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Creation of Biocrude Consuming a Well Worn Cyanobacterium

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Abstract

A crucial tactic for reducing pollution and climate change is the use of renewable energy, which has led to an increase in the demand for new sources. Studies are currently being conducted on proprietary, rapidly growing cyanobacterial strains of Fremyella diplosiphon with a 7–10 day life cycle on average and a demonstrated ability to produce lipids for biofuel production. The growth and photosynthetic pigmentation of a cyanobacterial strain (SF33) were examined in this study, as well as the production of biocrude through hydrothermal liquefaction. Under less-than-ideal conditions, including in outdoor bioreactors with growth differences of less than 0.04 ($p = 0.035$) between different batches, the cultivation of F. diplosiphon did not significantly differ (0.05). The components of the biocrude were examined, and fatty acids were found.

Keywords: Tactic • Pigmentation • Hydrothermal • Photosynthetic

Introduction

Carbon dioxide and toxic air pollutants that are released into the atmosphere as a result of the burning of fossil fuels are grave threats to the environment that have catastrophic effects on the planet [1]. Additionally, exposure to the diesel exhaust produced by these fuels has been linked to lung inflammation, respiratory symptoms, and other chronic diseases, particularly in children and elderly people with compromised immune systems. Nearly all of the sulphur dioxide and nitrogen oxide released into the atmosphere, as well as 85% of airborne particulate pollution, are produced by the most popular fossil fuels, including coal, natural gas, and oil. As a result, excessive use of fossil fuels has a negative impact on the environment, which has increased demand for renewable energy in recent years; it is more crucial [2].

Since biofuels are produced using methods that significantly lower net carbon emissions, they represent potential replacements for fossil fuels. The use of biofuels as a renewable energy source has not significantly increased due to high capital and cultivation costs, despite the fact that numerous initiatives aim to reduce emissions by limiting the consumption of fossil fuels. The high capital cost associated with the large-scale cultivation of these organisms' places significant restrictions on the economic viability of cyanobacterial biofuel production, necessitating the development of optimised cultivation systems. When switching from fossil fuels to biofuels, cost-efficiency is a major concern for fuel producers, distributors, and consumers. As a result, this technology may have the potential to completely change the energy sector but only if capital costs and cultivation costs can be brought down [3].

Literature Review

Additionally, efficient strains must be used to produce biodiesel from algae and cyanobacteria. Despite being the best option for the wellbeing of planet Earth, using cyanobacterially derived biofuel won't be practical until these options are made available. According to projections, the United States' water and land resources could support the production of 23.5 billion gallons of fuel made from algae each year. In addition, efficient use of brackish/saline waters could lower the cost of fuel production. The technology may then be of great use to island countries where the cost of importing fuel is high and freshwater is scarce enough to not be used for cyanobacterial or algal growth [4].

To store energy, cyanobacteria produce about 50% lipids in their cells, which are then extracted and converted to biodiesel through transesterification. Cyanobacteria and algae are reported to produce oil at a theoretical yield of 38,000 gallons per acre per year and at a practical yield of 4350-5700 gallons per acre per year. Cyanobacteria are suitable production platforms for biofuels due to their quick 10-day generation time, high biomass conversion, ability to fix greenhouse gas emissions, and ability to produce lipids. These organisms effectively capture concentrated carbon dioxide released from fossil fuels and industrial emissions and use it in photosynthesis [5].

Discussion

The filamentous cyanobacterium Fremyella diplosiphon is a favourite model organism because it has a short (7–10 days) life cycle, thrives best in low light conditions, and is simple to manipulate. This cyanobacterium has a reported 18% total lipid content, which can be converted to fatty acid methyl esters (FAMEs), making it the perfect biodiesel agent. However, there is no information on the viability of this organism as a commercial-scale feedstock in terms of extraction and cultivation. With the help of readily available brackish waters (5-20% NaCl), we evaluated the production process and identified technical challenges related to the large-scale cultivation of F. diplosiphon in greenhouse and outdoor conditions. Following adjustments and optimisation of the bioreactor's settings, we assessed culture growth [6].

The scale-up process led to the discovery of additional high-value co-products in addition to biocrude and biochar, expanding the potential for commercial opportunities. Scaling up cultivation did not have a negative impact on the accumulation of photosynthetic pigments, according to a significant rise in phycocyanin and chlorophyll abundance over a 15-day period. This is in line with earlier research that demonstrated that pigmentation rises with growth; however, abiotic stresses like salinity, light intensity, and nutrient availability have an impact on levels of chlorophyll a and phycobiliprotein. This makes sense because measuring the amount of these pigments sheds light on the photosynthetic process, which directly affects cellular macromolecules. Due to the antioxidant properties of phycocyanin, a pigment of great interest to the nutraceutical market, which were quantified in the current study, it offers a wide range of commercial opportunities [7].

Conclusion

Biofuels from cyanobacteria such as F. diplosiphon offer great value beyond their use as transportation fuels given their environmental benefits and lucrative co-products generated during fuel production. A significant reduction in greenhouse gas emissions through the blending of additives will further drive the commercial production and adoption of advanced biofuels. With the current initiatives undertaken, an era of using biofuels as an alternative to fossil fuels is on the horizon. Our results provide additional knowledge regarding scale-

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up cultivation, and the extraction and purification of bioproducts with real-world applications. Future studies will aim to use hydrothermal liquefaction as a scalable method for thermochemical conversion of cyanobacterial biomass, which will lead to the production of biocrude, as well as conduct a comprehensive analysis of fuel properties. This innovative research, which includes scaled-up cultivation systems and the development of a biofuel production system combining extraction and conversion to provide high biocrude yield, has great potential for commercialization.

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Conflict of Interest

There is no conflict of interest by author.

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