BIOFULES: PRODUCTION AND CHALLENGES USING ALGAE SUSTAINABLE PRODUCER

Abstract

Biofuels derived from algae have gained significant attention as a promising alternative to fossil fuels due to their potential for high yields, carbon neutrality, and versatility. This review paper provides a comprehensive overview of biofuel production from algae, focusing on the challenges faced and sustainable strategies to overcome them. Algae, as efficient photosynthetic organisms, offer various advantages including rapid growth rates, minimal land use, and ability to thrive in diverse environments. However, several technical, economic, and environmental obstacles hinder large-scale commercialization. This paper discusses cultivation methods, lipid extraction techniques, and conversion processes, while also addressing issues such as resource utilization, water and nutrient management, and the need for genetic optimization. The integration of algae-based biofuel production with other industries, such as wastewater treatment and carbon capture, is explored as a means to enhance sustainability. Furthermore, regulatory frameworks and policy incentives are examined to understand their role in facilitating the growth of algae-based biofuel technologies. By acknowledging these challenges and potential solutions, this review paper aims to contribute to the development of a more sustainable and efficient biofuel industry.

Keyword: Biofule, algae, lipid extraction

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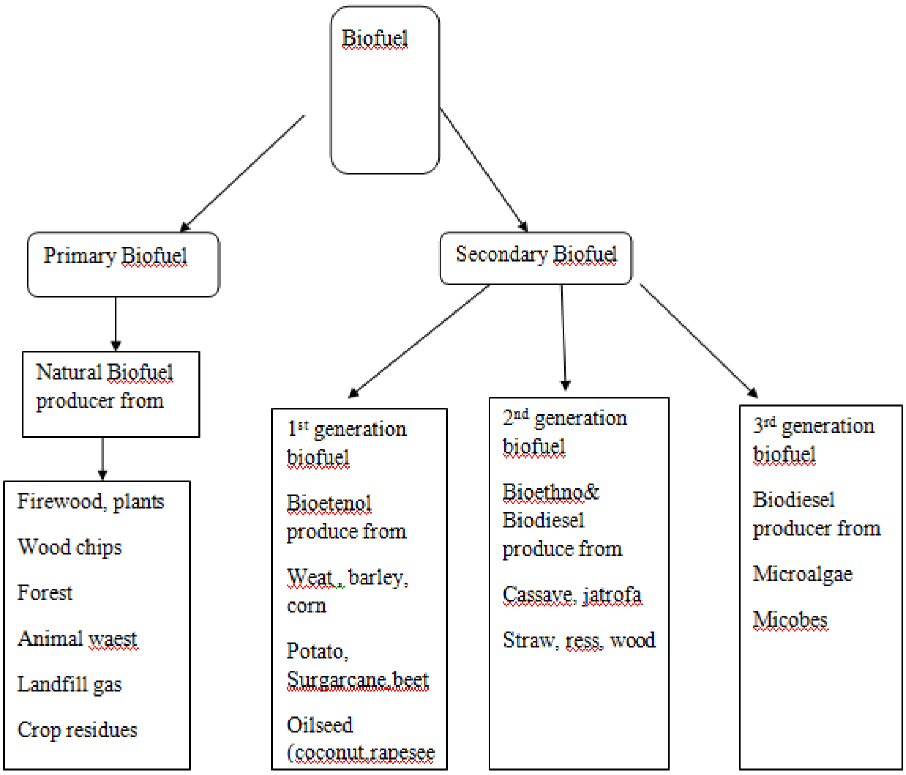
I. INTRODUCTION

Algae are typically thought of as photosynthetic autotrophs that thrive in water, produce oxygen, and exist as single cells, colonies, or flamentous forms. Numerous photosynthetic organisms that live primarily in aquatic environments make up algae. Algal species are often divided into macroalgae and microalgae based on size and physical traits. Macroalgae, often known as seaweeds, have a vast number of cells and are visible to the unaided eye.Microalgal species are far more significant than macroalgal species in the field of micro nanomedicine since they can only be seen under a microscope. Brown algae, blue-green algae, and red algae are the three kinds of macroalgae based on the colors already present. Blue-green algae and bacteria both have some structural similarities, but blue-green algae were classified as an algal due to the existence of chlorophyll and associated complexes.

The red algae belong to a different class of algae. Rhodophyta species that fall under this classification are eukaryotes with chloroplasts and phycobilins Large macroalgae commonly referred to as brown algae have an enormous capacity to convert photons, which allows biomass to be created considerably more quickly. Because their efficiency is significantly higher than that of cyanobacteria or red algae, brown algae are given more attention for the creation of maintainable biofuels. Because a lot of microalgal strains have the ability to accumulate lipids and produce more photosynthetically and at a faster rate than their counterparts that live on land, they have also become a potential source of feedstock for the generation of biofuels. Biogas is created by anaerobic microbes using biomass, and because it contains a lot of methane, it can be utilized as a substitute for fossil fuels (Mes et al., 2003). It is necessary to break the cell wall in algae cells because the cell wall keeps the biofuel components intact. Anaerobic digestion is typically favored because it is the most common way to extract these components from the cells (Reith, 2004). It is desirable to cultivate algae with high biofuel content. This review article's goal was to critically analyze several elements of algae as a potential source of biofuel.



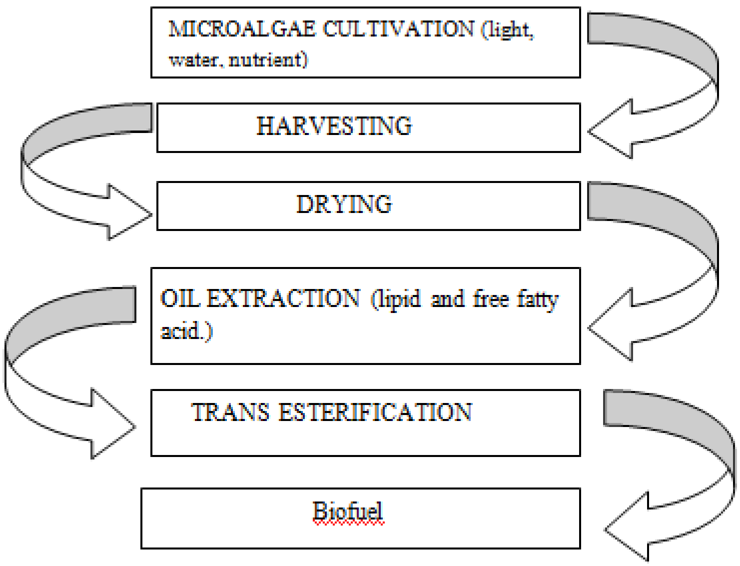
II. VARIETIES OF ALGAE

Microalgae grow quickly and have a high oil content, in contrast to terrestrial crops, which require a season to mature and have a maximum oil content of just about 5% dry weight (Chisti, 2007). They frequently increase daily by a factor of two. When at their pinnacle of development, some microalgae can double every three and a half hours (Chisti, 2007). The oil content of microalgae ranges from 20% to 50% (dry weight), with some strains reaching up to 80% (Metting, 1996; Spolaore et al., 2006). Because of this, the algae-to-biofuel sector is focusing on microalgae.

Microalga	**Oil content (% dry weight)**
Botryococcusbraunii	25-75
Chlorella sp.	28-32
Crypthecodiniumcohnii	20
Cylindrotheca sp.	16-37
Nitzschia sp.	45-47
Phaeodactylumtricornutum	20-30
Schizochytrium sp.	50-77
Tetraselmissuecia	15-23

III. CONVERSION OF MICROALGAE TO BIOFUEL

Several processes is involved in the conversion of microalgae into biofuels. These processes are cultivation, harvesting, drying and oil expression. Several authors have studied these processes over the years and published papers dealing with the conversion of microalgae into biofuels. Following this study, techniques for algal biofuel production, processing and extraction were examined. To increase yields and reduce production costs, it has been proposed to combine the conversion of algae into biofuels with carbon sequestration and wastewater treatment.



IV. SUSTAINABILITYOF 3RD GENERATION ALGAL BIOFUEL

Algal biofuel has the potential to produce no greenhouse gases and emit substantially less CO2, as they can absorb, tolerate, and utilise far more CO2 than terrestrial plants, allowing them to use CO2 from petroleum power plants or other industrial sources. Using processing techniques like anaerobic digestion, pyrolysis, gasification, catalytic cracking, and chemical transesterification enzymes, both algal biomass and algal oil extracts can be converted into various types of fuel, including biogas, liquid and gaseous transport fuel, kerosene, ethanol, aviation fuel, and biohydrogen.It appears that the issues around carbon capture and sequestration (CCS) primarily center on geological CO2 storage. We can only decrease carbon capture by restricting the release of new fossil deposits if we remove carbon from the atmosphere. Botryococcusbraunii, a colonial green microalga, is a very abundant renewable hydrocarbon source. A solvent extraction cycle was used to improve hydrocarbon recovery in a study that used wet microalgae that had been harvested. samples that include a B blend. Ten minutes were spent keeping Braunii and water below 100 ° C. The observed hydrocarbon recovery was 97.8% at 90 °C. Oil from oilseed crops actually produced 0.592 t ha1 of global oil in 2007–2008. Since they may be produced from combustion gases and industrial effluent, the manufacturing of algae-based biofuels appears to be particularly efficient, sustainable, and promising. Additionally, compared to terrestrial crops, it uses less area while still sequestering significant amounts of CO2. This is why many believe that these microalgae are the only feasible economic path to producing biodiesel. The main determinants of the impact of biofuels include their role in changing land use, the feedstock they consume, as well as challenges with technology and scale. Under the appropriate conditions, biofuels can boost the economy, cut pollution, and significantly increase energy security. The various biofuels' development each has its own advantages, challenges, and risks.

V. ADVANTAGES OF ALGAE-BASED FUELS

The growing promise for the usage of algae-based aircraft fuels demonstrates how easily algal biomass may replace present petroleum fuels when compared to other renewable energy sources like solar and wind power. Algal fuel production has various benefits over alternative biofuel technologies. For instance, compared to land plants, some algae strains have better photosynthetic rates, allowing for more effective greenhouse gas removal. By channeling smokestack pollutants into ponds of algae, which utilize the carbon to fuel their own growth, power companies are even starting to use algae to reduce these emissions. In the past, the high price of production has greatly limited algae biofuel's economic feasibility. Algae biofuel has historically had limited commercial viability due to the high cost of manufacture. The existing method does have the capacity to generate 47,000–308,000 liters/hectare of oil from algae yearly, but, once optimized and scaled up. As a result, the cost of algal biofuel would drop to just $20 per barrel, or about one-fifth the cost of oil. Approximately 15,000 square miles of land would be needed, according to the U.S. Energy Department, if algal biofuel were to replace petroleum use. Algae wouldn't compete much with agricultural crops for fertile soil as they can survive in environments that are normally uninhabitable.

VI. CONCLUSION

Algae-based biofuel offers a promising replacement for fossil fuels and has the potential to reduce harmful carbon emissions. However, the state of technology today prevents commercial, low-cost production. Oil will probably continue to be the main source of energy in the world even though biofuels made from algae are becoming more and more popular on a global scale. The potential of algae-based biofuels to revolutionize our energy landscape cannot be ignored. By addressing the challenges head-on and leveraging interdisciplinary approaches, we can pave the way for a more sustainable and resilient energy future. Algae-based biofuels, with their inherent environmental benefits and technological possibilities, are poised to play a crucial role in the transition towards a greener and more sustainable energy paradigm.

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