ANTIMICROBIAL PROPERTIES OF SILVER NANOPARTICLE-IMPREGNATED BACTERIAL CELLULOSE AND BIODEGRADABILITY ASSESSMENT OF BACTERIAL CELLULOSE FOR SUSTAINABLE FOOD PACKAGING

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ABSTRACT

Bacterial cellulose (BC) is a naturally derived biopolymer with excellent mechanical properties, water-holding capacity, and biodegradability, making it a promising material for food packaging. BC can be impregnated with silver nanoparticles (AgNPs) to enhance its antimicrobial properties to inhibit foodborne pathogens. Additionally, the environmental sustainability of BC as a packaging material depends on its biodegradability, which different drying methods can influence. This study investigates the antimicrobial efficacy of BC-AgNP films and evaluates the biodegradability of BC dried using various drying techniques.

BC was produced using *Komagataeibacter xylinus* (ATCC 53524) in a Hestrin-Schramm medium under static conditions at 30°C. The purified BC discs were immersed in AgNP solutions synthesized using pullulan as a stabilizer. Antimicrobial activity was tested against *E. coli* O157:H7, *Listeria monocytogenes*, *Salmonella*, and *Staphylococcus aureus* by measuring inhibition zones on Mueller-Hinton agar. Biodegradability was assessed by drying BC using room temperature drying (RT), freeze-drying (FD), and oven-drying (OD) and burying samples in soil under greenhouse and growth chamber conditions. Degradation was monitored over four weeks through visual inspection and weight loss measurements.

BC-AgNP films exhibited significant antimicrobial activity ($p<0.05$). BC-AgNP (pullulan) inhibited *E. coli* O157:H7, *Listeria monocytogenes*, and *Staphylococcus aureus* with inhibition zones of 22.16±0.10 mm, 19.67±0.15 mm, and 24.33±0.21 mm, respectively. However, no significant inhibition was observed against *Salmonella*. In contrast, the biodegradability assessment was conducted on BC without AgNP impregnation. BC samples showed visible degradation within the first week, with substantial decomposition occurring over four weeks. By the end of the trial, no visible remnants of BC were found in greenhouse soil, while small amounts remained in the growth chamber.

BC-AgNP films demonstrate strong antimicrobial properties, making them suitable for enhancing food safety in packaging applications. Moreover, the high biodegradability of BC underscores its potential as an eco-friendly alternative to plastic packaging. These findings highlight BC as a promising material for sustainable food packaging, combining antimicrobial efficacy with environmental responsibility.

Keywords:silver nanoparticles, antimicrobial properties, bacterial cellulose, food packaging

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