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Tensile, Thermal, and Antimicrobial Properties of Eco-Friendly Rotten Cassava Starch-Based Bioplastics Enhanced with Tea Tree Essential Oil

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Abstract

Cassava starch-based bioplastics incorporating tea tree oil (TTO) were developed as an antimicrobial and sustainable packaging alternative. In this study, rotten cassava (RC) starch was evaluated as a raw material and compared with fresh cassava (FC) starch. FTIR analysis indicated that both RC and FC starches possessed identical functional groups, confirming similar chemical structures. The analysis revealed that although RC film exhibited a yellowish-brown color, it only demonstrated 7% lower transparency compared to the clear FC film. FC film exhibited slightly better mechanical properties, with 25% higher tensile strength and 8% greater elongation at break compared to the RC film. Moreover, thermal analysis revealed that RC film had a higher glass transition temperature but slightly lower thermal stability than FC film. Biodegradability tests indicated that RC degraded faster than FC film, with approximately 8.5% greater weight loss. Furthermore, both FC and RC films demonstrated antimicrobial efficacy against *Bacillus subtilis* and *Escherichia coli*. These results indicate that RC starch-based bioplastics with incorporated TTO provide comparable functional properties to FC films while offering enhanced biodegradability and effective antimicrobial activity. These findings support the use of RC starch as a feasible alternative for bioplastic production, thereby contributing to sustainability and circular economy goals. © 2026 Wiley-VCH GmbH.

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biodegradability; bioplastic; rotten cassava; tea tree oil; tensile properties

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