RETASTE Conference Abstracts
Vol. 3 RETASTE-ANA-500-Oral
Athens, Greece, 27-29 September, 2023

rethink food resources, losses, and waste 2023 retaste

The Effects of Hydraulic Retention Time, Applied Potential and Pretreatment Process During the Electrofermentation of Cheese Whey

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Abstract

Cheese whey (CW) is the most potent waste generated by dairy industries, as it is characterized by high Chemical Oxygen Demand (COD) and dissolved solids, posing a risk to the environment, the aquatic life and human health, if not properly disposed (Dereli et al., 2019). The conventional CW treatment methods mainly include biological and physico-chemical processes, which result in inefficient valorization or significant capital and operating costs, respectively (Asunis et al., 2020). Anaerobic Digestion (AD) is a well-established and widely-applicable process. However, it can be inhibited from factors such as Volatile Fatty Acids (VFAs) accumulation or high Organic Loading Rates (OLRs) (Stamatelatou et al. 2011). Recently, scientists introduced electrodes in the conventional AD, in order to form an electrofermentation (EF) process (Vassilev et al., 2021). The integrated technology is a promising solution for the efficient treatment of high-strength wastewaters and the enhancement of biogas production, overcoming the limiting factors of the AD reactors (Vassilev et al., 2021). The aim of this study was to examine the EF process, comparatively with the typical AD, utilizing CW as the feed (pH 3.8; sCOD 60 gO2/L; tCOD 66 gO2/L). For this scope two identical 2 L bioreactors were constructed, a typical AD bioreactor and an EF bioreactor. The EF bioreactor was equipped with two submerged carbon felt electrodes (2.5 cm x 10 cm x 2.5 cm each). Both bioreactors were kept in a temperature-controlled box (35 ^{o}C) and were constantly stirred magnetically and operated in a draw-fill mode. The parameters examined were the Hydraulic Retention Time (HRT) (35 and 55 d), CW pretreatment and the applied potential on the EF bioreactor (1 and 2 V). The raw CW was fed with no pretreatment, while the pretreated CW was filtered and the pH was adjusted to 6.2 using a 2% v / v NaOH 2 M solution. The results showed that the AD process failed within the first 20 and 35 d of the draw-fill operation, with the raw and the pretreated CW, respectively. On the

other hand, the EF bioreactor operated for 180 d. Initially, the EF bioreactor treated successfully the raw CW (HRT 55 d), at an applied potential of 1 V (94% sCOD removal and 78% tCOD removal); however it failed at a lower HRT (35 d). The optimal performance of the EF process, in terms of waste treatment, was achieved during the operation with the pretreated CW (HRT of 35 d), at an applied potential of 1 V (98% sCOD removal, 79% tCOD removal and a production of 2.1 Lbiogas / (d * Lreactor) with 62% v / v CH4), while in terms of biogas upgrading, the optimal performance was obtained during the treatment of pretreated CW (HRT 35 d), at an applied potential of 2 V (95% sCOD removal, 84% tCOD removal and a production of 1.8 Lbiogas / (d * Lreactor) with 75% v / v CH4). All in all, the EF process can effectively treat the CW, while producing a good effluent quality and achieving high biogas production, rich in CH4 content, whereas the AD process fails.

Keywords: electrofermentation, cheese whey, applied potential, anaerobic digestion, biogas upgrade, carbon electrodes

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Acknowledgments: The research work was supported by the Hellenic Foundation for Research and Innovation (HFRI) under the 3rd Call for HFRI PhD Fellowships (Fellowship Number: 5675).