Feasibility of biological hydrogen production from anaerobic fermentation of dairy wastewater

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This research was conducted to estimate the potential of dairy wastewater as one type of agri-food feedstock for biological hydrogen production via anaerobic fermentation in a sequencing batch reactor. The bioreactor has a working volume of 6.5 L; it was operated under mesophilic temperature, and without pH control or any pretreatment of the substrate, hence no chemical additives were required. This operation strategy would provide the baseline data for future improvements where necessary. Seed sludge was obtained from a pilot-scale domestic wastewater treatment system for biological nutrients removal. For acclimatization, the reactor was operated for 55 days, with hydraulic retention times (HRT) of 6–12 d and low organic loading rate (OLR) of 0.1 kg COD/m^3.d. During this period, methane was generated along with COD removal efficiency of 80.2%; however, hydrogen evolution was not observed. When the operation mode was changed to HRT of 15 d and OLR of 0.23 kg COD/m^3.d, the amount of hydrogen generated was 0.56 mL H_2/g COD removed, and COD removal efficiency was reduced to 68.0%. In contrast, a decrease in HRT to 2.8 d led to a yield of 13 mL H_2/g COD removed during 16 cycles of operations, though COD removal efficiency was further reduced to 24.2%. The pH of the reactor contents was observed to fall within the range of 4.9-6.5 and the percentage of H_2 in the biogas varied from 42 to 46%. While the hydrogen yield of 0.10 L H_2/L.d was greater than those reported in the literature from previous studies, it is significantly lower than the yield of biohydrogen from other carbohydrate-rich waste materials such as molasses and potato processing wastewater using continuous flow bioreactor and pretreated cornstalks using lab-scale serum bottles. This amount of hydrogen produced will not be sufficient to run a 0.5 kW PEM fuel cell after purification. On the other hand, previous studies have shown that it is possible to power a 5 kW PEM fuel cell using biogas derived from dairy manure, with methane reforming. Anaerobic fermentation of agri-food waste for biohydrogen would be considered a more sustainable technology versus methane reforming; however, substantial increase in hydrogen yield is required before it could become economically feasible.