EMPIRICAL MODELING AS AN EXPERIMENTAL APPROACH TO EVALUATE SIMULTANEOUS SACCHARIFICATION AND WHEAT STRAW FERMENTATION FOR BIOETHANOL PRODUCTION

Hector A. Ruiz[1], Daniel P. Silva[2], Denisse S. Ruzene[2], Luis F. Lima[1], Diana Jasso de Rodriguez[3], Antonio A. Vicente[1], and Jose A. Teixeira[1]

[1]Institute for Biotechnology and Bioengineering, Centre of Biological Engineering, University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal

[2]Instituto de Tecnologia e Pesquisa, Universidade Tiradentes, Campus Farolândia, 49032-490 Aracaju/SE, Brazil

[3]Universidad Autónoma Agraria Antonio Narro, 25315, Saltillo, Coahuila, México

In simultaneous saccharification and fermentation (SSF) of lignocellulosic materials, a rapid conversion to ethanol of the produced glucose is expected. The principal benefits are to minimize enzyme sugar inhibition, to improve cellulose conversion rates and to reduce cost compared with separated hydrolysis and fermentation, due to the occurring synergy between enzyme-yeast-substrate in one bioreactor. Wheat straw (WS) is an abundant by-product from worldwide wheat production making it an important substrate for bioethanol production.

The aim of this work was to evaluate the effect of temperature, substrate concentration and loading enzyme on bioethanol production by SSF having as substrate WS pretreated by autohydrolysis (AH) and using flocculating Saccharomyces cerevisiae CA11.

A 23 central composite design was applied and the limits of the different parameters were: 30-45ºC; 2-3 % of substrate; 5-30 FPU of cellulose enzyme (Celluclast 1.5) per g dry substrate and 30-60 of β-glucosidase (Novozym 188) IU per g substrate. Ethanol production, residual glucose, and cellobiose were analyzed by HPLC. CO2 was kinetically monitored by weight loss in Erlenmeyer flasks.

Results showed that after 60 h of fermentation the highest ethanol concentration – 14.84 g/l (with a corresponding CO2 value of 14.27 g/l) was obtained at 45ºC, 3% of substrate, 30 FPU and 60 IU. This value, corresponding to an ethanol yield of 84.2%, shows a low enzyme inhibition during SSF process as the glucose produced by enzymatic hydrolysis is rapidly assimilated for yeast cells.

Overall, it may be concluded that WS pretreated by AH is a good substrate for SSF process as high substrate conversion into ethanol can be achieved as a result of the synergy between enzyme-yeast-substrate.