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Optimization and kinetic studies on biodiesel production from microalgae (*Euglena sanguinea*) using calcium methoxide as catalyst

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ABSTRACT

The present work investigates the production of biodiesel from *Euglena sanguinea* microalgal bio-oil using calcium methoxide as a heterogeneous catalyst. The catalyst was synthesized and characterized by Fourier Transform Infra-red (FTIR) spectroscopy, Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD), Brunauer-Emmett-Teller (BET), basicity, and basic site strength analysis. Initially, bio-oil was extracted from mass-cultivated biomass obtained from *Euglena sanguinea* algae. It is further pretreated and transesterified using calcium methoxide catalyst at various experimental conditions through which an optimum yield of 94.83% was achieved. The catalyst yielded above 90% up to 5 cycles of recovery and recycling. The kinetic studies were investigated at various reaction temperatures to find the rate of reaction. It confirms that the reaction follows pseudo-first-order reaction. The activation energy and pre-exponential factor for the transesterification reaction were found to be 99.33 kJ mol^{-1} and 1.07×10^{14} min^{-1} respectively. The properties of the produced biodiesel were within the limits of ASTM D6751 standard.

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Introduction

Depletion of fossil fuels in the near future has urged researchers to look for an alternative fuel to meet the energy needs of the world. In addition, the continuous use of fossil fuels leads to the emission of harmful greenhouse gases. Hence, scientists are in search of alternative fuels. Biodiesel is one of the best available sources to satisfy the energy demands of the earth (Basha, Gopal, and Jebaraj 2009). It is a mixture of monoalkyl esters of long chain fatty acids derived from vegetable oils or animal fats which is produced by reacting triglycerides present in feedstock with a short chain alcohol in the presence of a catalyst (Lam and Keat 2012). Moreover, it is non-toxic and biodegradable with fewer pollutants receiving much attention because of its potential as a sustainable and environmental-friendly alternative to petroleum-based fuel (Knothe 2009).

The use of biodiesel has not expanded globally due to its high production cost which is associated with the expensive feedstock used (Sharma and Singh 2017). Similarly, the use of catalysts gives rise to problems like increased cost, post-treatment, regeneration, disposal, and operational hazards and these can be solved by the use of a heterogeneous catalyst (Liu et al. 2008a; Yadav et al. 2016). Among the low cost feedstocks, microalgae has been identified as a potential feedstock that absorbs carbon dioxide from

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