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PRODUCTION TECHNIQUE OF BIOFUEL FROM ALGAE PLANTS TO CONTROL THE ENERGY CRISIS - A REVIEW

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ABSTRACT

In the current decade, the energy crisis of fossil fuel is the biggest problem, so because of fossil fuel the world is unsafe. The available resources of fossil fuels in the universe are rapidly decreasing and one day they will vanish, so we need to concentrate on biofuels as a possible replacement for conventional fossil fuel. For biodiesel production we need animals as well as plant resources. The use of crops for food production will never be a suitable source for biofuel production, because it will definitely destroy the demand for food. The biofuel production from algae plants is economical and easy. According to lipid content ability different types of algae are available in nature. Chlorella algae have the highest lipid content. Generally, the lipid content of algae is between 20% and 50%, which can be converted into various types of biofuels, such as biodiesel and kerosene oil. Trans-esterification methodology used for biodiesel production, in this present research article focused on the part of algae biodiesel as a possible alternative to traditional fossil fuels.

Keywords: crisis, algae, biodiesel, trans-esterification, lipid, biofuel, fossil

1 Introduction

The demand for fossil fuels is increasing day by day. Renewable energies require more attention because available resources are quickly depleted and signs will soon disappear. Fossil fuels are used extensively around the world, increasing carbon dioxide and nitrogen dioxide, making the environment unhealthy. To keep the environment clean, we need to produce renewable and environmentally friendly fuels. Therefore, biomass is one of the best energy sources. Microalgae contain more oil and grow faster and easier. Gene technology can be used to increase the oil production and biodiesel content in algae plants. A lot of research has been conducted, but it is necessary to identify suitable species that have good growth and production. . The growth of algae requires a suitable environment, and a large amount of growth requires cultivation and harvesting. More progress needs to be made in the development of genetically modified species to produce the necessary amount of biodiesel in a shorter time and use less energy [1].

Suliman Khan, Reported that algae is the best source of biodiesel production because,

- ❖ Biodiesel from algae does not contain any chemical substances, so it can keep the environment clean when burned.
- ❖ Algae can effectively remove toxic components in water and play a role in wastewater treatment. The algae have high biofuel content and are easily cultivated. Algae cells contain 30% to 50% lipid content [1].

Biodiesel is one of the alternative fuels, which is obtained through the trans-esterification of triglyceride oil and monohydric alcohol. Biodiesel extracted from rapeseed oil and soybean, palm oil, sunflower oil, and seaweed oil has been widely reported as a substitute for diesel fuel. Studying biodiesel production from algae biomass is the way to produce enough fuel to replace conventional gasoline. An alga produces 7 to 13 times more palm oil. Removing oil from algae is very simple. The best algae for biofuel production are the microalgae among other

algae. The purpose of this paper is to critically elucidating various aspects of algae, including biofuel content, algae production, growth, and method-based selection of known algae species and proper trans-esterification. This study was conducted to find the exact trans-esterification process, biodiesel production rate and physical properties of biodiesel. In this study, they compared the amount of biodiesel production using common types of algae species i.e. oedogonium and spirogyra. The production of algae oil and biodiesel from oedogonium was higher in comparison with spirogyra. However, biomass/triglycerides were higher in spirogyra than in spirogyra species. Sediments (mixtures of glycerine and water) were more common in spirogyra than in oedogonium species. There was no difference in pH between Spirogyra and oedogonium species. These results indicate that biodiesel can be produced from these two species, and that oedogonium is a better source than Spirogyra sp. Our research results show that biodiesel can be produced from microalgae. In this they reported that microalgae can be used as renewable energy for better biodiesel production. Objective of this work is to study oil extraction methods as well as production techniques of biodiesel from algae plants [2].

2 Cultivation Method

According to reports, small algae can grow in a variety of conditions, even if they lack the available nutrients. It is better to choose for planting. Sampling devices must be handled carefully to obtain full biofuel content. This process must be followed carefully, as various environmental factors affect growth. There are two main types of cultivation: open method and closed method. An open system is usually a painful process and the algae can grow naturally [1]. Closed systems are preferred because they are easier and allow for easier handling of nutrients [5]. C.U. Ugwa reported that algae can be grown in both open and closed crops, but large-scale open production systems are preferred. The open approach (natural agriculture) is economical because it does not require much energy or manpower. The open method is easily adaptable [6]. Oladabo Martinez discussed the natural cultivation of algae that require sunlight for photosynthesis and the biological processes of growth and reproduction of algae plants to convert sunlight into chemical energy. Absorbed carbon dioxide is converted into chemical energy. Absorbed carbon dioxide is converted into chemical energy such as hydrocarbons and fats. Algae need essential nutrients such as sunlight, carbon dioxide and water to grow. [4]

Table No.1: *Generalized condition for algae cultivation [4]*

Parameter	Range	Option
Temperature(C0)	16-27	18-24
Light Intensity	1000-10,000	2500-5000
Photoperiod	12:12	16:08(m)
pH	7-9	8.0:8.2

Closed Method (Artificial Culture): All restrictions and challenges associated with natural agriculture have been removed. The main disadvantage of these methods is the cost of capital, and artificial agriculture is mainly in

various forms of solar reactors. This method checks all environment parameters. The culture of algae, carbon dioxide and nutrients is essential for the growth of algae entering the photo-reactor.

Table No 2: *Comparison of Natural cultivation Method and Artificial cultivation Method [4]*

Natural Cultivation Method	Artificial cultivation Method
Easy to maintain	Difficult due to the technically involvement
Capital and operating cost is cheap	Expensive to operate
Environmentally controlled	Environmentally controlled
Average biomass production	Very high biomass production

3 Lipid Extraction Methodology

The production of biodiesel from biomass of spirulina algae and its characterization are reported. The dry spirulina powder and biomass come from local suppliers in India. It can grow in both freshwater and saltwater. Spirulina has a fat content of 10 to 25% by weight. The dried spirulina biomass sample after spraying is added to the glass reaction of the trans-esterification unit. The extraction of lipids/fats is the main process for the production of biodiesel from algae biomass [2]. There are two widely used conventional solvent extraction methods, namely the Folch method and the Bligh Dyer method. Folch method uses chloroform-methanol to extract lipids from biomass. This method requires a quarter volume of saline solution to equilibrate the homogenized cells. On the other way Bligh and Dyer method uses chloroform and methanol (Bligh and Dyer, 1959) [3]. Recently, high voltage discharge (HVED) has been applied to cell changes and helps to extract biologically active compounds and lipids from cells (Li et al., 2019). This technology uses voltage charges to destroy the cell structure, thereby releasing cellular compounds In addition; the mechanically assisted extraction method uses mechanical equipment for cell disruption to facilitate the release of the extracted compound into the solution. For example, a homogenizer is a high-speed rotating device, usually up to 35,000 rpm, with higher pressure and heat treatment (Zaaboul et al., 2019).The high speed of the homogenizer can break the cell wall and release the cell components into the solvent. Hydrodynamic cavitation is a mechanical extraction process in which a microalgae culture is continuously delivered to a device to extract oil from the microalgae and disrupt the cell wall. The application of the magnetic pulse of hydraulic cavitation makes the cavitation distribution in the hydraulic cavitation treatment device uniform, and the bubbling is the driving force to produce turbulent liquid. Solid-liquid particles are separated as the collapse of cavitation bubbles in the boundary phase. In algae extraction, the pressure in the cavitation bubble can reach 150,000 psi and a shock wave can be generated until the cavitation bubble collapses (Larach,2012).On the other way, supercritical fluid extraction method is widely used to extract lipids from algae biomass. Liquid carbon dioxide is used as the extraction solvent. Supercritical fluids can be easily removed by compressive pressure and extracts can be obtained from solvents. Therefore, supercritical fluid extraction appears to be a good

candidate for extracting various natural products from biomass. (Prado et al., 2015).Soxhlet extraction method is a simple and effective method for extracting lipid from biomass. It has been used in a wide range of samples such as animal and plant tissues. A variety of solvents can be used, such as dichloromethane (DCM), acetone or hexane, and acetone-hexane mixtures. It is not recommended to use non-polar solvents alone. The minimum time required for a normal soxhlet extraction is usually about 8 hours for 8 cycles.

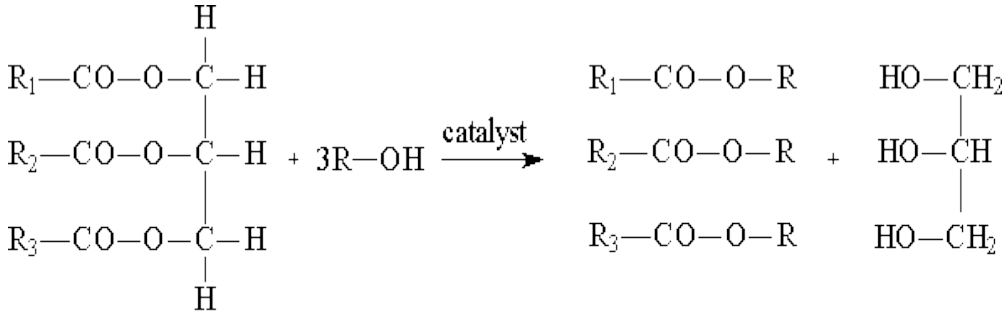
4 Trans-esterification process for biodiesel production using algae biomass

Biodiesel is a renewable type of fuel that is produced from algae by using a trans- esterification process, so in this research biofuel is used (which is prepared from algae plants). It is mixed with diesel fuel as a blend and then is used in engines for combustion. In this study, different types of algae fuel have been prepared based on ASTM 6751-09 standard.

- Algae sample selection: A.B.M. Sharif Hossain reported two 26.5g and 20.0g oedogonium and spirogyra petri dishes were selected from the algae laboratory of the Institute of Biological Sciences, Faculty of Science, University of Malaya, Kuala Lumpur, Malaysia. In this study, spirulina algae were chosen because it is easily available and grows faster.[2]
- Extraction Process Containing Algal Fats and Oils: This activity uses the soxhlet extraction process to extract fat containing algal biomass.
- Biodiesel Production: The trans-esterification process is a chemical reaction in which a raw material mixture is reacted with alcohol (methanol) in the presence of potassium hydroxide (KOH) as a catalyst to produce the final biodiesel product (glycerol).[2]

The following reaction takes place:-

Chemical Reaction: [2]



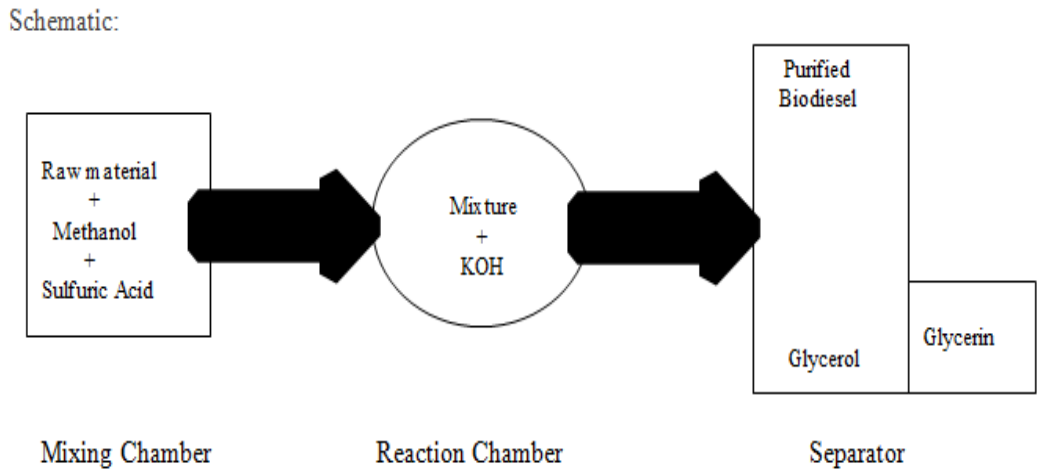


Figure 1: *Trans-esterification Process*

As shown in the diagram above, biodiesel is produced by animal source as well as plant source. In the mixing chamber add the raw material of algae and methanol together with sulphuric acid, after that mixing everything in the first chamber is transferred to the reaction chamber i.e. reactor. While in the second chamber is the reaction chamber known as the heart of the biodiesel production process. In this reaction chamber mix the potassium hydroxide (KOH) as a reactor with mixture. Last chamber is known as a separator or purifier, in which pure biodiesel separates from glycerol by using two sensors, one at top side and another at lower side. Pure biodiesel drags out from the top side and glycerol is settled at the down side of the separator. By adding some molecules in glycerol produce the glycerine at the counter chamber

5 Conclusions

Algae are an economical option for biodiesel production because of its availability, low cost, and easy cultivation. A lot of work has been done to select the suitable species. The growth of algae requires a suitable environment and natural cultivation method used. In this way, algae can be used as a renewable energy source. Many researchers reported that microalgae might be more suitable for increasing biodiesel production. Many researchers used different lipid extraction methodology but soxhlet extraction methods were used very efficiently. Trans-esterification process is used to converting the lipid content into biodiesel production by using KOH as catalyst and methanol as solvent.

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