Saccharification of Fermented Solids for a Hydrogen Producing Biorefinery

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ABSTRACT

Biorefineries are being devised as an effort to find solutions to multiple problems, i.e. decreased dependence on fossil fuels, new bioproducts development and commodities satisfaction. The production of hydrogen has been successfully coupled to a biorefinery model coined H-M-Z, providing advantages such as the generation the environmental friendly clean fuel hydrogen, and surprisingly an intermediate organic by-product coined as fermented solids (FS) that showed interesting properties for more biofuel and enzymes production. This biorefinery model is comprised by an in-series process for hydrogen and methane production and by a parallel process for holocellulases production. The main substrate was the organic fraction of municipal solid wastes (OFMSW). The objective in this work was to add a new stage for the saccharification of lignocelullosic substrates in a hydrogen producing biorefinery model.

Two saccharification experiments were performed. In the first one (SS-1) two factors were evaluated: type of substrate and type of holocellulolytic enzymes according to a 2x3 factorial design. The substrates were OFMSW, FS, and filter paper Whatman No. 1 (FP). As holocellulolytic enzymes, we used the enzyme extract from Z-stage (*Trichoderma reesei* extract) of the biorefinery model and the commercial enzyme Celluclast (Sigma-Aldrich, USA). In the second experiment (SS-2), the FS was subjected to evaluation at four different levels of enzyme:substrate ratio [40, 60 80, 100 and 120 FP units (g volatile solids)$^{-1}$].

In SS-1 all substrates were best saccharified with the *T. reesei* extract, whereas the most saccharified substrate, independently of the enzyme used, was the FP [up to 18 g of glucose and xylose (L)$^{-1}$]. The FS had up to 34 % higher saccharification than OFMSW, with up to 13.09 g of gluc + xyl (L)$^{-1}$. The highest saccharification efficiency for FS was 75 % on holocellulose basis. In the SS-2, we found that contrary to what expected, the highest enzyme:substrate ratio had no significant positive effect on saccharification yield. Indeed, the ratio 40 FP units (g volatile solids)$^{-1}$ had the highest saccharification yield [11 mg sugars (filter paper unit)$^{-1}$].

In conclusion, the hydrogen production in a biorefinery is transcendental because on the one hand, it provides a renewable clean fuel, and on the other hand, it provides a pre-degraded substrate (saccharified liquors) easily convertible into valuable bioproducts, or even into more biofuels.

Keywords: biohydrogen; cellulases; municipal organic solid wastes; saccharification.