Hydrothermal Liquefaction of Municipal Solid Waste Streams for Sustainable Biocrude Production

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ABSTRACT (250-300 words)

Hydrothermal liquefaction (HTL) is emerging as a promising thermochemical route for the conversion and upgrading of wet organic waste into energy carriers. HTL promotes the depolymerization and recondensation of organic compounds under subcritical water conditions (250-350 ºC), producing: biocrude, hydrochar, and process water. HTL advantages lie in its ability to process wet feedstocks without prior drying and simultaneously recover energy and nutrients. In this work, food waste (FW; 8 wt.% total solids; 9 wt.% lipids and 1 wt.% protein content) and chicken carcasses (CC; 52 wt.% total solids; 37 wt.% lipids and 22 wt.% protein content) were evaluated as potential feedstocks for biocrude production via conventional and catalytic HTL, as well as through co-HTL of FW and CC. HTL and co-HTL experiments carried out in a 1.8 L high-pressure batch reactor (4530, Parr) varying temperatures between 270 and 330 ºC and solids loadings from 5 to 15 wt.%, whereas catalytic HTL assays were conducted at 330 ºC for 60 min testing the activity of several homogeneous catalysts (0.1 M HCl, 5 wt.% KOH, and 2 wt.% $Cu(C_2H_3O_2)_2$). Biocrude yields ranged between 22-29 wt.% for FW and 61-67 wt.% for CC, depending on operating conditions. While co-HTL of FW and CC exploits synergistic interactions between the lipid- and protein-rich fractions of both feedstocks, the biocrude yield of the mixtures remains intermediate (~40 wt.%) between those obtained from the individual wastes. Catalytic HTL did not significantly increase biocrude yield, but it promoted an increased formation of light distillation fractions (heavy naphtha, kerosene, and gas oil), enhancing their combined proportion by approximately 75% as evidenced by the simulated fractional distillation analysis. Regarding biocrude quality, HHV values were in the range of 32-38 MJ/kg in all cases, while nitrogen content decreased up to 3% under catalytic conditions. The results demonstrate that FW and CC can be efficiently valorized through HTL and co-HTL, achieving competitive biocrude yields and enhanced fuel properties. The incorporation of catalytic pathways enabled both product upgrading and improved energy recovery.

BIOGRAPHY (100-150 words)

Byran Chiguano Tapia holds a B.Sc. in Chemistry from Yachay Tech University (Ecuador, 2020) and an M.Sc. in Materials Science from Eötvös Loránd University (Hungary, 2023). His background includes synthesis and characterization of materials, coordination compounds, and nanomaterials, with experience in different characterization techniques as well as high-pressure and high-temperature experimentation. He has been involved in scientific outreach activities, conferences, and specialized courses. He is currently pursuing a Ph.D. focused on hydrothermal biomass valorization (HTC and HTL) to produce sustainable biofuels and carbonaceous materials.

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