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

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Valorization of food waste into carbon-based materials and bio-based chemicals and fuels

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Invited Speakers #1

Valorization of food waste into carbon-based materials and bio-based chemicals and fuels

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Keywords: *Integrated catalytic process; Waste-derived carbons; Carbohydrate valorization; Renewable platform molecules; Hydrogenative upgrading; C–C coupling; Sustainable aviation fuels*

Food waste is an abundant renewable carbon resource with considerable potential for the production of functional materials, platform chemicals, and sustainable fuels. This work presents an integrated valorization strategy in which food residues are used both as feedstocks for catalytic conversion and as precursors for carbon materials and catalysts.

Glucose-derived and food waste-derived catalytic materials were developed and applied to the conversion of cellulose and carbohydrate-rich food residues into ethylene glycol (EG), demonstrating the feasibility of coupling renewable feedstocks with carbon-based catalytic materials. Within this integrated framework, food residues were also converted into carbonaceous materials through hydrothermal carbonization, followed by carbonization/activation treatment, with the resulting materials applied to the production of biomass-derived value-added chemicals, including EG and furfural.

Low-cost Ni–W catalysts supported on glucose-derived carbons were developed for the one-pot conversion of cellulose into EG, achieving complete cellulose conversion and EG yields of 60–62 % [1-2]. The optimized glucose-derived catalysts were also applied to real waste, producing EG yields of around 40 % from cellulosic urban wastes and up to 21 % through the direct conversion of banana peel, orange peel, and spent coffee grounds [1]. To further integrate waste into catalyst synthesis, orange- and banana-peel-derived carbons were used as Ni–W catalyst supports, yielding 34.7 and 44.3 % EG from cellulose, respectively [3]. Additionally, preliminary results obtained with activated carbon derived from orange peel showed a highly developed porous structure and effective catalytic performance in xylose dehydration, reaching 98 % conversion and a furfural yield of 30.4 %.

The approach further integrates the production of furfural and levulinic acid from carbohydrate-rich feedstocks with their subsequent upgrading into sustainable aviation fuel precursors. These oxygenated platform molecules then undergo carbon–carbon coupling reactions, followed by hydrodeoxygenation, to produce hydrocarbons within the carbon-number range relevant for aviation fuels (C_8-C_{16}).

Overall, this strategy combines waste-derived material synthesis, carbohydrate conversion, and catalytic upgrading within a unified framework, demonstrating the versatility of food waste as both a source of catalytic materials and a renewable feedstock for chemicals and fuels.

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