

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

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Waste management; acidogenic fermentation; biomass

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P.I.2 — From residual municipal waste to high value products: volatile fatty acids and biohydrogen

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Acidogenic fermentation (AF) represents a sustainable pathway for biohydrogen generation from the residual fraction of municipal waste (RFMW). This study evaluated the AF of thermo-hydrolyzed RFMW under batch and semicontinuous regimes, analyzing hydrogen yields, fermentation kinetics, volatile fatty acids (VFA) production, and microbial community shifts. Batch assays tested mixed stabilized sludge (MSS) and digested sewage sludge (SSD) as inocula under different substrate-to-inoculum ratios (SIR). MSS was identified as the superior inoculum, achieving maximum hydrogen yields of 19.4 mL H₂/g volatile solids (VS) at an SIR of 1.5. In these assays, kinetics for MSS were best described by a modified logistic model, favoring the enrichment of hydrogen-producing taxa such as *Bacillus* and *Caloramator*, while end-point VFAs showed a high correlation with butyrate prevalence. Semicontinuous trials were conducted in continuously stirred tank reactors (CSTR) using MSS at hydraulic retention times (HRT) of 3, 5, and 8 days. Semicontinuous operation initially favored fermentative pathways, reaching a peak hydrogen production rate of 19.6 mL H₂/g VS·d at an HRT of 3 days. However, operating at longer retention times induced a progressive metabolic shift from hydrogenogenesis toward methanogenesis, accompanied by moderate acidification, a substantial accumulation of intermediates (VFAs up to 8.4 g/L), and a decline in stability. Microbial community dynamics reflected these functional changes: hydrogenogenic consortia dominated the initial H₂-producing stages, but extended HRTs caused a transition where *Caproiciproducens* shifted toward *Thermoclostridium* and *Deftuviitoga*, allowing low-abundance hydrogenotrophic methanogens to establish. In conclusion, while batch operation optimized hydrogen production via specific inoculum selection, semicontinuous operation revealed that short retention times enhance initial hydrogen yields but compromise system stability. These findings highlight that maintaining long-term acidogenic performance requires strict operational control, particularly pH regulation, to avoid the metabolic diversion of intermediates toward methanogenesis during the valorization of municipal organic waste.

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