ENHANCING H_2 PRODUCTION BY ANAEROBIC CO-DIGESTION OF ORGANIC SOLID WASTES AND CHEESE WHEY

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Introduction. Anaerobic Digestion (AD) has been used as a suitable way for the treatment for organic solid wastes (OSW). Additionally, in this process is possible to obtain hydrogen (H_2), which is considered as a potential biofuel due its energetic content. There are several reports on H_2 production using pure cultures and model substrates [1]. However when OSW are used as feedstock the application of axenic cultures is not possible. Therefore the use of mixed cultures is a suitable option for this process.

One of the challenges of the AD is the increment of H_2 production yields. Co-digestion of OSW with other residues or wastewaters that provide complementary nutrients has been reported to increase H_2 production. Moreover, the presence of proteins allows the release of NH_3^+ when hydrolyzed, so that a better control on pH can be attached [2].

In this work, co-digestion of organic wastes and cheese whey was tested for increasing the H_2 production using a mixed anaerobic culture.

Methods. Two batch cultures were performed in a 30 L bioreactor (15 L operation volume). The inoculum for the experiments was taken from an anaerobe digester, and heath pre-treated to eliminate methanogenic bacteria. A mixture of OSW was combined with cheese whey in a 1:1 proportion and then half diluted in water. After inoculation, the bioreactor was flushed with N_2 to guarantee anaerobic conditions. Operation conditions were 35 °C, pH 5.5, 150 rpm. Concentration of protein, reducing sugars, organic acids and hydrogen were measured by Bradford, DNS, HPLC and TCD chromatography, respectively. NaOH 4N and H_2SO_4 20% v/v solutions were automatically added to maintain pH.

Results. Fig. 1 shows the performance of the co-digestion process during the H_2 production. The initial concentration of reducing sugars (1.6 g/L) were 90% during the first 20 h and then maintained below 0.4 g/L. Biogas was produced from the beginning of the process (data not shown) but H_2 production started after 28 h. The same occurred for cellular growth. This lag phase can be associated to an initial hydrolysis process. At this stage, the NaOH solution was added automatically to maintain pH. After 40 h, H_2 production rate increased and the growth rate decreased. At 60 h of culture no more NaOH solution was required for pH control but H_2SO_4 was consumed. This fact could be explained by an increase in the protein hydrolysis rate, which produced alkaline condition due to constant releasing of NH_4^+ groups. At the beginning of the culture, bacteria consumed mainly free sugars. Then, when availability of sugars dropped hydrolysis of proteins increased (60 h). At this time, the highest hydrogen content in biogas was detected (51%). After 110 h, 51 L of H_2 were produced and concentration of reducing sugars was above 0.3 g/L. The highest H_2 production was associated with a better pH a control due to the NH_3^+ release.

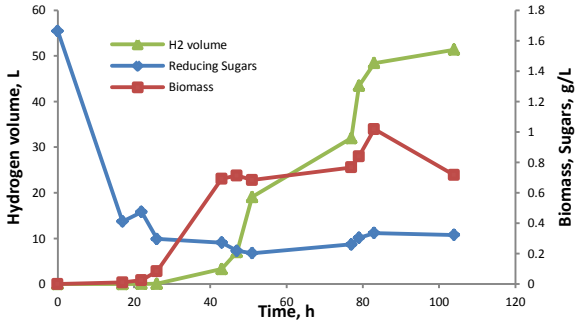

Fig.1 Hydrogen production during co-digestion process.

Conclusions. During this process, a lag phase between inoculation and the start of hydrogen production was identified. Although H_2 production started at 28 h, the highest production rate occurred when the availability of sugars decreased and proteins started to be hydrolyzed The highest H_2 content in the biogas was determined in a relatively short time (60-80 h) makes the co-digestion a suitable process for the H_2 production.

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