

Abstract

BIODIESEL PRODUCTION FROM SUNFLOWER OIL USING CALCINED CIGARETTE ASH AS A WASTE-DERIVED CATALYST

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Students: Nebojša Radović^{1,a}, Aleksa Vizi^{2,b}, Željka Nikolić^{3,c}

Mentors: Ivan Kojić^{2,d}, Ksenija Stojanović^{1*,e}

¹ University of Belgrade – Faculty of Chemistry, Studentski trg 12-16, Belgrade, SERBIA

² Innovative Centre of the Faculty of Chemistry Ltd., Studentski trg 12-16, Belgrade, SERBIA

³ Institute of General and Physical Chemistry, Studentski trg 12-16, Belgrade, SERBIA

^a <https://orcid.org/0000-0002-7587-8569>

^b <https://orcid.org/0009-0006-5253-7530>

^c <https://orcid.org/0000-0002-2922-0256>

^d <https://orcid.org/0000-0001-7737-1844>

^e <https://orcid.org/0000-0002-5566-2648>

Abstract

Biodiesel, a renewable fuel mainly composed of fatty acid methyl esters (FAMES), is commonly produced by transesterification of triglyceride-rich feedstocks with short-chain alcohols, most often methanol [1,2]. Although homogeneous alkaline catalysts are widely used, heterogeneous catalysts are increasingly investigated because they can simplify product separation, reduce wastewater generation, and enable catalyst recovery and reuse [3]. In this context, ash-based catalysts obtained from waste materials are especially attractive, as they connect biodiesel production with waste valorization and green chemistry principles [3,4]. This work investigates the laboratory-scale production of biodiesel from sunflower oil using calcined cigarette ash as a low-cost waste-derived catalyst.

Cigarette ash was thermally treated at 800 °C to constant mass and stored under dry conditions before use. The catalytic transesterification reaction was carried out with 25.00 g of sunflower oil, 25.00 g of methanol, and 1.00 g of finely powdered calcined ash. The reaction mixture was magnetically stirred at 70 °C for 120 min. After cooling to room temperature, n-hexane and saturated sodium chloride solution were added to improve phase separation. The upper hexane layer, containing the formed methyl esters, was separated, filtered through filter paper to remove residual ash particles, diluted to a defined volume with n-hexane, and stored at low temperature prior to instrumental analysis.

The obtained biodiesel fraction was characterized by gas chromatography–mass spectrometry (GC-MS). The dominant products were identified by comparison of retention behavior and mass spectral data with the instrument database. GC-MS analysis confirmed the formation of

*ksenija@chem.bg.ac.rs

the methyl esters of palmitic, linoleic, oleic, and stearic acids, which are expected products of sunflower oil transesterification. Based on peak-area evaluation of these four major components, the relative composition of the obtained FAME fraction was 6.55% methyl palmitate, 55.25% methyl linoleate, 36.19% methyl oleate, and 2.00% methyl stearate. The predominance of methyl linoleate and methyl oleate is consistent with the fatty acid profile expected for sunflower oil, supporting the conclusion that the triglyceride feedstock was successfully converted into the corresponding methyl esters under the applied experimental conditions.

The results indicate that calcined cigarette ash may serve as a promising heterogeneous catalyst for biodiesel preparation from sunflower oil under simple laboratory conditions. The proposed procedure has both practical and environmental relevance because it combines renewable feedstock utilization, catalytic conversion, and valorization of an otherwise discarded waste material. However, the present results should be regarded as preliminary. Further work should include detailed catalyst characterization, optimization of the methanol-to-oil ratio and catalyst loading, determination of conversion and isolated yield, reusability testing, comparison with established heterogeneous catalysts, and evaluation of the final biodiesel according to relevant fuel-quality standards.

Keywords: biodiesel, sunflower oil, transesterification, cigarette ash, waste-derived catalyst

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