

ABSTRACT

This study was carried out to investigate the potential for bioethanol production from microalgae in Okara, Punjab, Pakistan, using Geographic Information Systems (GIS) and remote sensing technologies. Microalgae are being considered as a promising feedstock for bioethanol because of their relatively rapid growth rates, small land requirements, and the capability to prosper in various environments, including wastewater. Present research work utilized GIS tools to analyze spatial data on environmental parameters like sunlight, temperature, and water availability, to determine optimal cultivation sites and estimate bioethanol yield. The results suggest that Okara is a suitable climate for microalgae cultivation to produce renewable energy. NDVI analysis revealed distinct growth phases, with peak biomass observed between February and March 2024. Using GIS, optimal cultivation sites were identified based on sunlight, temperature, and water availability. Results show that 85% of the region is suitable for microalgae growth. Biomass yields from wastewater were substantial, with the potential to produce approximately 9,000 liters of ethanol daily. Current study revealed that district Okara can supply up to 9,000 liters of bioethanol per day from around 30 million liters of wastewater, helping to meet local energy demand and offset the dependence on fossil fuels. There remain challenges; principally, large-scale production of it is economically unviable, along with the requirement for ideal growing conditions. Nevertheless, microalgae-based bioethanol could be the part of Pakistan's renewable energy strategy with strategic investments in infrastructure, policy support and technological improvements. The results highlight the ability to develop a microalgae cultivation system and bioethanol conversion efficiency to optimize the microalgae cultivation systems for enhanced microalgae production and bioethanol conversion efficiency. This study demonstrates the feasibility of using wastewater for sustainable bioethanol production while addressing environmental concerns.

Keywords: Bioethanol production, Microalgae cultivation, Geographic Information Systems (GIS), Wastewater treatment, Spatial analysis.