

Biochemical Methane Potential of Coconut and Pineapple Waste

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Structured Abstract

Background: The management of food waste, particularly from tropical fruits like coconuts and pineapples, is a pressing environmental challenge due to its contribution to greenhouse gas emissions and inefficient waste disposal practices. These residues hold potential as renewable energy sources through biogas production, which aligns with global efforts to transition to sustainable energy systems. This study investigates the biochemical methane potential (BMP) of coconut and pineapple waste through anaerobic digestion, aiming to assess their feasibility as biogas feedstocks and to address agricultural waste management challenges.

Methods: Residues of coconuts and pineapples were collected and prepared by chopping and pre-treating for optimal biodegradability. The characterization of substrates included analyses of moisture content, total solids (TS), volatile solids (VS), pH, and CHNS composition. Biochemical methane potential tests were performed under controlled anaerobic conditions with a substrate-to-inoculum ratio of 1:3. Methane production was measured over 40 days using gas chromatography. Kinetic modeling was applied using the first-order kinetic and Modified Gompertz models to analyze and predict methane generation trends.

Results: The study demonstrated that coconut waste yielded a higher cumulative methane production (355.3 mL CH₄/g VS) compared to pineapple waste (303.5 mL CH₄/g VS). The higher yield in coconut waste was attributed to its greater volatile solid and carbon content, which facilitated enhanced microbial activity. Pineapple waste, despite its lower methane yield, showed potential due to its high hydrogen and moisture content, which supported microbial adaptation. Kinetic analysis revealed that the Modified Gompertz model offered superior predictive accuracy, with lower root mean square error (RMSE) and smaller percentage error compared to the first-order kinetic model.

Conclusion: Coconut and pineapple residues demonstrate significant potential for biogas production, offering a sustainable solution for agricultural waste management in tropical regions. The findings highlight the importance of leveraging waste resources to generate renewable energy and mitigate environmental impacts. Coconut waste, with its higher methane output, emerges as a particularly promising feedstock. Future research should explore the economic feasibility and integration of these processes into existing waste management systems to maximize their practical and environmental benefits.

Keywords: Biochemical Methane Potential (BMP), Anaerobic Digestion, Coconut Waste, Pineapple Waste, Renewable Energy

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