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Valorization of Pig Hair Waste for Sustainable Automotive Composites: Mechanical Properties and Environmental Benefits

The global automotive industry faces increasing pressure to reduce environmental impact while maintaining performance standards. Simultaneously, the meat processing industry generates substantial waste, including approximately 30% pig hair from the 28 million metric tons of pig waste produced annually in Africa alone. This research presents a sustainable solution by developing pig hair fiber (PHF) reinforced polypropylene composites for automotive applications. Pig hair fibers were extracted, characterized, and treated with 0.2M NaOH to enhance fiber-matrix compatibility. Composites were fabricated via compression molding with varying fiber lengths (7-15mm), weight fractions (0.6-6%), and processing temperatures (170-180℃). Response Surface Methodology was employed to optimize formulation parameters. The optimized composite (10.4mm fiber length, 3.6% weight fraction, 175℃ processing temperature) exhibited significant improvements over pure polypropylene: 2% higher tensile strength (15.5MPa), 21.6% enhanced flexural strength (25.4MPa), 14.1% increased impact strength (62.5kJ/m²), and 48.9% improved wear resistance. Thermal conductivity increased with fiber content, reaching 0.058W/mK at 6% loading. SEM analysis confirmed good fiber dispersion and matrix adhesion. The study demonstrates that agricultural waste valorization can produce materials with comparable or superior mechanical properties to conventional polymers, simultaneously addressing waste management challenges and reducing automotive carbon footprint. This approach contributes to circular economy principles by transforming biowaste into value-added products, potentially reducing landfilling and incineration of pig hair waste while decreasing reliance on petroleum-based materials in automotive manufacturing.

Keywords: Waste valorization, Pig hair fiber, Sustainable composites, Automotive applications, Mechanical properties, Environmental sustainability

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