Semana de Engenharia 2010

Guimarães, 11 a 15 de Outubro

PROCESS DEVELOPMENT FOR BIO-ETHANOL PRODUCTION USING WHEAT STRAW BIOMASS

Héctor A. Ruiz*, António A. Vicente, José A. Teixeira
Department of Biological Engineering
E-mail:hector_ruiz@deb.uminho.pt

KEYWORDS

Wheat straw, bioethanol, yeast, lignocellulosic material.

ABSTRACT

Wheat straw is nowadays being considered a potential lignocellulosic raw material (LCM) for fuel-ethanol production as an alternative to starch or sugar-containing feedstock. In this work, the evaluation of process variables (temperature, residence time and particle size) autohydrolysis pretreatment of wheat straw for ethanol production was addressed by means of design of experiments. The recovery of hemicellulose derived sugars (HDS) in the liquid fraction and the ethanol production of the solid residue obtained after filtration of pretreated material were considered as response variables to different processes conditions.

Results show that the optimal conditions were 200 ºC and 30 min, leading to HDS recovery yield of 31.88% of HDS content in raw material and ethanol production yield of 80.1% of theoretical.

METHODOLOGY

Substrate preparation

Wheat Straw was obtained from autohydrolysis of the Department of Biological Engineering.
As soon as obtained the material was washed with water until neutral pH, and dried at 30±5 ° C to attain 8% moisture content (untreated material). The untreated material was submitted to a reaction with water, which consisted in a 1:10 solid:liquid ratio, 200 ºC for 30 min. After reaction the resulting solid material (cellul+lignin) was separated by filtration.

Microorganisms

Saccharomyces cerevisiae strain was isolated from cachaça distilleries in different regions of the state of Minas Gerais, Brazil.

Experimental design for simultaneous saccharification and fermentation process

Cultivations in shake conical flasks were carried out under anaerobic condition in order to determine the fermentability of wheat straw (Figure 1). The cultivation was carried out in a 100- mL Erlenmeyer flask with a loop trap described by (Taherzadeh,1996) in a total volume of 50 ml. The addition of medium solution is: 1% yeast extracted, 2 % peptone, 2.5 ml of citrate buffer and water. To achieve

anaerobic condition, all flasks were purged with nitrogen whereafter a constant overpressure of about 5 mbar was maintained in the flasks during cultivation. Sterile glycerol was used in the loop-traps to prevent oxygen backdiffusion to the medium, while permitting nitrogen and evolved CO2 to leave the flask. The fermentation was carried out in a shaker bath. The liquid samples were withdrawn before inoculation, and after 2, 4, 6, 8, 12, 24, 36, 48, 60 and 72 h of cultivation.

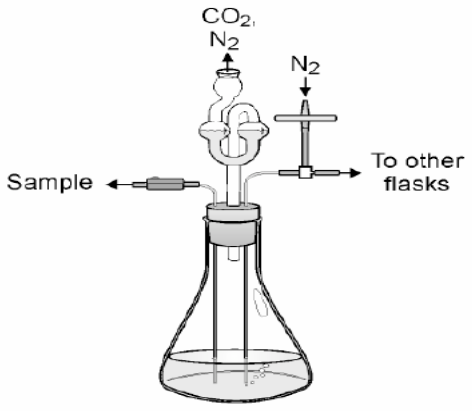


Figure 1. Conical flask for anaerobic batch cultivation

RESULTS AND DISCUSSIONS

Hemicellulose extraction

The hemicellulose extracted after of the pretreatment consisted of xylan. As temperature and time increased, xylan content in WIS decreased as a result of a greater release into the liquid fraction (Figure 2).

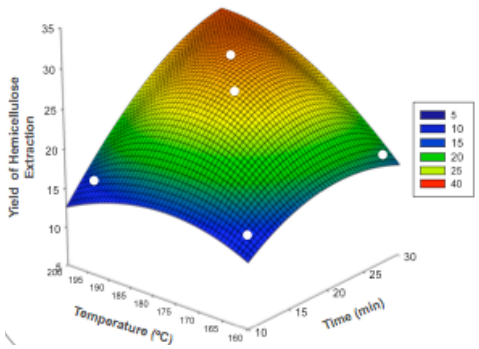


Figure 2. Hemicellulose recovery yield

Simultaneous saccharification and fermentation process

A central point experimental design was performed with different combinations of the variables that were selected shows the experimental data and the values predicted by the model constructed using the final ethanol titre as the response variable. By applying multiple regression analysis on the experimental data, the following second-order polynomial equation giving the ethanol (Y) as a function of Temperature ºC (X1), Substrate % (X2) and loading enzyme (X3) was obtained:

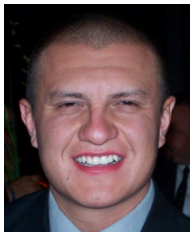
$$\%Y = 12.823 + 1.567X_1 + 3.567X_2 - 1.245X_3 - 2.567X_1^2 - 1.135X_2^2 - 2.582X_3^2 + 3.784X_1X_2 + 3.898X_1X_3 - 2.367X_2X_3 \quad (1)$$

The maxim yield of ethanol was 80.1 at 45 ºC, 2.5 % of substrate and 17.35 FPU/g of cellulase. These results are in agreement with others works, (Alfani, 2000).

REFERENCES

M.J., T. (1996). “The effects of pantothenate deficiency and acetate addition on anaerobic batch fermentation of glucose by Saccharomyces cerevisiae.” 176-182..

Alfani, A., Gallifuoco, a., Saporosi, A., Spera, a., and Cantarella, M. (2000). “Comparison of SHF and SSF processes for the bioconversion of steam-exploded wheat straw”, *Journal of Industrial Microbiology and Biotechnology*, 184-192.



HECTOR A. RUIZ was born in Saltillo, Coahuila Mexico and went to the University of Coahuila, where he studied chemical engineering and obtained his degree in 2004. He worked for three years for the Peñoles Chemical Company before moving in 2007 to the University of Minho where he is studying his PhD in Chemical and Biological Engineering.