RETASTE Conference Abstracts
RETASTE-COM-1393-In-person Oral
Rethymno, September 16-18, 2026
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DOI:10.5281/zenodo.23678267

Lignocellulolytic Fungi and Bacteria for the Sustainable Valorization of Mediterranean Organic Waste Biomasses

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Abstract

Organic waste biomasses accumulation highlights needs of sustainable strategies aimed at their recovery and valorization. The present study evaluates four Mediterranean organic waste matrices: olive pomace (OP), lemon/orange pomace (LOP), Posidonia oceanica detritus (POD), and forest pruning residues (PR). Selected lignocellulolytic fungi and bacteria were evaluated for their ability to enhance complex plant-derived polymers degradation, improve substrate characteristics, and support the production of value-added bioproducts. Fungal degradation trials were performed using Aspergillus niger, A. tubingensis, Trichoderma harzianum, Pleurotus ostreatus, and Laetiporus sulphureus. Substrate properties were modified by fungal activity, leading to decreased pH and increased electrical conductivity, both related to organic matter transformation and mineralization processes. OP, LOP, and PR supported extensive mycelial growth, reaching up to 9 cm, whereas POD showed limited colonization, with growth values ≤ 0.5 cm after 9 days of incubation process. Among the tested fungi, A. niger, A. tubingensis, and T. harzianum emerged as the most effective strains, showing strong colonization ability and high degradative potential. Dual-energy computed tomography (DECT) revealed substrate-specific radiodensity changes during fungal biotransformation. OP and LOP inoculated with A. niger and A. tubingensis showed increased median radiodensity values, suggesting biomass accumulation and partial mineralization. Conversely, PR shifted toward negative Hounsfield Unit values, reflecting structural disaggregation and pore formation. In parallel, four bacterial microorganisms were isolated from native P. oceanica detritus and individually inoculated into the four selected matrices to assess their degradative potential. DECT proved to be a powerful non-destructive approach for monitoring density variations and degradation dynamics during microbial biotransformation of organic waste conversion processes. The chemical and physico-analytical results highlight the potential of selected fungal and bacterial microorganisms as promising biotechnological tools to improve substrate biodegradability and support sustainable valorization of agricultural, marine, and forestry waste biomasses.

Keywords: biomasses degradation, biotrasformation, structural disaggregation, DECT