Bioplastics value chain in a circular economy context

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Stating the problem: The increasing environmental impact of petroleum-based plastics, especially regarding their persistence in ecosystems and low recyclability, has expedited the pursuit of sustainable alternatives, such as thermoplastic starch (TPS), which is both biodegradable and sourced from renewable feedstocks. Nevertheless, the widespread adoption of TPS necessitates its integration into circular economy frameworks that address not only production but also end-of-life processes, which still need to be better studied. This study explores the feasibility of anaerobic digestion (AD) as an effective downstream strategy for the valorization of TPS, evaluating its conversion into biogas and intermediate compounds under diverse operational conditions. Methodology & Theoretical Orientation: Employing a Taguchi orthogonal design, 22 experimental trials were conducted with varying combinations of TPS concentrations, alkalinity levels, temperature regimes, and biochar supplementation. Key performance metrics included methane production, methanization efficiency, specific methanogenic activity (SMA), and volatile fatty acid (VFA) accumulation. The findings indicated that thermophilic conditions (37 °C), moderate TPS loading (4–7 gCOD/L), and alkalinity around 0.5 g/L promoted optimal methane yields and process stability. Conclusion & Significance: Biochar exhibited mixed effects, enhancing microbial activity under certain conditions but not universally improving outcomes. The signal-to-noise ratio analysis corroborated these trends, underscoring the significance of robust system configurations. Overall, this research advances TPS valorization strategies and endorses anaerobic digestion as a promising approach within a circular bioplastics value chain.

Recent Publications

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Biography

Joao Pedro da Silva Moreira dos Santos is an environmental engineering student at the University of Aveiro, with a background in physics and expertise in data science, machine learning, and sustainable innovation. He has contributed to several interdisciplinary research projects involving bioplastics, green chemistry, and artificial intelligence, particularly in the fields of the circular economy, polymer valorisation, and air quality modelling.

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