Fabrication of Chitosan-Based Bioplastic Films and Their Potential for Eco-Friendly Food Packaging

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The widespread use of single-use plastic packaging has intensified pollution and microplastic accumulation, motivating biodegradable alternatives suitable for food packaging. This study investigated whether chitosan–glycerol films can be formulation-tuned to balance mechanical strength, antibacterial activity, and biodegradability. Chitosan films were prepared in an acidic aqueous system with glycerol as a plasticizer using a 3×3 design (chitosan 1.0–3.0 g; glycerol 0.3–1.2 g). Six formulations produced stable, peelable films and were evaluated. Mechanical performance was quantified by breaking load. Antibacterial activity against Escherichia coli was assessed by zones of inhibition and compared using an area-normalized antibacterial index. Biodegradability was examined using Bacillus subtilis by continuously tracking CO2 evolution over 7 days and confirming surface erosion by scanning electron microscopy (SEM). Film performance showed clear formulation-dependent trade-offs. A film containing 2.0 g chitosan and 0.3 g glycerol achieved the highest breaking load (15.44 N) and the largest CO2 increase, accompanied by pronounced SEM-visible surface roughening, indicating strong cohesion and high biodegradation potential. In contrast, a film containing 3.0 g chitosan and 1.2 g glycerol produced the highest antibacterial index while retaining high strength (13.65 N), supporting its use as a functional antimicrobial packaging candidate. Overall, chitosan–glycerol ratio was the primary determinant of film formability and performance, and targeted formulation enables selection for strength/biodegradation-dominant or antibacterial-dominant packaging applications.

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