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Utilizing Microcrystalline Cellulose Extracted from Coconut Waste for Sustainable Biodegradable Plastics Production

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Structured Abstract

Background: The study investigated the structural, morphological, and functional aspects of cellulose and microcrystalline cellulose (MCC) isolated from desiccated coconut waste, as well as how they affected biodegradable starch-based films. Coconut residue, a typical agricultural waste in Malaysia, is frequently disposed of incorrectly, resulting in environmental issues such as air pollution and waste building. MCC, a renewable and cost-effective substance, increases film flexibility and mechanical qualities.

Methods: Microcrystalline cellulose was isolated from desiccated coconut residue using sodium hydroxide, bleaching with hydrogen peroxide and hydrolysis with 4% acid hydrochloric. MCC was characterized for chemical structure, crystallinity, and morphological investigation. Biodegradable films were produced by combining starch powder, microcrystalline cellulose (MCC), distilled water, and glycerol. The films were tested for water absorption by soaking in water for 24 hours, and biodegradability by burying them in soil for 5, 10, and 15 days.

Results: FTIR studies validated the extraction of non-cellulosic components such as lignin and hemicellulose, with MCC showing sharper O-H stretching and greater crystallinity. SEM pictures proved the progressive elimination of lignin and hemicellulose, resulting in unique surface morphologies for cellulose and MCC. XRD measurement revealed a rise in crystallinity index (CrI) from 14.97% for isolated cellulose to 26.45% for MCC, indicating successful acid hydrolysis. Biodegradation studies revealed that films containing MCC decayed more slowly due to their crystalline structure, whilst those without MCC degraded more quickly. Water absorption studies revealed that MCC films absorbed less water (34.38-37.05%) than non-MCC films (58.69-63.99%).

Conclusion: This study reveals the ability of microcrystalline cellulose (MCC) derived from coconut waste to improve the qualities of biodegradable starch-based films. The extraction procedure successfully eliminated non-cellulosic components, yielding MCC with increased crystallinity and specific structural features. Because of their crystalline structure and lower porosity, films reinforced with MCC outperformed those without MCC in terms of durability, water absorption, and biodegradation rate. These findings highlight MCC's capacity to improve the durability, water resistance, and environmental performance of biodegradable films for long-term applications.

Keywords: Biodegradable Film, Coconut Residue, Microcrystalline Cellulose

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