Wastewater, a valuable resource

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INTRODUCTION

Wastewater requires adequate treatment to prevent water pollution and human health risks, before being discharged in the main water bodies. Biological wastewater treatment is an environmentally friendly process. Anaerobic digestion processes do not need oxygen and are able to produce and recover high valuable chemicals (hydrogen, methane, short chain organic acids SCOAs) from WW treatments [1,2].

This research project focuses on the anaerobic digestion and conversion of municipal wastewaters into valuable chemicals (short chain organic acids SCOAs and hydrogen), energy (hydrogen and methane) and biofertilizer, using open mixed microbial cultures. An in-depth literature review investigated the effect of operating parameters on hydrogen yields, using anaerobic digestion (AD) [3].

METHODS

Laboratory-scale semi-batch rectors (SBR) were carried out using synthetic model of organic waste (50 g COD/1) and an open mixed microbial culture at 38 ºC (**Figure 1**). The inoculum, the source of the mixed microbial culture, was collected from the Gask anaerobic digester plant, which is operated under mesophilic conditions in Turriff, Aberdeenshire, Scotland.

Figure 1: Two-stage SBR process.
Stage 1: Dark fermentation DF fed the prepared organic waste.
Stage 2: Anaerobic digestion AD fed the effluent of the dark fermentation (volatile fatty acids and residual organic waste)

The SBR process is being tested to improve the production of hydrogen (H2) and methane (CH4) and volatile fatty acids (VFA) using a 2-stages process. The pH of the first stage is maintained at slightly acidic conditions (5-6) best for H2 production and stage 2 alkaline focusing on CH4 production.

RESULTS

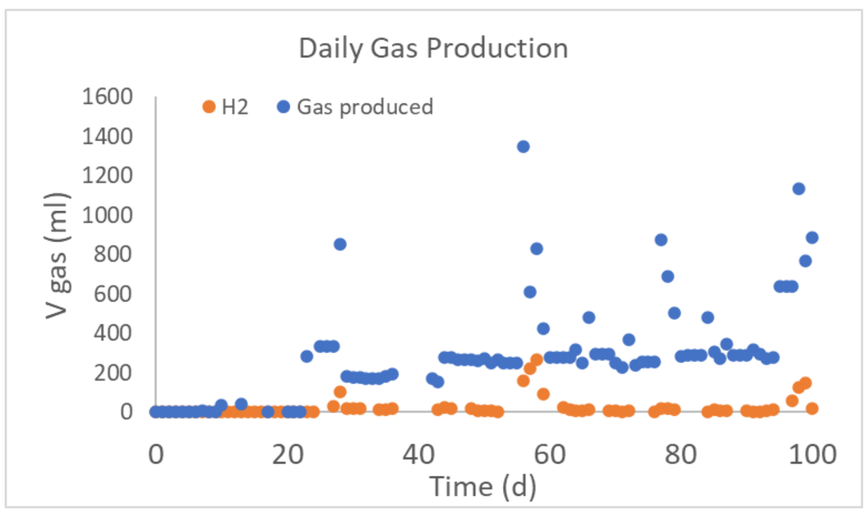

Figure 2: H2 and total gas produced in DF.

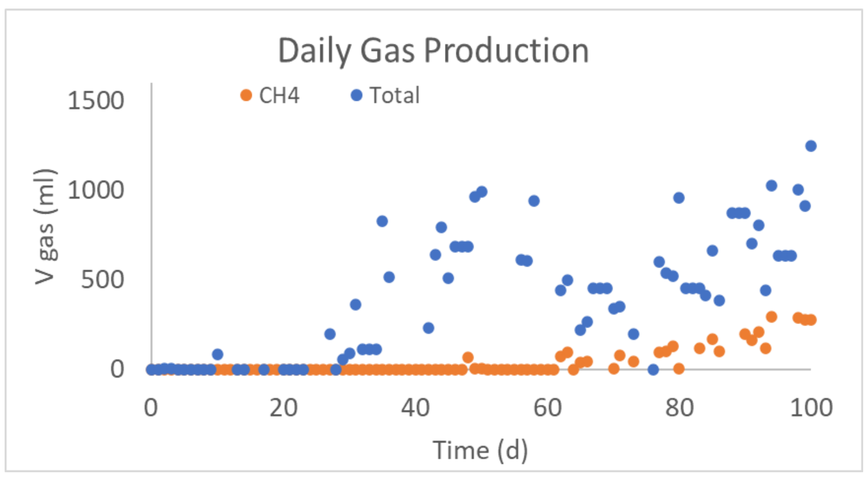

Figure 3: CH4 and total gas produced in AD.

DISCUSSION

During the DF (Stage 1), with a hydraulic retention time (HRT) of 2 days, the SCOD (Soluble COD) drops due to the production of H2 (20 ml per day, on average and yielding 13.96 ml H2/Kg COD) and VFA (**Figure 4**). However, the TCOD does not significantly drop due to the production of new microorganisms using SCOD. The main VFA produced are acetic acid, (iso) butyric acid and propionic acid.
During the AD (Stage 2), with HRT of 6 days, the VFA produced in stage 1 are being converted into CH4 (140.5 ml per day on average and yielding 4.02 ml CH4/Kg COD) and the undigested organic matter into more VFA (**Figure 4**).

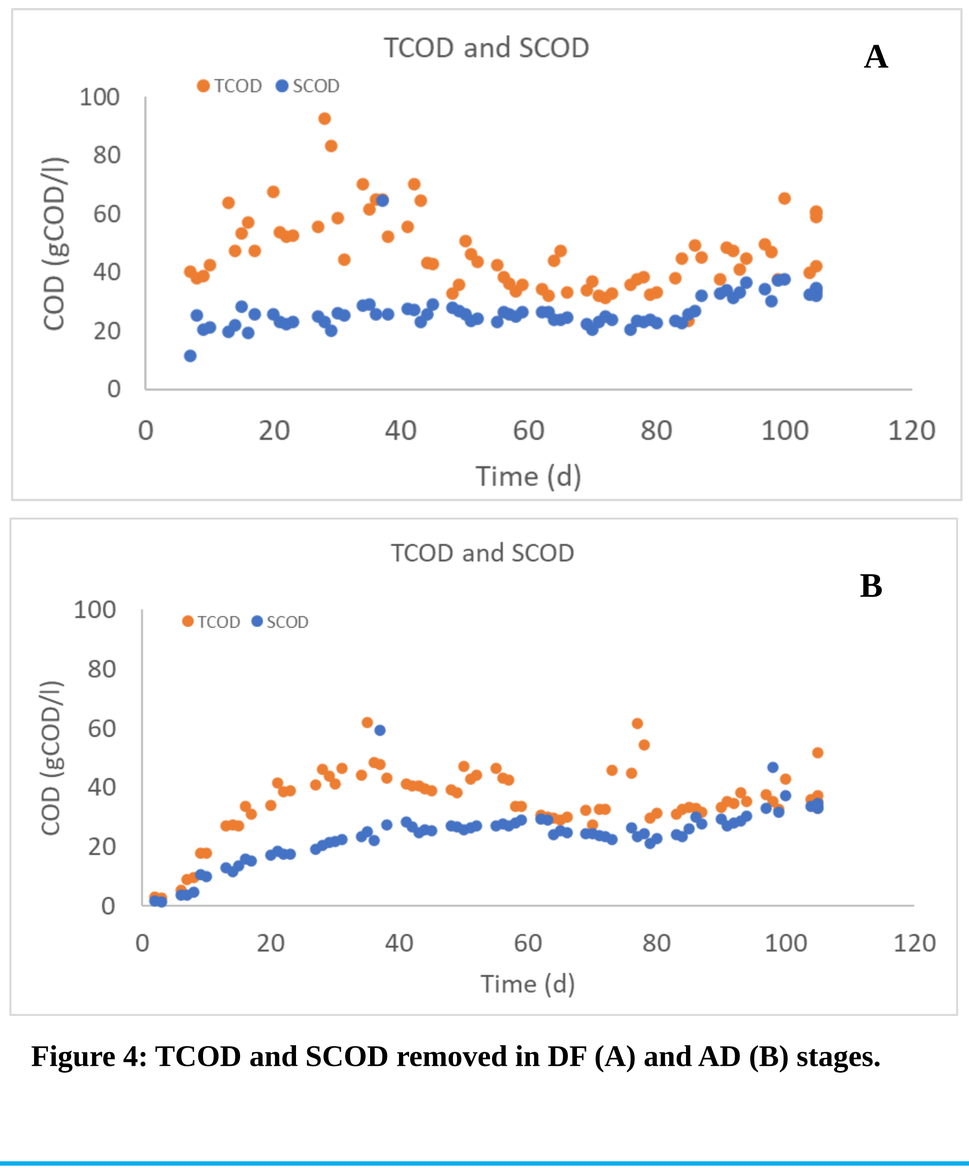

Figure 4: TCOD and SCOD removed in DF (A) and AD (B) stages.

CONCLUSIONS

- SBR process can degrade in a 2-stage process the organic waste (50 g COD/l) using an open mixed microbial cultures and separate DF and AD.

- Next steps involve analyzing the effect of different hydraulic retention time (HRT) on the degradation of the organic substrate and the effect on H2 and CH4 production.

References: [1] L. De Bere, 2000 Anaerobic digestion of solid waste: state-of-the-art. *Wst,* **41** (3), 283-290.
[2] DIONISI, D., BOLAJI, I., NABBANDA, D. and SILVA, I.M.O., 2018. Calculation of the potential production of methane and chemicals using anaerobic digestion. *Biofuels, Bioproducts and Biorefining,* **12** (5), 788-801.
[3] Moussa RN, Moussa N, Dionisi D. Hydrogen Production from Biomass and Organic Waste Using Dark Fermentation: An Analysis of Literature Data on the Effect of Operating Parameters on Process Performance. Processes. 2022; **10**(1):156.

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