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

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Oral Presentations #4

Scaling up organosolv fractionation processes to improve the utilization of lignocellulosic food industry waste

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Keywords: *biomass, fractionation, furfural, cellulose, lignin*

The transition towards a renewable resource-based economy requires technologies capable of fully valorizing lignocellulosic biomass and agro-industrial residues while producing compounds that can compete with petroleum-derived products. This work presents a biorefinery platform based on the use of gamma-valerolactone (GVL) as an organosolv solvent for the efficient fractionation of biomass and agro-food industry residues. The technology enables the selective separation of cellulose, hemicellulose, and lignin under mild operating conditions, preserving the quality of each fraction while reducing process-related costs. Thanks to the high solubilization capacity of GVL, more than 90% of both hemicellulose and lignin can be extracted, while simultaneously obtaining a solid cellulose stream with purities exceeding 90%.

The versatility of the process has been demonstrated using a wide range of feedstocks, including eucalyptus, birch, sugarcane bagasse, pruning residues, grape rachis, grapevine canes, and brewer's spent grain. In addition, the co-processing of materials with different characteristics and particle sizes, ranging from fine powders to wood chips, has been successfully evaluated while maintaining high fractionation yields. Results obtained using fresh and recycled solvent showed equivalent performance, highlighting the feasibility of GVL recovery and reuse.

The cellulose obtained can be directed toward high-value applications such as fiber and textile production or converted directly into fermentable sugars, ethanol, levulinic acid, or 5-hydroxymethylfurfural without additional purification steps. In parallel, the lignin retains much of its native structure, exhibiting high purity, low ash content, and high molecular weight, characteristics that make it suitable for the production of carbon foams, phenolic resins, and polyurethanes. Likewise, the hemicellulose fraction can be directly converted into furfural with yields close to 80%.

Overall, this technology enables the conversion of up to 80% of the biomass into high-value products, generating attractive economic returns while providing a sustainable and scalable pathway for the development of advanced biorefineries. Experiments conducted at the hundreds-of-grams scale further support future industrial scale-up and comprehensive technology validation.