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THE ADVANTAGES OF CULTURING MICROALGAE AS A SOURCE OF BIOFUEL- A CRITICAL REVIEW

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Any fuel that is derived from biomass that is plant or algal material or animal waste is a biofuel. It is considered as renewable energy as it is replenished readily. Biofuel is a contemporary topic of great interest particularly in the present fossil fuel crises. Many critics express concern about the scope of the expansion of certain biofuel because of the economic and environmental cost. Biofuel are liquid, solids, gases obtained from different sources like starch, sugar, wood, soybean, jatropha, algae etc. The use of microalgae can be a suitable alternative feedstock for next generation biofuels as they contain high concentration of oil. Microalgae like *Chlorella vulgaris, Nannochloropsis* sp. etc. are the best oil sources. This study gives awareness on the potential utility of some microalgae as source of biofuel.

Key words: Microalgae, Biofuel, *Chlorella vulgaris*

Fuel is any material capable of releasing energy. A natural fuel such as coal or oil is formed from dead animals or plants in the ground. The age of the organisms and their resulting fossil fuel is typically millions of years and sometimes exceeds 650 million years. Fossils fuels include coal, petroleum, natural gases, oil and heavy oil. Petroleum is the most common fossil fuel derived from ancient fossilized biomass through a variety of endothermic reactions at high temperature and pressure Anonymous (2009). Ironically we still gain most of our energy from non-renewable energy sources commonly known as fossil fuel. Increasing consumption of petrol, diesel and fuel demands alternate sources of energy. Renewable energy resources that naturally replenish offer clean alternatives to fossil fuel by minimum pollution or less green house gas emissions. The national biofuel policy 2009 encourages use of renewable energy resources as alternate fuel to supplement fossil fuel and aims to meet 20% of India's fuel demand with biofuel by the end of 12^{th} five year plan (2017) but biofuel production accounts very less around 1% of the total production (Morais and Costa, 2007).

A biofuel is a fuel that is produced through contemporary biological process such as agriculture and anaerobic digestion rather than a fuel produced by geological processes such as those involved in the formation of fossil fuels, such as coal and petroleum. Due to lower carbon dioxide emission and biodegradable nature, biofuel are less polluting and less toxic compared to fossils. It also ensures energy equity by the sustainable utilization of locally available biomass rather than depending on the imported fossil fuels (Sydney *et al.*, 2010). Another important feature is the sustainable development of rural areas by utilizing degraded land for cultivation of plants that yields biofuel, mostly in areas with adverse agro-climatic condition where other crops cannot be cultivated. Algae are photosynthetic plants that grow in water and produce energy from carbon dioxide and sunlight .Single-celled microalgae can be used to produce biofuel. The goal of microalgae for biofuels is not only to replace fossil in quantity but also for the cost to be at parity with the existing fuel. Biofuels productions from micro algae received wide attention recently and have high potential to replace fossil fuels (Das, 2015).

Due to high photosynthetic efficiency of microalgae mass, activation of microalgae is believed to be able to efficiently reduce CO_2 emissions to atmosphere and thus reducing the impact of global warming (Chisti, 2007). This is because microalgae have high growth rate and is able to develop maximum of 70% of lipid content within their cells depending on species. These algae have the ability to survive under harsh conditions. The harvested microalgae biomass can be used for electrical generation while its crude lipid can be used as transportation fuel as it has 80%average energy content of petroleum (Norsker, 2011 and Nevase, 2012).

Microalgae have a capacity to produce biodiesel, fuel, gas, bio oil, methane, hydrogen and alcohol. The potential of microalgae as a source of renewable energy has received considerable interest, but if microalgae biofuel production is to be economically viable and sustainable, further optimization of mass culture conditions are needed. Waste water derived from municipal, agriculture and industrial activities potentially provide cost effective and sustainable means of algal growth for biofuel. In addition, there is also potential for combining waste water treatment by algae, such as nutrient removal, with biofuel production.

MATERIALS AND METHODS

The present study was carried out to give the awareness on the potential utility of microalgae as a source of biofuel. General data was collected from different institutes like F.R.I, B.S.I. and Petroleum Institute. Views were also taken from secondary data. Microalgae oils may be used for good quality biodiesel if associated with other oils. Lipids extracted from microalgae are considered an alternative raw material for biodiesel production.

RESULTS AND DISCUSSION

Due to lower CO_2 emission and biodegradable nature, biofuel are less polluting and less toxic as compared to fossil fuel. Biofuels demand is unquestionable in order to reduce gaseous emission (fossil CO_2, nitrogen and sulfur oxides) and their purported greenhouse, climatic changes and global warming effects, to face the frequent oil supply crises as a way to help non fossil fuel produces countries to reduce energy dependence contributing to security of supply promoting environmental sustainability and meeting the EU target of at least of 10% biofuel in the transport sector by 2020 is usually produced from oleaginous crops such as rape seed ,soybean, sunflower and palm. However, the use of microalgae can be a suitable alternative feed stock for next generation biofuel because certain species contain high amounts of oil which could be extracted processed and refined into transportation fuel, using currently available technology, they have fast growth rate permit the use of non-arable land non potable water, use far less water and do not displace food crops cultures, their production is not seasonal and they can be harvested daily.

The screening of microalgae like *Chlorella vulgaris, Spirullina maxima, Nannochloropsis* sp., *Neochlorisole abunda, Scenedesmus obliquus* and *Dunaliella* sp. are some marine and fresh water algaeproved to be suitable as raw materials for biofuel production due to their high oil contents 29.0 and 28.7%, respectively. These microalgae when grown under nitrogen shortage, shows a great increase in oil quantity. Biodiesel production from microalgae is of great achievement. Several micro alga species have been studied for CO_2 reduction such as *Scenedesmus obliquus, Chlorella* sp*, Spirulina* sp. (Moriais and Costa, 2007). Some species like *Dunaliella tertiolecta, Botryococcus braunii, Spirulina platensis*, *Nanochloropsis oculata* were studied mainly for their effect on various concentrations of CO_2 on biomass production (Sydney et al., 2010). Microalgae like *Synechococcus sp., Chlorella vulgaris, Chlorococcum parinum* have been reported as potential biodiesel feedstock. Many factors influence the lipid accumulation and cell growth microalgae such as CO_2 concentration, light intensity temperature and nutrition. It has been reported that nitrogen deficiency leads to higher amount of lipid production in micro algal cells. Micro algal bio-fixation of CO_2 in photo reactors is a promising approach for higher biomass and biofuel production. The utilization of photo bioreactors for capturing CO_2 by microalgae offers principal advantages of higher micro algal productivity due to controlled environmental conditions with optimized space or volume utilization hence more efficient use of costly land. Thus, microalgae can serve a dual purpose of mitigating global warming through CO_2 fixation and generating fuel to satisfy the ever increasing energy demand.

Biofuel microalgae appear to be a suitable word wide solution towards the replacement of conventional fuels such as petrol and diesel. Economically also it was found that higher costs has to be increased on the production and down strain processing (Das, 2015). The cost of building a biodiesel depends upon the factors like feedstock, location of the plant, plant capacity, plant design and plant equipment. When biodiesel is produced from soya seeds or rape seeds oil, the cost of biodiesel production increases because the cost of feedstock is the largest expense. Therefore, use of non-edible feedstock like Jatropha oil reduces the cost incurred on feedstock to a considerable amount. The economic analysis of Jatropha biodiesel revealed the cost of production of Jatropha ethyl ester to be 0.40 euro per liter, (Nevase *et al*., 2012), whereas the cost of production of biodiesel from palm oil is 0.57 euro per liter (Chisti, 2007).Although the use of non-edible oil for biodiesel production reduces the cost of production yet, there are major drawbacks which prevents the industry to flourish. A Jatropha plant takes 2-3 years to grow and produce seeds.

Under such circumstances the various advantages of microalgae gives interesting perspective for the future. The potential benefits of microalgae feedstock's for biofuel production are as follows:

1 Microalgae grow rapidly and have high per acre productivity.

2. Using microalgae to produce feed stocks for biofuel production will not compromise with the production of food.

3. Water used to grow microalgae can include waste water and saline water that cannot be used by conventional agriculture or for domestic use.

4. Microalgae have a tremendous technical potential for greenhouse gas abatement through the process of biological carbon capture.

5. Once the CO_2 is trapped with the microalgae there is no need for further removal of the CO_2. The CO_2 converted into lipids and carbohydrates.

6. A micro algal bio refinery could produce an array of co products including oils, proteins and carbohydrates along with biofuel.

Conversions technologies can be integrated for the production of biofuel including biodiesel, green diesel, aviation fuel, methane or green gasoline. Therefore, microalgae have attracted many industries for the commercialization of the biofuel production process. The biomass production costs for three different production systems have been calculated by (Norskeret *et al*., 2011). There are numerous funding program created to promote and assist the use of renewable energy. The sustainable development program (STDC) has applied $500 million to assist the construction of next generation fuels. The U.S. Department of energy's aquatic species program focused only on biodiesel production from microalgae. In India also huge amount of money is given by the government towards the research and development of micro algal biofuels. Reliance industries of India have collaborated with the Algenol, USA and commissioned a pilot plant to produce bio oil in the year 2014. Increasing emission of greenhouse gases and rapid depletion of conventional fuels has made micro algal biofuel a more compelling renewable and clean alternative fuel source.

Microalgae have been shown to be a potential candidate for biological CO_2 capture by many researchers. Some *Chorella* species were fund to be capture 40% of CO_2, based on these studies CO_2 emission could be pumped from industries and power plants at the bottom of microalgae cultivating open ponds. The captured CO_2 by micro algae cells used to produce lipids. The algae lipids can be extracted and converted to biodiesel to be used as transportation fuel. Many researchers have demonstrated that these microalgae biofuel production through captured CO_2 is technically possible but there are currently no biodiesel companies based on this route.

There are major technical challenges which have to be conquered to achieve this goal. Higher capital and operating cost prevent the commercialization of algal biofuel. The downstream process in micro algal biofuel production consumes a huge amount of energy which increases the cost of production. Hence, recovery of a co-product with higher market value becomes an urgent necessity. Finally the cost of micro alga biofuel production can be minimized by capturing with microalgae bio refinery. In the coming decade genetic and metabolic engineering will play a prominent role in the development of micro algal biofuels for future? Therefore, micro algal biofuel has strengths to overcome controversies in form of delivering clean and sustainable fuel to the future world while eliminating global warming.

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