SHINING PATH TO FUEL SUSTAINABILITY – BIOFUEL GENERATION USING CHLORELLA VULGARIS AND DUAL-PHOTO BIOREACTORS

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Introduction

In response to environmental challenges and finite fossil fuel reserves, the pursuit of sustainable energy solutions has intensified globally. Biofuels, derived from organic sources such as biomass and algae, stand out as renewable alternatives to conventional fossil fuels, offering promise in combating climate change and ensuring energy security. Among biofuel candidates, microalgae, notably Chlorella vulgaris, have attracted significant interest due to their high lipid content and rapid growth rates.

This project delves into the pivotal role of biofuels, particularly microalgae-based ones, in driving sustainable energy solutions amidst a changing world. By harnessing the photosynthetic efficiency of microalgae, researchers envision a future where biofuels play a substantial role in decarbonizing the transportation sector.

Through a comparative study of natural sunlight and artificial LED light conditions, this research seeks to optimize microalgae cultivation methods, aiming to maximize biomass yield and lipid accumulation. The study explores how variations in light quality influence photosynthetic efficiency, biomass productivity, and ultimately, biofuel production efficiency.

Additionally, this project examines the global energy landscape and the increasing significance of biofuels in meeting energy demands sustainably. Countries like India are actively promoting biofuel usage to diversify energy sources and reduce reliance on imported fossil fuels.

In conclusion, this project emphasizes the critical role of biofuels, particularly microalgae-based biofuels, in advancing towards a more sustainable and energy-independent future. By optimizing cultivation methods and leveraging the potential of microalgae, biofuels offer a renewable and versatile alternative to conventional fossil fuels, contributing to environmental preservation and energy security worldwide

Objectives

1. Sustainable approach towards creating a renewable energy resource using micro algae.
2. Cultivation and Comparison of algae by two different methods
    - Cultivation under natural sunlight.
    - Cultivation under Artificial light.
3. Approach to provide an alternative towards replacing the fossil fuels in future.

Methodology

Microalgae inoculated in Bold's Basal Media. The cultivation is done in two systems, One Cultivated under Natural Sunlight, another Cultivated in Dual Colour Photo-Bioreactors (Blue & Red). 60 ml of Microalgae Culture is added to the both the systems, each containing 60 litres of water. NPK was added to the systems for nutrition. After the complete growth of the algae, biomass is extracted and is separated by sieving through layers of cotton cloth as the size of the Chlorella Vulgaris is very small (3 micron). The extracted Wet Biomass was dried under sunlight for 24 hours. The dry biomass was tested for lipid content. For extraction of lipid content, Soxhlet extraction method is adopted. The process involves use of chloroform and methanol in the ratio 2:1.Materials

Chemicals	**Chemical formula**	**Concentration /molar mass**
Dipotassium Phosphate	K_2HPo_4	5.0g/200ml
Calcium Chloride	$CaCl_2$	0.5g/200ml
Sodium nitrate	$NaNO_3$	5.0g/200ml
Potassium Dihydrogen Phosphate	KH_2PO_4	3.5g/200ml
Boric Acid	H_3BO_3	1.14g/100ml
Sodium Chloride	NaCl	0.5g/200ml
Magnesium Chloride	MgCl	1.44g/100ml
Potassium hydroxide	KOH	3.1g/100ml
Ethylenediaminetetraacetic Acid	EDTA	5.0g/100ml

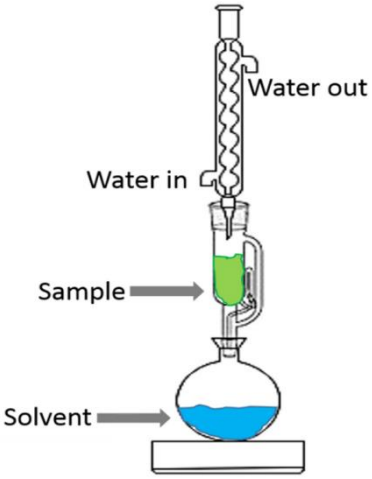

Fig.1: Soxhlet apparatus

Results and conclusion:

Moisture & Lipid Content

1. Lab Testing was done, the moisture and lipid content (Dry Basis) of Algae grown under sunlight is 94.64% and 9.47 % respectively
2. The moisture and lipid content of algae grown under Artificial light (Red and Blue) is 96.14% and 22.9 % respectively

Growth Rate

1. The micro algae under Sunlight grew faster compared to algae grown under Artificial light.
2. The cultivation of microalgae under sunlight took 7 days where as under artificial light it takes 16 days.

Quantity of wet Biomass

1. Under sunlight =2500 gm
2. Under Artificial light =15gm

We were able to

1. Cultivate the microalgae in a sustainable manner under natural conditions and artificial conditions.
2. Harvest microalgae with minimal power consumption.
3. Compare the quality and quantity of algae under both conditions.
4. Extract the biofuel from microalgae.
5. Test moisture content and lipid content.

1. Diverse Range of Biofuels: The project highlights the diverse array of biofuel types, including bioethanol, biodiesel, biogas, and biojet fuels, showcasing the versatility of biofuels as sustainable energy alternatives.
2. Renewability and Sustainability: Emphasizes the renewable nature of biofuels, sourced from contemporary biological processes, in contrast to finite fossil fuel resources, underscoring the importance of transitioning towards sustainable energy sources.
3. Environmental Benefits: Discusses the potential of biofuels to significantly reduce greenhouse gas emissions compared to fossil fuels, highlighting their role in mitigating climate change and addressing environmental concerns.

4. Energy Security: Addresses the issue of energy security and economic stability, advocating for a reduction in dependence on imported fossil fuels through the adoption of biofuels and other renewable energy sources.
5. Growing Significance in Global Energy Landscape: Highlights the increasing production and consumption of biofuels globally, with statistics demonstrating their growing significance in the energy sector, particularly in countries like India.
6. Focus on Microalgae-based Biofuels: Explores the potential of microalgae, specifically Chlorella vulgaris, as a promising source of biofuel due to its high lipid content, rapid growth rates, and adaptability to various environments.
7. Optimization of Cultivation Practices: Proposes a comparative study between natural sunlight and artificial LED light conditions to optimize microalgae cultivation methods for enhanced biomass yield and lipid accumulation, crucial for sustainable biofuel production
8. Comprehensive Analysis: Conducts a comprehensive analysis of various parameters including growth rate, temperature sensitivity, biomass yield, and lipid content under different light conditions, aiming to provide valuable insights into optimizing cultivation practices.

Future work-scope

Research into advanced cultivation techniques like photobioreactors and genetic engineering offers opportunities for hands-on experimentation in enhancing biomass yield and lipid accumulation. Integrating carbon capture technologies into cultivation systems could yield renewable biofuels while mitigating climate change. Exploring novel microalgae species beyond Chlorella vulgaris expands the potential feedstock, while environmental impact assessments inform sustainable practices. Collaborative research initiatives between academia, industry, and government foster interdisciplinary collaboration and real-world applications. Education and outreach efforts are vital for raising public awareness and garnering support for sustainable energy solutions. Through these avenues, undergraduates can play a significant role in shaping the future of microalgae-based biofuels and advancing towards a more sustainable energy landscape.