COMPARISON OF PROCESS CONFIGURATIONS FOR ETHANOL PRODUCTION OF EMPTY FRUIT BUNCH PALM

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Key words: Ethanol, Empty Fruit Bunch Palm (EFBP),SHF, Sequential System

Introduction. Rachis or empty fruit bunch palm (EFBP) is a residual material generated during the extraction of palm oil. This lignocellulosic material is a potential sugar source organized as holocellulose (cellulose+ hemicellulose) for ethanol production. In this work, the recovery of sugars present in rachis was studied. For this aim, three sequential steps were used: (1) an alkaline pretreatment, (2) an enzymatic digestion, and (3) holocellulose fermentation with three different fermenting yeasts. Steps two and three were combined in different process configurations. The highest ethanol yield obtained was 158.3 mg/g rachis, with a two-yeast consortium

Methods. Rachis was collected from "Manantiales", a palm oil extraction plant located in Barrancabermeja, Colombia, and characterized using adapted protocols from NREL (Piarpuzán, Quintero, & Cardona, 2011) Enzymatic hydrolysis with commercial enzymes, digestibility calculations and ethanol determination were carried out according to López-Abelairas et al, 2012. The better alkaline washing conditions (alkali concentration, temperature and time) for increasing sugars recovery were determined using a central composite experimental design (data no shown). Fermenting yeast *Saccharomyces cerevisiae* CECT 1332 (SC), *Pachysolen tannophilus* CECT 1426 (PT) and *Pichia stipitis* CECT 1922 (PS) were kindly provided by the Bioprocess Group Strain Collection from USC. Fermentative configurations did include: SHF System, consisting of digestion followed by fermentation using SC or PT; Sequential System comprising three steps, first, hemicellulose digestion, second, PT or PS fermentation, and third, simultaneous cellulose digestion and SC fermentation.

Results. Interestingly**,** the SHF system using PT (which is able to catabolize glucose and most of the hemicellulosic sugars), and SC (which only catalyzes glucose, after the complete enzymatic hydrolysis of holocellulose), did show comparable ethanol yields and productivities (around 64.9-65.7 mg/g rachis and 0.66-0.67 g/L.h, respectively). However, as it can be seen in Fig 1, the best results (21.1 g/L corresponding to 158.3 mg/g rachis) were obtained with the Sequential System, using PT and SC. In contrast, the Sequential System using PS and SC did render 18.73 g/L (140.5 mg/g raquis). This hydrolysis configuration favors the hemicellulosic sugar consumption by PT, compared to the preferential glucose assimilation, showed by these microorganisms.

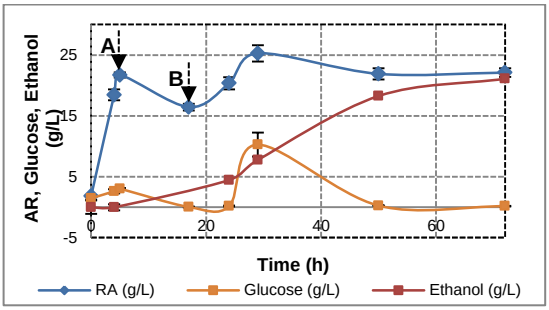

Fig.**1.** Dynamics of a Sequential System, using PT and SC. In A, final time for hemicellulose digestion and beginning of fermentation with PT; temperature is decreased from 50°C to 30°C. In B, beginning of simultaneous cellulose digestion and fermentation with SC; temperature is risen to 35°C.

Conclusions. EFBP, a plentiful residue in palm oil producer countries has showed itself as a remarkable raw material for ethanol production. The use of an alkaline pretreatment together with the optimization of subsequent steps of hydrolysis and fermentation, allowed for obtaining higher ethanol yields.

Acknowledgment. NAG thanks the predoctoral program for Latin America, Banco Santander (Spain) and Colciencias (Colombia) for financial support.

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