ABSTRACT

The increasing use of conventional plastics as packaging materials poses environmental problems because they are difficult to degrade naturally. The development of packaging materials such as composite films focuses not only on biodegradability but also on the ability to protect against microbial contamination. The development of biopolymer-based composite films that are biodegradable and possess antibacterial activity offers a relevant solution. This study aims to synthesize eugenol-methylenebisacrylamide copolymers, synthesize CMC/PEMBA/ZnO-based composite films with varying ZnO content, and determine the physical properties and antibacterial activity of the composite films. This study began with the synthesis of eugenol-methylenebisacrylamide (PEMBA) copolymer using BF3O(C2H5)2 as a catalyst via a cationic addition polymerization reaction. The synthesized PEMBA was tested for physical properties such as molecular weight, melting point, and FTIR characterization. CMC/PEMBA/ZnO composite films were synthesized using the solution casting method with varying ZnO concentrations (1%; 2%; 3%). The resulting composite films were characterized using FTIR, SEM mapping-EDX, mechanical testing, contact angle testing, and biodegradability testing via the soil burial method. Antibacterial activity was assessed using the disk diffusion method against Escherichia coli and Staphylococcus aureus. The results of the synthesis of eugenol-methylenebisacrylamide copolymer (PEMBA) yielded a light brown powder with a yield of 73.4%, a melting point of 61–65°C, and a molecular weight of 6029.561 Dalton. FTIR results showed N–H and C=O functional groups derived from methylene bisacrylamide, as well as O–H groups from eugenol, along with a decrease in the C=C alkene absorption band. The synthesis of composite films produced CMC/PEMBA/ZnO 1%, CMC/PEMBA/ZnO 2%, and CMC/PEMBA/ZnO 3% composite films with a white color. The addition of ZnO was successfully incorporated into the film matrix, as indicated by the presence of Zn in the EDX results and the appearance of Zn-O vibrations in the FTIR (Fingerprint) spectrum. The addition of 3% ZnO produced a composite film with the following physical properties: a contact angle of 80.5°, an elongation percentage (E%) of 114.16%, and a degradation percentage of 73.38%. The best antibacterial activity was obtained in the CMC/PEMBA/3% ZnO film, with inhibition zones against Staphylococcus aureus and Escherichia coli bacteria of 10.8 mm and 14.0 mm, respectively.

Keywords: Carboxymethyl Cellulose, Composite Film, Eugenol, Antibacterial, Biodegradable.