ABSTRACT

The increasing bacterial resistance to antibiotics has driven the development of alternative antibacterial agents based on inorganic materials. Mesoporous silica possesses a high surface area and porosity, making it a promising matrix for metal ion incorporation. This study aimed to synthesize hydroxyethyl cellulose-based mesoporous silica (HECMS) and Cu(II)-doped hydroxyethyl cellulose-based mesoporous silica (HECMS-Cu) using a one-pot sol-gel method, characterize their physicochemical properties, and evaluate their antibacterial activity against Escherichia coli (E. coli) and Staphylococcus aureus (S. aureus). The materials were synthesized using hydroxyethyl cellulose (HEC) as a pore-directing agent with Cu(II) mass variations of 0.06, 0.12, and 0.18 g. The synthesized materials were characterized by Fourier Transform Infrared Spectroscopy (FTIR), Surface Area Analyzer (SAA), and Scanning Electron Microscopy–Energy Dispersive X-ray Spectroscopy (SEM-EDX), while their antibacterial activity was evaluated using the disk diffusion method. The results demonstrated that HECMS and HECMS-Cu were successfully synthesized via the one-pot sol-gel method. FTIR spectra indicated the formation of the silica framework through the characteristic Si–O–Si and Si–OH absorption bands and the disappearance of the CH_2 band after calcination. SAA analysis revealed that all materials exhibited type IV nitrogen adsorption-desorption isotherms with H2 hysteresis loops, indicating mesoporous structures, with specific surface areas ranging from 70.81 to 172.78 m^2/g and pore sizes ranging from 5.78 to 15.52 nm. SEM-EDX analysis revealed changes in surface morphology and confirmed the presence of Cu in the composites. The antibacterial activity against E. coli increased with increasing Cu(II) content, with the highest activity observed for HECMS-Cu containing 0.18 g of Cu(II), which produced an inhibition zone diameter of 12.1 mm. In contrast, no inhibition zone was observed against S. aureus. Therefore, HECMS-Cu has potential as an antibacterial material against E. coli.

Keywords: *mesoporous silica, hydroxyethyl cellulose, Cu(II), antibacterial activity, one-pot sol-gel.*