ABSTRACT

The limited availability of fossil fuels and the high level of greenhouse gas emissions have encouraged the development of biomass-based renewable energy, including the utilization of 5-hydroxymethylfurfural (5-HMF) as a platform compound. This study aims to develop a heterogeneous catalyst based on coconut-shell activated carbon supported with NiO and ZnO for the synthesis of 5-HMF from glucose. Activated carbon was prepared through carbonization and activation, followed by metal loading via physical blending. Characterization was performed using TGA, XRD, FTIR, BET–BJH, FESEM–EDX, and acidity tests to evaluate the physicochemical properties of the catalyst. The AC/NiO–ZnO 10% catalyst exhibited the best performance, with a surface area of 285.460 m^2/g, pore volume of 0.165 cm^3/g, an average pore size of 23.243 nm, and a porous morphology with uniform metal distribution. TGA confirmed the thermal stability of the coconut shell up to 450°C, while XRD identified NiO crystallite size at 13.32 nm and ZnO at 20.10 nm. Acidity tests showed a significant increase in acid sites, and catalytic evaluation achieved an optimum 5-HMF yield of 40.08% under reaction conditions of 200°C for 3 h with 1.5 mmol glucose in 40 mL solvent. These findings indicate that the AC/NiO–ZnO 10% composite has potential as an efficient and sustainable heterogeneous catalyst for glucose conversion into 5-HMF.

Keywords: 5-HMF, glucose, activated carbon, composite.