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Hydrothermal carbonization of slurry after dark fermentation

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Dark fermentation (DF) of kitchen waste (KW) produces hydrogen, volatile fatty acids and other by-products, leaving a slurry containing inoculum (digested sludge) and undecomposed KW. Hydrothermal carbonization (HTC) is the thermochemical process that accept moisture in the substrate. The main product of this process is hydrochar, but liquid and gaseous fractions are also produced. In this study the HTC of slurry after the DF process was carried out.

The HTC was performed in a reactor (4563M, Parr) with a working volume of 0.4 dm^3. The temperature of the process was 215°C and was maintained for 2.0 hours. The reactor was then rapidly cooled down. In the first step, the gas fraction was analyzed, followed by the liquid and solid fractions after separation by filtration. Three different substrates were used: slurry before DF, slurry after DF, and slurry after DF concentrated by centrifugation. The dry mass of the slurries (before DF, after DF, and concentrated after DF) were 3.2, 2.5 and 10.7%, respectively.

Based on the analysis, a higher hydrochar production yield was observed for the slurry after DF (40.5%) than for the slurry before DF (28.3%). Interestingly, the concentrated slurry after DF was characterized by the highest production yield of hydrochar (50.7%). Higher calorific values of the hydrochar was obtained, ranging from 16.1 to 18.2 MJ/kg. An inverse relationship was observed for the oil production yield. The highest production of the liquid fraction (70.4%) was obtained for the slurry before DF and the lowest one for the concentrated slurry after DF (48.3%). The pH of the liquid fractions ranged from 4.96 to 5.12. Total organic carbon (TOC) in the liquid fraction after HTC of the slurry before DF, after DF, and concentrated after DF was equal to 5.76, 6.52 and 9.19 g/L, respectively. The number of volatile organic compounds (VOCs) detected by the GC/MS system in the liquid fraction was in the ranged from 52 to 63. Such a complex mixture requires further treatment before it can be used in other processes. The main product in the gas fraction was CO_2, which means that the gas has little potential for use in other processes. The gas production yield ranged from 0.94 to 1.25%.

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