An iterative comprehensive evaluation of pretreatment methods, comparative biomass analysis, and sustainability assessment for optimizing anaerobic biogas production from lignocellulosic biomass

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Aims and scope

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Abstract

The burgeoning demand for sustainable energy sources necessitates the exploration of eco-friendly alternatives like biogas derived from lignocellulosic biomass, an abundant and renewable resource. However, the efficacy of biogas production is often marred by the complexity of lignocellulosic structures, necessitating pretreatment to optimize biogas yield.

Current pretreatment methods are either energy-intensive or yield by-products detrimental to the environment, and there is a lack of comprehensive comparative analysis on the biogas potential of diverse lignocellulosic sources. In this study, we propose a holistic model encompassing an integrated approach to optimize biogas production from lignocellulosic biomass. We conducted a comprehensive comparative analysis of diverse biomass sources, namely rice straw, sawdust, bagasse, peanut shells, and corn stover, evaluating their proximate traits and biogas potential. Furthermore, innovative and environmentally benign pretreatment methods were explored to enhance the anaerobic digestion process. Life cycle assessment (LCA) and economic analysis were also performed to evaluate the environmental impacts and cost-effectiveness of the proposed model, ensuring its sustainability. The results revealed a significant enhancement in biogas yield with the employed pretreatment methods, with the optimized anaerobic digestion parameters further augmenting the production. The LCA and economic analysis validated the environmental and economic viability of the model, establishing it as a sustainable alternative to conventional energy sources. This comprehensive study not only addresses the limitations of existing methodologies but also propels the quest for sustainable energy solutions by providing a viable, eco-friendly, and cost-effective method for biogas production from lignocellulosic biomass.

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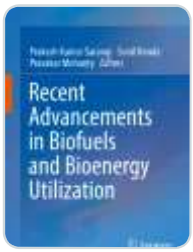

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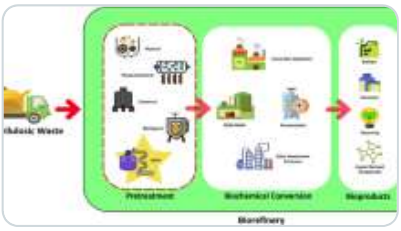

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Ethics declarations

Conflict of interest

The authors declare that they have no conflict of interest.

Ethical approval

The procedure conducted in studies involving human participants adhered strictly to the ethical standards established by the institution and research center. The study obtained ethical approval in accordance with the guidelines set forth by the relevant institutional and research bodies.

Informed consent

Prior to participating in the study, all participants provided informed consent. This consent process ensured that participants were fully informed about the nature of the study, its potential risks and benefits, and their rights as research subjects.

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Keywords

Anaerobic digestion · Lignocellulosic biomass · Biogas production · Pretreatment methods · Sustainability assessments