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Sustainable biopolymers from agricultural waste for packaging applications

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This study investigates the development of eco-friendly biopolymers derived from agricultural waste specifically rice husk cellulose, potato peel starch, and banana fiber lignin for biodegradable packaging materials. With increasing global concern about plastic pollution, converting agricultural by-products into value-added biomaterials presents a sustainable alternative. Cellulose and starch were extracted using environmentally benign alkali and enzymatic treatments. Films were produced through casting and extrusion processes, followed by reinforcement with lignin nanoparticles to improve barrier and mechanical properties. Tensile testing revealed a 40% increase in strength and 25% improvement in elongation at break after lignin incorporation.

Water vapor transmission tests showed significant barrier improvement, making the films suitable for dry food packaging. Biodegradability assessments demonstrated complete film degradation within 8–10 weeks under composting conditions. FTIR and SEM characterization confirmed strong molecular interactions and uniform dispersion of lignin nanoparticles across the polymer matrix. The study also assesses cost-effectiveness and scalability, revealing that production costs could be reduced by 35% using local agricultural waste streams. These findings demonstrate the potential of next-generation biopolymer films to replace synthetic plastics, contributing significantly to circular economy models and environmental sustainability.

Biography

Melissa Turner is a sustainability scientist and Associate Professor at Michigan State University specializing in biopolymers, waste valorization, and green materials engineering. Her research focuses on converting agricultural residues into high-performance biodegradable materials for food, packaging, and biomedical sectors. She has published more than 75 scientific papers and collaborates with global industries on sustainable packaging innovations. Dr. Turner's work has earned multiple environmental research awards in the United States.

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