coal and others due to rapid urbanisation, industrialisation and to abate the usage of fossil fuels. There is less energy consumption in the generation of biofuels and low input energy also^[21]. The energy used for converting crops into biofuels is low.

The uses of biofuel includes the following: fuel for vehicles, effective solvents, replacement for gasoline, in the production of electricity, cooking purposes , heating process in the digesters and so on^[22,23,24].

The biofuels has both social and economic benefits as they are easily tradable and has accessible storage facilities^[22].

Converting the agricultural feedstock into biofuel can increase the farm income and leads to rural development^[25].

SOURCES OF ALGAE FOR FUEL PRODUCTION:

The most common macro algae species used in fuel extraction are *oedogonium* and *spirogyra*. The microalgae species used are *Botryococcus braunii*, *Chlorella sp*, *Cryptocodinium cohnii*, *Cylindrotheca sp*, *Dunaliella primolecta*, *Isochrysis sp.*, *Monallanthus salina*.

Among the oil crops micro algae serve as the finest source of fuels, as they are rich in lipid content with higher photosynthetic efficiency and many productions are involved using microalgae^[26,27,28]. Microalgae cultivation may be in open ponds system and distinct photobioreactors are used in closed system^[29]. The production by using photobioreactors is comparatively high than open pond systems^[30]. Some species of Marine algae have also been rendered for the energy production^[31].

The table below gives the oil content of some micro algal species^[32]

Table1:

MICROALGA	OIL CONTENT (%dry weight)
<i>Botryococcus braunii</i>	25-75
<i>Chlorella sp</i>	28-32
<i>Crphtecodinium cohnii</i>	20
<i>Cylindrotheca sp</i>	16-37
<i>Dunaliella primolecta</i>	23
<i>Isochrysis sp</i>	25-33
<i>Monallanthus salina</i>	>20
<i>Nannochloris sp</i>	20-35
<i>Neochloris oleoabundans</i>	35-54
<i>Nitzschia sp.</i>	45-47
<i>Phaeodactylum tricorutum</i>	20-30
<i>Schizochytrium sp</i>	50-77
<i>Tetraselmis sueica</i>	15-23

ADVANTAGES OF ALGAL BIOMASS:

Algae biomass do not produce higher concentration of oxides of sulphur, nitrogen, phosphorous in the atmosphere than fossil fuels^[33]. There is higher biomass productivity is from algae. The algae is being used for biomass cultivation as it is economically feasible than other sources^[34]. The microalgal species absorbs less amount of water than others. Oil productivity is higher when compared to other crops.

Algae has the ability to tolerate high carbon dioxide content^[35]. They can grow in any substrate medium.Wastewater can also be used in the algae cultivation as wastewater treatment can be associated with fuel production from algae^[36,37]. The expenditure of water is less and the lipid content is higher for oil production and cultivation processes are financially feasible^[38,39].

Microalgae in biomass production can helps in conserving other agricultural crops and can reduce carbon sequestration too^[40]. Some of the results says that microalgae gives best production of oil than macroalgae^[41].

The application of genetic engineering in the algae may makes it to have high potential towards producing renewable energy^[42]. The genetic modifications in metabolic pathways can be done in algae to increase the biomass production and oil production because they has the ability to develop strains in a rapid manner^[43,44].

DRAWBACKS:

Among several benefits there is also some disadvantages over the production of biofuel from algae^[45]. Their production needs energy from the fossil fuels.

At certain stages in lifecycle of some species of algae in their production they may releases toxins^[46].The wastes from biomass released after the biofuel production may

contains algal bloom that has higher concentrations of toxins. Some marine microalgae are not suitable for biofuel cultivation since they cause human illness.

There may be some of the limit in light penetration that results in low biomass concentration.

It requires higher cost for commercial implementation and large scale production of biofuels from algae^[47]. However in algal biomass cultivation involves many processes like centrifugation, flocculation, drying etc which is not economically fit for larger scale. The equipments for production process is also expensive^[30,48].

During cultivation of algae there may be a risk of contamination by pathogens like fungi, bacteria etc^[49,50]. There may be a demand for the land areas for the production.

CONCLUSION:

Among the many sources of biofuel algae serves to be the improved one as it is easily available and renewable too. This production should be implemented all over to reduce and control the pollution and exploitation of natural resources. An awareness should be created about the bioenergy to conserve our natural resources.

Algae are technological armamentarium with many purposes within it. Research are carried out to find the exclusive uses of it. In future there is a chance for many perspectives to be arises regarding biofuel productions.

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CONFLICTS OF INTERESTS:

The authors declare that they do not have any Conflicts of Interests.

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