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High-value VFAs production from sewage sludge by acidogenic fermentation using food industry waste and organic compounds

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Oral Presentations #5

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Hydrothermal carbonization (HTC) is an efficient technology for sewage sludge valorization, producing a solid fraction (hydrochar) and a liquid by-product labeled as process water (PW). While hydrochar has been investigated for energy and agricultural applications, PW remains underutilized despite its high content of soluble organic compounds and nutrients. This study evaluates the potential use of PW derived from secondary sewage sludge as a substrate for acidogenic fermentation. This work focuses on volatile fatty acid (VFA) production, studying the influence of pH and the effect of different electron donors' addition on VFA yield and selectivity.

Batch fermentation assays were performed under mesophilic conditions (35 °C) using a thermally pretreated inoculum obtained from an industrial anaerobic digester. The effect of pH (5.5, 7.2 and 9.0) and PW solid content, after two different filtration degrees, was initially assessed. Subsequently, chain elongation potential was evaluated by supplementing the reactors with different electron donors (ethanol and lactic acid) at concentrations of 5, 10 and 15 g/L. Thereafter, wine lees and cheese whey were also assessed as electron donors at the same concentrations to substitute the pure compounds. Process evolution was analyzed, monitoring also VFA production and composition.

Results demonstrated that acidic conditions severely limited VFA production regardless of filtration level of PW. In contrast, neutral and alkaline conditions enhanced acidogenic activity, with acetic acid being the predominant product. The highest VFA concentration was achieved using PW filtrated through 0.45 µm at neutral pH. The addition of external electron donors significantly increased VFA production compared with the control. Ethanol addition at 15 g/L resulted in the highest VFA concentration (21.2 g COD/L) and promoted chain elongation towards butyric and caproic acids. Lactic acid addition (15 g/L) achieved similar VFA levels (23.1 g COD/L), favoring propionic and butyric acid formation, likely through the acrylate pathway. Wine lees, despite their ethanol content, showed limited effectiveness and did not promote chain elongation. Conversely, cheese whey increased VFA production to 25.7 g COD/L, with extremely high selectivity to butyric acid, representing 67.8% of the total VFA profile.

These findings demonstrate that HTC integrated with acidogenic fermentation offers a sustainable resource recovery pathway.

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