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Biotechnology Makes Algae as a Novel

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Abstract—*Since from the ancient time algaes are intimately connected with a source of food, medicine and other uses. These organisms are earliest inhabitants of planet and these are highly diverse members of the biodiversity plays an important role in bio-geochemical cycles as it sequester a significant quantity of carbon from atmosphere, Industrial flue gases and waste water. Algae has gained importance because of their potential use in various areas. The potentiality is due to different techniques adopted by biotechnology such as pyrolysis, transestrification, Hydrothermal liquefaction etc. Application of algaes in various fields like agriculture , pharmacology, food supplements, Bio-fertilizers, Bio-fuel etc. The energy crisis and the world food crisis have ignited interest in algal culture for making bio-diesel and other fuels. So algal biomass have dual benefit it provides biomass and save environment. Renewable and carbon neutral bio-fuels are necessary for environment and economic sustainability.*

Keywords*: Algal, Biotechnology, Biomass, economic sustainability*

1. INTRODUCTION

Microalgae are most abundant primary unicellular producer found in all the aquatic system such as freshwater, seawater, saline lakes, even in desert ecosystems. (1,2) Their photosynthetic mechanism is similar to land based plants but due to a simple cellular structure and submerged in an aqueous environment where they have efficient to access water carbon dioxide and other nutrients. They are more efficient in converting solar energy into biomass. (4).

The world is undergoing a transition of moving to renewable energy sources which are cleaner and can be easily adopted in rural areas as well as renewable energy sources such as solar photovoltaic , solar thermal, geo-thermal wind etc. However these are generate power but do not produce oil and natural gas which are required for transport, shipping, mining etc. and also provide feed stock for fertilizer, dyes and pharmaceuticals, chemical industries. In fact bioenergy is the only renewable source of energy which can effort liquid as well as gaseous fuels besides power.

Microalgae are energy rich feedstocks which have received so far more attention due to their facial adaptability. To grow in photobioreactor or open ponds for high yields and multiple application. They have inherent advantages some of them are higher productivity in two days, easy adaptability in new environment and highly lipid content. (5)

Microalgae can serve as alternative bio-fuel feedstock due to their rapid growth, green house gas fixation ability. The high lipid production capacity. (5) Moreover, the whole algal biomass or algal extract can be converted into different twelve forms like bio-gas, liquid and gases transportation fuels and hydrogen through the implementation processing technology such as and anaerobic digestion, pyrolysis gasification, transesterfication etc. (9,10) Current anthropogenic activities delivered high demand of green house gases, emission to the atmosphere contributing global warming. Transport and energy sectors are the major source of green house gases emissions, in addition global consumption of coal and natural gases are responsible for about 40% and 20% of total carbon dioxide emission respectively.

Microalgae are considering the fourth alternative to reduce carbondioxide by biological carbondioxide fixation (11) The process is currently achieved through the photosynthesis of all terrestrial plants and tremendous number of photosynthetic microorganisms. (12) However plants are expected to contribute only with a 3-6% reduction of global Co_2 emissions (13). Therefore since years ago, researchers have focused in the evaluation of microalgae. (14) Since they can grow much more faster than terrestrial plants, and their carbon dioxide fixation efficiency compared with higher plants is about 10-50 times higher. (15) Therefore, microalgae cultivation have been proposed to fix Co_2 emitted to power plants.

2. METHODOLOGY

Materials are collected via electronic search using public media, science finder, Google scholar and web of science and library search for articled published in peer reviewed journals.

3. DISCUSSIONS

Bio-mass production: Microalgae are the best choice for recombinant protein productions for production of fine chemicals, pharma products, poultry feeds, feedstocks and the source of future biofuel. Because they have simple and inexpensive growth requirements, rapid growth rates with sufficient light, the high density and large scale cultivation of micro-algae is the preferred way for the development and production of is high value products. This could be achieved by either growing algae in closed photo-bioreactor or open pond system.

Bio-mass harvest

Bio-mass harvest is a kind of technique and it accounts 15-20% of the production cost. The very small size of algae and their low concentration in the culture media makes the cell recovery harder one. The harvesting cannot be done by a single process because of the several species of algae with varying characteristic. Centrifugation, filter process, downstream processing are the most commonly used techniques to harvest micro-algae in a laboratory scale as well as R&D laboratories.

4. TECHNIQUES

Dehydration : The algal mass is dehydrated and then a solvent such as hexane is used to extract energy rich compounds like triglycerides from the dried material. Then, the extracted compounds can be processed into fuel using standard industrial procedures.

Transestrification: Algae lipids react by transesterification to produce biodiesel.Transesterification reaction of triglycerides with an alcohol inpresence of a catalyst produces fatty acid chains (biodiesel) and glycerol [16,18,19]. Methanol, ethanol, propanol, butanol are common alcohols used for transesterification reaction [17]. Limitations in thetransesterification reaction are mainly due to oil impurities, reaction conditions (time and temperature) and catalyst nature (acid, basic,enzymes) [20,21].

Fermentation: Fermentation is used commercially on large scale in various countries to produce ethanol from sugar crops and starch crops. Some microalgae are known to contain a large amount (>50% of the dry weight) of starch,cellulose and glycogen, which are raw materials for ethanol production.Also, the absolute or near absence of lignin makes the enzymatic hydrolysis of algal cellulose very simple [9]. For ethanol production, pretreatment of biomass is needed to release the carbohydrates contained in the cells later,fermentation of this carbohydrates occurs producing ethanol. Finally,separation and purification by distillation is required [25].

Anaerobic metabolism: Biogas or bio-methane is the fuel produced by anaerobic digestion of organic matter. Biogas is mainly formed by methane from 55 to 75% and CO2 from 25 to 45% [24]. Algae have been proposed as feedstock for this type of fuel [9,26]. However, it has also been reported that low biogas formation yields are due to the resistibility of algae cell walls to bacteria degradation and to the low carbon to nitrogen (C/N) ratio microalgal species allowing ammonia formation (inhibitor) [27-28].Anaerobic digestion occurs in four stages: (a) hydrolization of biopolymers to mono-saccharides by hydrolytic bacteria, (b) fermentation of mono-saccharides to carboxylic acids and acids (c) formation of acetate, hydrogen and carbon dioxide by acetogenic bacteria (d) formation of carbon dioxide and methane by methanogenic bacteria[24].

Gasification: Biomass gasification in presence of oxygen, water vapor or air, produces carbon monoxide, hydrogen, methane, water, other

hydrocarbons and ashes, the product is called synthetic gas or syngas.High temperatures are needed for gasification (800 to 1200°C) and

water content in the biomass feedstock should not be higher than 20% [29]. Later, the syngas can be burned in turbines and boilers to produce

electricity, or for the Fischer-Tropsch synthesis (FTS). From this lastreaction wax, nafta, kerosene, diesel and gasoline can be obtained [11].

5. BIOHYDROGEN

Hydrogen is the fuel with the highest energy content per unit weight compared with other fuels (142 KJ/g) [33]. In case of algae, biohydrogen metabolic production occurs by direct (Ec. 1) or indirect photolysis (Ec. 2, Ec. 3) as follows [33,36]:

$2H_2O \rightarrow Light \rightarrow 2H_2 + O_2$ (1)

$12H_2O + 6CO_2 \rightarrow Light + C_6H_{12}O_6 + 6O_2$ (2)

$C_6H_{12}O_6 + 12H_2O \rightarrow 12H_2 + 6CO_2$ (3)

In algae, nitrogenases and hydrogenases enzymes are related to hydrogen production [24]. Both enzymes are oxygen sensitive, therefore cultures conditions should be controlled for hydrogen production [24]. Nitrogen starvation is often used at the end of the growth stage as an efficient metabolic stress to induce the activity of nitrogenase [29]. Also,sulfur deprivation enhances the inactivation of photosynthetic water oxidizing activity, catalyzed by the reaction center of photosystem two (PSII) [24]. In case of direct photolysis absence of oxygen is required,while in indirect photolysis, microalgae first produce hydrates to later produce carbohydrates by dark anaerobic mechanism [29].

Bio-oil: Hydrothermal liquefaction (HTL) process'advantage is that algae biomass does not need to be dry (80% water content) . Process conditions range at temperature from 250 to 360°C with high pressure (10-30 MPa) to maintain the water in the liquid phase . However, bio-oils from HTL are more viscous and have higher oxygen content than petroleum diesel crude oil, therefore, refining steps like hydrodeoxygenation, hydrotreating and hydrocracking, have been proposed . Hydrocracking produces diesel fuel, while catalytic cracking produces gasoline [29]

Pyrolysis: In case of pyrolysis, bio-oil is produced by thermal degradation in absence of oxygen. When particle size range from 5 to 50 mm,temperature is lower than 400°C and residence time is longer than 30 min, it is consider slow pyrolysis. This produces almost same fractions of liquid, char and gas. For small particles (<1 mm) at moderate temperature (500°C), with contact residence time from 10 to 20 s, a fast pyrolysis occurs, producing higher aqueous fraction. Finally, at short residence time (1s) of small particles (<0.2 mm), a flash pyrolysis takes place, producing high aqueous fraction (75%), followed by gas fraction (13%) [35,40]. Carbon monoxide, alkanes, alkenes, phenolformaldehyde resins and carboxylic acids are byproducts of pyrolysis

Bio-Refinary: Dermibas and Dermibas [8] described bio-refinery as a facility that integrates biomass conversion process and equipment to produce fuels, power, and value-added chemicals from biomass with minimal waste and emissions. In addition, food and natural products production are also included in the bio-refinery concept [47,48].

6. CONCLUSION

As far as the algal biomass production has concerned, currently there are lot of projects going on in many countries and they are using these harvested biomass for multitude of applications. Algae also have the scope of growing in municipal sewages (or from effluents) containing heavy metals and unwanted chemicals which are bio-absorbed. This is the best biological method recommended by naturalists and scientiststo protect the environment clean. At the same time, algae capturing atmospheric CO2 as well as contribute to reduce global warming considerably.

Around the world, many research centers and companies are developing technology process and products from these microorganisms.Some advantages from microalga

- Technology based in these microorganisms currently represents an opportunity for GHG reduction from anthropogenic activities.
- Biofuels as biodiesel, bioethanol, bio-oil, bio-hydrogen or biogas can be produced. Decreasing political and economic pressure of some countries.
- Biomass can be produced in areas that cannot support agriculture. Avoiding deforestation and change of land use.
- Wastewater can be used in algae systems as source of nitrogen and phosphorous. Biomass can be further used as fertilizers.
- Species are source of products needed in human nutrition: DHA, EPA, antioxidants, proteins.
- Algae biomass can be used as feedstock for bio-refineries to produce different kinds of products (energy, food, plastics, and fertilizers).

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