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Effect of Substrate Concentration and Retention Time on the Anaerobic Digestion of Food Waste for the Production of Valuable Chemicals

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PENDING

Abstract

Food waste (FW) is, thanks to its composition and high organic and moisture content, a suitable substrate for anaerobic digestion (AD), an established process currently exploited for the production of biomethane. In AD, ethanol, lactic acid and volatile fatty acids (VFAs), such as acetate, propionate and butyrate, are produced as intermediates during acidogenesis and acetogenesis. Because of their various applications, the economic value of these liquid products is higher than methane. They are currently produced from petrochemical sources and food crops and their industrial production from AD is not yet economically feasible, due to high recovery costs and product inhibition. Hence, a concentrated substrate, which is rarely investigated, would facilitate their recovery and lead to a higher volumetric productivity. To maximise yield, concentration and productivity of the desired liquid phase products, batch and semi-continuous reactors were run, investigating different substrate concentrations of a model FW, hydraulic and sludge retention times (HRT and SRT). In order to have a process with low operating costs and low energy consumption, room temperatu.re was maintained and pH was uncontrolled, reaching acidic values that would inhibit methanogens. Initial substrate concentrations between 429 and 27 gCOD l^{-1} were assessed in batch runs. Lactate was the main product, being 80% in most experiments, due to the low pH (around 4). Results achieved with a more concentrated substrate have so far been promising, reaching a maximum product concentration of 61.5 g l^{-1} with the highest substrate concentration. Similar yields were obtained at all substrate levels (22-16% COD COD^{-1}). Different HRT and SRT were then investigated in semi-continuous runs, in combination with different substrate concentrations. Maximum product concentration of 101 g l^{-1} and yield of 29 % COD COD^{-1} were obtained at HRT of 30 days and fed with a substrate concentration of 429 gCOD l^{-1}. However, the highest productivity of 9.7 g l^{-1}•d^{-1} was achieved in a CSTR with same feed concentration but shorter HRT (7.5 d).

Keywords: food waste, anaerobic digestion, volatile fatty acids (VFAs), acidogenic fermentation

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