



ASSESSMENT OF PHYTOPLANKTON AS THE THIRD GENERATION AND FOURTH -GENERATION BIOFUELS

Vasundhara Priyadarshi
Manglatayan University, Aligarh

Dr Dinesh Kumar Sharma
Professor, Department of Chemistry
Manglatayan University, Aligarh

Dr Shuchi Verma
Assistant Professor, Ramjas College,
University of Delhi

ABSTRACT

Like India a highly populous country, when the conventional Mode of fuel is on the verge of finishing, there is a huge demand searching for an alternative source of fuel, to satisfy automobile transportation. In this scenario, we have one option to shift the whole transportation system on fourth-generation Biofuels like electricity, but for this many things must be changed at a rapid rate, which is not feasible, so here comes another option using Phytoplanktons as the feedstock for producing Biofuels to overcome the present deficit. Due to shorter growth cycles, as compared to any terrestrial plants, the potential productivity of biofuels is much higher in magnitude. Phytoplanktons is a great food source as well because of their unique properties like high mineral content, its availability, presence of rare carotenoids the most importantly greatest source of long-chain of omega 3 fatty Acids. The objective of this research is to study Phytoplanktons as an alternative source of our today's highest demand Biofuels. The main attraction of this review is the promising content of Phytoplanktons in the Food and medicine field too.

Keypoints: Phytoplanktons, For medicinal properties its PUFA analysis, Alternative Source of Biofuels.



INTRODUCTION:

Climate change due to the emission of greenhouse gases caused by the depletion of oil reserves has become the most critical issue facing humanity in the next couple of decades. To be considered for the position of replacement fuel for the transport sector, the potential candidates would have to meet a set of requirements that are aimed at ensuring that they can meet the requirements for a long-term and low-carbon emission. Hybrid and electric vehicles are more fuel-efficient but they require a limited resource of heavy metals for their batteries. Biofuels are also more sustainable and are produced from biomass. As a major source of renewable energy, biomass has been regarded as a vital part of the world's energy supply. It is expected to contribute more than 50% of the US total energy consumption by 2050. About 98% of greenhouse gas emissions come from fossil fuels. By reducing the use of these fuels, we can reduce their carbon footprint. For energy security, the global energy mix consists of fossil fuels such as oil and natural gas, as well as renewable energy such as wind and solar. The industrialization has significantly shrunk the biomass consumption of primary energy. Despite this, the role of phytoplankton is often overlooked. They play key roles in Earth's biogeochemical and human economy. Since biomass now accounts for only a small portion of Earth's primary energy consumption, the importance of phytoplankton has been neglected. We

commonly use petroleum and natural gas for our energy needs. The *Chlorella Vulgaris* can provide both a bioenergy source and fuel oil.

Systems that use algae for wastewater treatment have the potential to provide low-cost and eco-friendly solutions for treating wastewater. Their systems can also serve as sources of advanced bioremediation and biofuel generation. Integrated algal water treatment systems can help minimize the harmful effects of nitrogen and phosphorus on the environment. They can also help produce valuable products by cultivating algae that can consume both N and P from wastewater.

In addition, ponds can be more efficient than plants in capturing solar energy. Bioreactors can also be more productive than plants. The US Department of Energy supported a project to develop algae for bioenergy production. Biodiesel is a processed fuel that is derived from biological sources. It is safe and is generally used as a replacement for traditional petroleum diesel. Its high lubricity and calorific value make it a clean-burning fuel. Due to their high volatility and low kinematic viscosity, animal fats and vegetable oil as combustible fuel are not suitable for use in diesel engines. Biodiesel has very high calorific values. The maximum calorific value of biodiesel is around 41 MJ/kg. In Table 1, the Calorific values of biodiesel are shown. They are also known to provide various advantages such as engine wear and longer engine life.



Table No.1 Calorific Values of Biodiesel from Different Vegetables oil

Biodiesel	Calorific value KJ/Kg	References	Biodiesel	Calorific value KJ/Kg	References
Argemone Mexicano oil	40,800	Singh and Singh 2010	Paradise oil	40,285	Devan and Mahalakshmi 2009
Castor seed oil	39,160	Panwar et al.,2010	Peanut oil	40,100	Kaya et al.,2009
Cottonseed oil	40,430	Hazar 2010	Palanga oil	38,660	Sahoo and Das 2009
	41,200	Aydin and Bayindir,2010		41,397	Sahoo et al.,2007
Cynara cardunculus oil	37,200	Lapuerta et al.,2005	Pomace oil	43,540	Caynak et al.,2009
Honge Oil	36,100	Banapurmath et al.,2008	Pongamia Pinnata oil	35,560	Suresh Kumar et al.,2008
Jatropha oil	42,673	Sahoo and Das,2009	Pumpkin seed oil	38080	Schinas et al.,2009

MATERIAL AND METHODOLOGY

Different materials like waste products of different dairy products will be collected separately. All the samples have been collected autoclaved and labelled as sample no1,2,3.....



Fig:1



Fig:2

Source: Ramjas College Chemistry Lab Delhi university



METHODS :

I will use the ultrasonic extraction method to harvest the algae. The oil will be used as fertilizer. Oil extraction should be converted into Biodiesel through transesterification reaction.

In the transesterification process, a glyceride reacts with alcohol, which is usually a catalyst.

There are different tools and techniques, which are used in my Research Work, which are

following:

- Autoclave
- NMR Spectroscopy
- LCA through GREET Software

Autoclave: Autoclave sterilizer is a device that uses steam to kill bacteria and other harmful substances in a sterilized environment. This method of sterilizing is very economical and can be done by using simple chemicals.



Fig:3



Fig:4

Source: Ramjas College Chemistry lab Delhi University

NMR Spectroscopy

NMR spectroscopy is a study of molecules by recording their interaction with radiofrequency radiations. Nuclear magnetic resonance spectroscopy is a vital tool for organic chemists. It can provide them with valuable information on the structure of their molecules and the purity of their samples. This method is an efficient and fast method for the quantitative analysis of complex lipids and fatty acids in microalgae. It is being used for the identification of new functional

health products and their derivatives. The procedure consists of extraction of the biological matrix by the modified Folch method and direct analysis of the resulting material by proton nuclear magnetic resonance (^1H NMR). The protocol uses a reference electronic signal as an external standard (ERETIC method) and allows assessment of total lipid content, saturation degree and class distribution in both high throughput screening of algal collection and metabolic analysis during genetic or culturing studies. [Genoveffa Nuzzo; et al. (2013)]

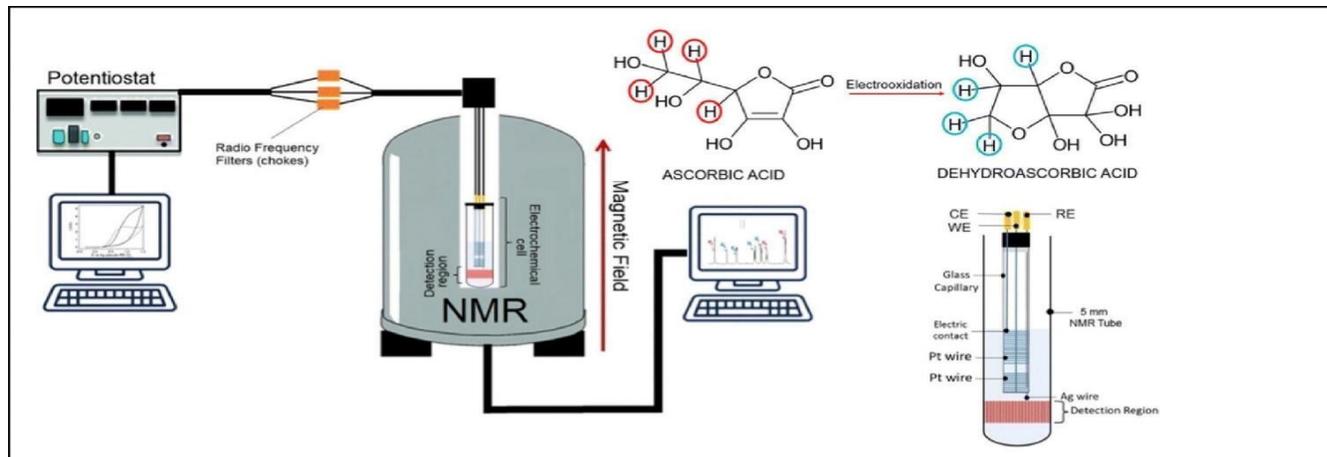


Fig:5 Source: <https://www.sciencedirect.com/science/article/pii/S0026265X18314206>

GREET & LCA Software

The Greenhouse gases, Regulated Emissions, and Energy use in Technologies Model

This software will be used to determine the bio-oil and oil properties. It will also determine the greenhouse gases' calorific value.

Comparison between Third generation Biofuel and Fourth generation Biofuel

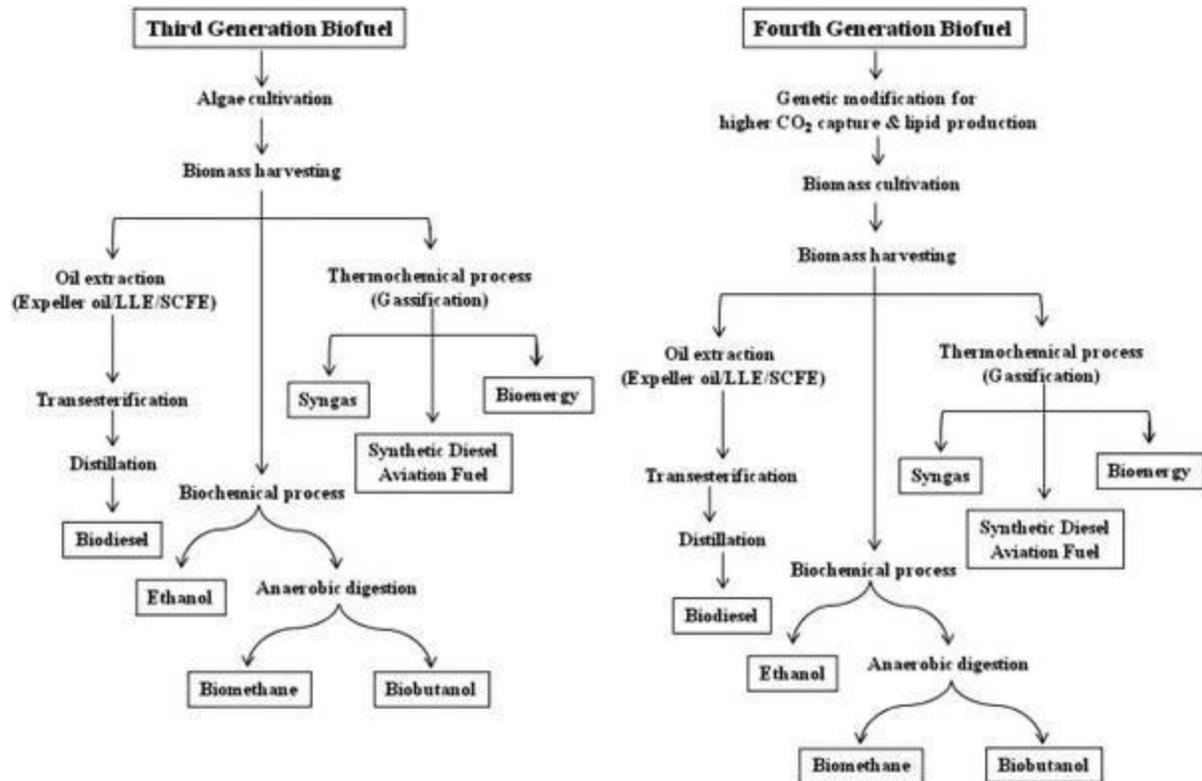


Fig:6 https://www.researchgate.net/figure/Third-and-fourth-generation-biofuels-28_303549322

Results and Discussion:

Third generation Biofuel suitable techniques:

Various steps can be utilized to convert the biomass of algae into energy sources. Some of these include the chemical reaction, direct combustion, and thermochemical conversion. A schematic

representation is illustrated in fig: 7 to produce biodiesel and bioethanol using microalgae as feedstock. In order to commercially utilize algae biomass, the by-products should be optimally used. This can be used as nutrients for various animal and human products.

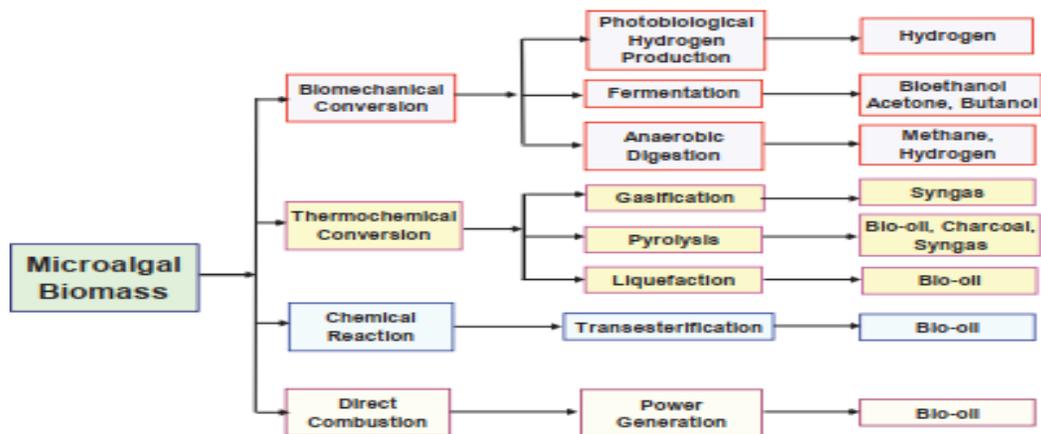


Fig:7 <https://www.sciencedirect.com/science/article/pii/S1877705815008656/pdf?md5=60590a56bb18984122cc1c1a0a9d907c&pid=1-s2.0-S1877705815008656-main.pdf>

Advantages Vs Disadvantages of third generation Biofuel:

One of the main advantages of algae is that they can use a variety of carbon sources. It has been suggested that algae could be tied to a carbon-neutral source such as a power plant or industry. This method would allow them to reduce their emissions without releasing any carbon dioxide. However, they also require a high amount of fuel to make their bio-based fuel. This makes algae-based fuel more expensive than other fuel sources. Biogas produced from algae tends to be less stable compared to

other sources. This is because their oil is highly unsaturated, which can cause it to become volatile and prone to degradation. Despite the significant progress made in the field of algae bioproduction, there are still many challenges that need to be overcome in order to make this process commercially viable. Currently, the process of extracting algae from suspended forms using centrifugation is very challenging due to its various steps. Although various techniques are available for recovering the algae, they are still very costly. (Mata TM et al;2010)

Fourth generation Biofuels and its techniques:

Fourth generation biofuel production mainly uses genetically modified algae to enhance the production of ethanol. Although it's widely known that algae biofuel can reduce greenhouse gas emissions, the environmental impacts are still very high. It is the result of the development of plant biology and biotechnology. This process involves the use of enzymes and synthetic biology



to convert biomass into energy. This process involves introducing bio-engineered plants or algae to capture carbon dioxide in their various parts. These components can then be used to generate bio-based fuel. The tabular form breaks down the various bioenergy sources according to their generation and explains their energy density, greenhouse gas effects, and their major uses (Yaser Dahman et al 2019).

Table 2. Comparison of conventional Fuel and Biofuels

Biofuel	Fossil Fuel	Difference
Ethanol	Ethane/gasoline	Ethanol has half the energy mass of gasoline, which means that it takes about twice the amount of ethanol to get an equivalent amount of energy. But, ethanol produces less amount of poisonous gas such as carbon monoxide than that of gasoline. However ethanol produces more ozone gas as compared to gasoline and contributes to smog. Hence all engines need to be improved to work on ethanol.
Biodiesel	Diesels	Biodiesels have lower energy than regular diesel oil. They are more prone to corrosion in their engine parts than a normal diesel that is designed to intake biodiesel. Biodiesel burns much cleaner than diesel and produces few sulphur compounds.
Methanol	Methane	Methanol has one-third to one-half the energy of methane. It is a liquid, and is easy to transport.
Biobutanol	Butane/gasoline	Gasoline has more energy than biobutanol and can work in any car, whereas gasoline is required without any modification of the engine parts.

Source: <https://www.sciencedirect.com/topics/engineering/generation-biofuels>

The difference between the fourth and third generation biofuels is that they capture CO₂ emissions at all stages of the production process by means of oxy-fuel combustion (Oh et al 2018, Sher et al 2018). Although oxy-fuel combustion is not currently competitive, it has been studied as a possible alternative to traditional biofuels production. Its potential environmental advantages are being

considered (e.g., carbon storage and carbon negative production) (University of Edinburgh). Nanotechnological solutions can help minimize the costs associated with the cultivation and harvesting of algae (Sekoai et al., 2019). For instance, nanotechnology can provide an energy-efficient method of extracting oil from algae (Pattarkine and Pattarkine, 2012).



burning produce less greenhouse gas emissions

Challenges of Fourth generation Biofuel in present situation:

- 1. High Cost of Production:** Even with all the benefits associated with ethanol, producing them is quite expensive in the current market. With low interest rates and the potential profitability of the industry, producing ethanol can still meet demand. If the demand rises, then increasing the supply will require a long-term operation that will be quite expensive.
- 2. Industrial Pollution:** Biofuels are significantly less carbon-intensive than traditional fuel when burned. However, their production is largely dependent on oil and water. Large scale industries that are involved in making ethanol are known to emit large amounts of greenhouse gases. As a result, they are also known to cause water pollution.
- 3. Global Warming:** Biofuels which are mostly hydrogen and carbon

than fossil fuels, but they still contribute to global warming. Biofuels can help us reduce our dependence on oil, but they can't solve all our energy needs. Instead, they can serve as substitutes for other technologies.

Advantages of fourth generation Biofuel:

In fourth-generation production systems, crops are known to capture carbon dioxide by storing it in their leaves and branches. This process is then used to convert the biomass into fuel and gases. They use the same feedstock as the third generation biofuels and have the same processing technology. The fourth generation biofuels are processed using thermochemical processes and are coupled to carbon capture and storage (CCS) technologies. This method is believed to reduce greenhouse gas emissions by up to 30%.

RESULTS: With the above facts it's clear that the fourth generation Biofuel produced by genetically modified algae will be the new future in next coming 50-60 decades but for present scenario Biofuel produced by algae is the best alternative source for conventional fossil fuels in transport field. A multifactor optimization strategy was used to improve the lipid pool of *Chlorella vulgaris* cells. The result was a 20-fold increase in the cell's lipid yield. The oil's stability and its antioxidant properties were also studied.

CONCLUSION: *C. vulgaris* biomass with 55% lipid content and adequate fuel properties is potentially a renewable feedstock for biodiesel.



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