

Optimization of Artisanal Fishing Waste Fermentation for Volatile Fatty Acids Production

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Abstract : Fish waste (FW) has a high content of potentially biodegradable components, so it is amenable to be digested anaerobically. In this line, anaerobic digestion (AD) of FW has been studied for biogas production. Nevertheless, intermediate products such as volatile fatty acids (VFA), generated during the acidogenic stage, have been scarce investigated, even though they have a high potential as a renewable source of carbon. In the literature, there are few studies about the Inoculum-Substrate (I/S) ratio on acidogenesis. On the other hand, it is well known that pH is a critical factor in the production of VFA. The optimum pH for the production of VFA seems to change depending on the substrate and can vary in a range between 5.25 and 11. Nonetheless, the literature about VFA production from protein-rich waste, such as FW, is scarce. In this context, it is necessary to deepen on the determination of the optimal operating conditions of acidogenic fermentation for VFA production from protein-rich waste. Therefore, the aim of this research was to optimize the volatile fatty acid production from artisanal fishing waste, studying the effect of pH and the I/S ratio on the acidogenic process. For this research, the inoculum used was a methanogenic sludge (MS) obtained from a UASB reactor treating wastewater of a slaughterhouse plant, and the FW was collected in the port of Tumaco (Colombia) from the local artisanal fishers. The acidogenic fermentation experiments were conducted in batch mode, in 500 mL glass bottles as anaerobic reactors, equipped with rubber stoppers provided with a valve to release biogas. The effective volume used was 300 mL. The experiments were carried out for 15 days at a mesophilic temperature of 37 ± 2 °C and constant agitation of 200 rpm. The effect of 3 pH levels: 5, 7, 9, coupled with five I/S ratios, corresponding to 0.20, 0.15, 0.10, 0.05, 0.00 was evaluated taking as a response variable the production of VFA. A complete randomized block design was selected for the experiments in a 5x3 factorial arrangement, with two repetitions per treatment. At the beginning and during the process, pH in the experimental reactors was adjusted to the corresponding values of 5, 7, and 9 using 1M NaOH or 1M H₂SO₄, as was appropriated. In addition, once the optimum I/S ratio was determined, the process was evaluated at this condition without pH control. The results indicated that pH is the main factor in the production of VFA, obtaining the highest concentration with neutral pH. By reducing the I/S ratio, as low as 0.05, it was possible to maximize VFA production. Thus, the optimum conditions found were natural pH (6.6-7.7) and I/S ratio of 0.05, with which it was possible to reach a maximum total VFA concentration of 70.3 g Ac/L, whose major components were acetic acid (35%) and butyric acid (32%). The findings showed that the acidogenic fermentation of FW is an efficient way of producing VFA and that the operating conditions can be simple and economical.

Keywords : acidogenesis, artisanal fishing waste, inoculum to substrate ratio, volatile fatty acids

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