

ABSTRACT

Gemilang Aquila Hasmi. 24020221140043. Exploration of Antimicrobial Agents and Their Application in the Formulation of Composite Biopolymer Films Based on Sodium Alginate (Na-Alginate), Polyvinyl Alcohol (PVA), and Carboxymethyl Cellulose (CMC).

The increasing demand for eco-friendly active packaging, along with rising microbial resistance, has driven the development of functional materials based on biopolymers. This study aimed to evaluate the antimicrobial effectiveness of six active agents (ZnO, TiO₂, CaCO₃, kaolin, andosol soil, and lauric acid), as well as to analyze the effects of incorporating selected antimicrobial agents at varying concentrations (0%, 1%, 2%, and 3%) into NaAlg–PVA–CMC films on their physical properties, surface morphology, antimicrobial activity (based on CLSI standards), and mechanical characteristics (based on JIS standards). The research employed a completely randomized design (CRD) with a single factor and three replications, consisting of two main stages: (1) antimicrobial screening of the active agents against five microorganisms commonly found as contaminants, pathogens, or spoilage agents in food and environmental products (*S. aureus*, *E. coli*, *P. aeruginosa*, *Xanthomonas* sp., and *A. niger*), and (2) characterization of the formulated films. Parameters assessed included physical properties (thickness and weight per unit area), mechanical properties (tensile strength, elongation, and Young's modulus), inhibition zones, and surface morphology (SEM). Data were analyzed using one-way ANOVA followed by Duncan's post-hoc test. Antimicrobial screening results identified ZnO as the most effective agent, showing strong activity against *S. aureus* and *P. aeruginosa*, moderate activity against *Xanthomonas* sp., weak activity against *A. niger*, and no detectable activity against *E. coli*. Incorporating ZnO into the biopolymer films affected the physical and morphological properties, as evidenced by increased thickness and weight per area with rising ZnO concentration. SEM analysis revealed a denser and more homogeneous surface morphology at higher ZnO concentrations. Films with $\geq 2\%$ ZnO exhibited enhanced antimicrobial activity, showing moderate inhibition against *S. aureus* and *P. aeruginosa*, and weak inhibition against *Xanthomonas* sp. According to JIS standards, all films containing ZnO met the minimum required values for tensile strength, elongation, and Young's modulus.

Keywords: Biopolymer film, Zinc Oxide, Antimicrobial Activity, Active Packaging, Pseudomonas aeruginosa.