Circular Economy in Food Industry Waste Management (BIVALIA Workshop2 - 2026)

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P.III.1 — Techno-economic assessment of microbial oil and carotenoids production from horticultural residues

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Poster Presentations #33

P.III.1 — Techno-economic assessment of microbial oil and carotenoids production from horticultural residues

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Intensive greenhouse horticulture generates large amounts of organic residues, mainly from vegetables that do not meet fresh market or processing industry requirements. The valorisation of these residues as feedstock for bioenergy and bioproduct production represents a promising strategy within a circular bioeconomy framework. In this context, biorefineries based on oleaginous yeasts are gaining interest for the production of microbial oils and high-value compounds [1]. However, vegetable residues usually present a low C/N ratio, which limits lipid accumulation. Therefore, the addition of an external carbon source is often required to improve lipid production. Lignocellulosic residues, such as urban pruning waste (PW), are particularly attractive due to their high carbon content, low cost and availability.

In this work, a biorefinery process for the production of microbial oils and carotenoids from vegetable residues (VR) and PW was assessed from a techno-economic perspective using the oleaginous red yeast *Rhodosporidium toruloides*. In the proposed process, VR is crushed and separated into a liquid fraction rich in glucose and fructose and a solid fraction mainly composed of glucans. In parallel, PW is pretreated by steam explosion, yielding a water-insoluble solid (WIS) fraction rich in glucan and lignin, and a xylose-rich liquid prehydrolysate. The solid fractions from both feedstocks are enzymatic hydrolysed, filtered to remove residual solids and mixed with the prehydrolysate. A pulse-feeding strategy was considered for fermentation to improve the use of sugar-rich streams. After fermentation, yeast cells are harvested, disrupted and processed through ethanolic KOH saponification, hexane extraction and evaporation to recover carotenoids, while the lipid fraction is obtained by acid neutralisation of fatty acid salts.

The process was modelled in Aspen Plus v14.0 using experimental data obtained at CIEMAT, with the aim of generating the mass and energy balances required for techno-economic evaluation. The results showed promising economic performance compared with conventional vegetable oils. Nevertheless, electricity consumption in the fermenters, mainly associated with aeration and agitation, was identified as the main contributor to operating costs. Therefore, optimisation of the fermentation stage, particularly aeration requirements and residence time, is essential to improve the overall economic viability of the process.

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