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BOOK OF ABSTRACTS

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Process Engineering and Disintegration Kinetics of Bio-Based Active Packaging from Agro-Food Waste

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Abstract

The NOVAPACK project addresses the intersection of food waste recovery and advanced material science by developing functional bio-based packaging. This research focuses on the bioconversion of agro-food by-products via Solid-State Fermentation (SSF). By utilizing Lactic Acid Bacteria (LAB), the process synthesizes high-yield bioactive compounds. These molecules, featuring antimicrobial and antioxidant properties, are integrated into polymer matrices through layer-by-layer (LbL) deposition. This technique creates a controlled-release functional barrier, essential for extending food shelf-life while ensuring safety. From an engineering perspective, the study covers the entire cycle: from fermentation protocol optimization to the design of a pilot demonstrator and industrial plant. A core component is the evaluation of end-of-life performance through standardized disintegration assays under industrial composting conditions (ISO 20200:2023). Results highlight a divergence in degradation kinetics. Polylactic Acid (PLA) matrices, neat or modified with 10% tomato extract, exhibited complete disintegration within 50 days at 58 ± 2 °C. The extract showed no inhibitory effect on PLA degradation. Conversely, PHBH demonstrated higher stability. After 85 days, disintegration (D) for the neat polymer reached only ~30%. However, the 10% tomato extract acted as a catalyst, increasing (D) to 40% by potentially enhancing hydrophilicity or microbial colonization, accelerating the breakdown of the PHBH structure. In conclusion, while LbL deposition imparts functionality, the polymer matrix is the primary determinant of the footprint. PLA-based systems are compatible with existing composting infrastructure, whereas PHBH requires further optimization of its architecture to meet rapid disintegration requirements.

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