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The Effect of the Electrically Conductive and Non-Conductive Carrier Materials on Dark Fermentation in Upflow Biofilters

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ABSTRACT

Due to the increasing global energy demand, the transition to renewable energy sources has become a pressing issue. Dark fermentation (DF) is a promising method for producing biohydrogen as a valuable fuel and simultaneously utilizing organic waste. Among the various methods for optimizing DF, the selection of cultivation parameters and the introduction of carrier materials are crucial. Carrier materials play a vital role in ensuring the formation of biofilms, stimulating electron transfer, and establishing an effective acidogenic microbial community. The aim of this study is to evaluate the impact of conductive and non-conductive carrier materials on the efficiency of DF in upflow biofilters at different organic loading rates (OLR). A model of confectionery wastewater with a carbohydrate concentration ranging from 7.4 to 44.4 g COD/L was used as the substrate. Carbon felt (CF) and iron wool (IW) were chosen as conductive carrier materials, while polyester felt (PF) served as a non-conductive control. The parameters of hydrogen production were similar for CF and PF reactors. The highest H_2 yield was observed at 14.8 g COD/L/d for CF and PF, amounting to 23.8 ml H_2/g COD/d. The highest production rate was noted at 33.3 g COD/L/d and consisted up to 590.5 ml H_2/L/d for PF. With a stepwise increase in OLR, an enrichment of the community with lactate-utilizing H_2-producing microorganisms, such as *Clostridium* sensu stricto 12 and *Prevotella*, was shown. Low DF efficiency was observed in IW-supplemented bioreactors due to methanogenesis. PF showed the best potential for biofouling based on the results of SEM and CLSM analysis. The efficiency of H_2 production in the case of CF was likely related to the contribution of conductivity and stimulation of electron transfer, as the highest ETS activity reached 1.41 mg/mg/h. Hydrogenase activity was similar for all carrier materials under the most effective experimental conditions.

Keywords: Biohydrogen; Dark fermentation; Upflow biofilters; Carrier materials; Organic loading rate

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