SIMPLIFICATION OF THE BIOMASS TO ETHANOL CONVERSION PROCESS BY INTEGRATION WITH THE PRODUCTION OF ENZYMES *IN-HOUSE*

Cristiane Sanchez Farinas
Embrapa Instrumentation
FAPESP Process 2014/19000-3 | Term: Feb 2015 to Jan 2017

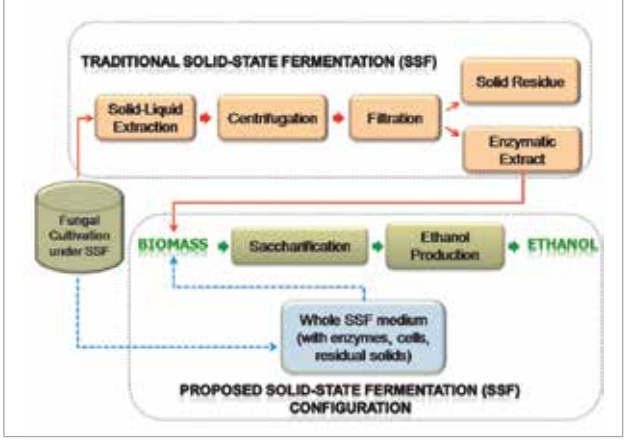

Figure 1. Schematic illustration of a simplified biomass-to-ethanol conversion process. On-site enzyme production is included by using the enzymes from the whole medium of fungal cultivation under SSF in the configuration of the saccharification and fermentation process to obtain ethanol. Conceptually, this process could be carried out in a single reactor system, avoiding the need for additional separation steps (Pirota et al., 2014).

The development of novel and efficient processes for the production of enzymes is a key step to ensure the economic viability of the enzymatic route for the production of biofuels and other bioproducts from plant biomass. To address this technological challenge, researchers from the Agroenergy Laboratory of Embrapa Instrumentation in collaboration with the Federal University of São Carlos conducted a preliminary study to assess the feasibility of an innovative strategy for the simplification of the biomass conversion process using enzymes produced *in-house*. These studies demonstrated the feasibility of using the whole solid-state fermentation (SSF) medium containing enzymes, fungal cells, and residual solid substrate for the saccharification of a lignocellulosic biomass and ethanol production. By using the whole SSF medium, the steps of extraction and filtration can be excluded from the overall process, providing advantages in terms of cost reduction and also avoiding the generation of waste streams. Since the results obtained by the group have shown potential results, this project aims to develop new strategies for the improvement and validation of this novel bioprocess. As a result of this project, it is expected to gather information in order to effectively contribute to generate the necessary technological advances to enable the use of plant biomass as a renewable energy source.

SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

A novel simplified configuration has been proposed for the conversion of biomass to ethanol, using whole-medium enzymatic cocktails (WM) and enzymatic extracts (EE) from different filamentous fungi (*Trichoderma reesei*, *Aspergillus niger*, and *Aspergillus oryzae*), cultivated under solid-state fermentation (SSF), for the hydrolysis of steam-exploded sugarcane bagasse (SESB). The hydrolyzed material derived from the saccharification of SESB using the combinations *A. niger* WM + *T. reesei* EE, *A. oryzae* WM + *A. niger* EE, and *A. niger* EE + *T. reesei* WM resulted in the best biomass conversion yields (66, 65, and 64% of the theoretical reducing sugar yields, respectively). The best ethanol production (84% of the theoretical yield) was obtained using the material hydrolyzed by a combination of *A. oryzae* WM + *A. niger* EE. The enzymatic conversion of SESB using on-site produced enzymes from the whole SSF cultivation medium, followed by an ethanol production step, could be a potential configuration for the biomass to ethanol conversion process. This novel simplified configuration would enable the use of a single reactor system, avoiding the need for additional separation steps. Further evaluation of the operating parameters and the addition of surfactants in the enzymatic hydrolysis step with the whole SSF medium, as well as the realization of fungal co-cultivations under SSF followed by the hydrolysis step with the whole SSF medium is currently been conducted.

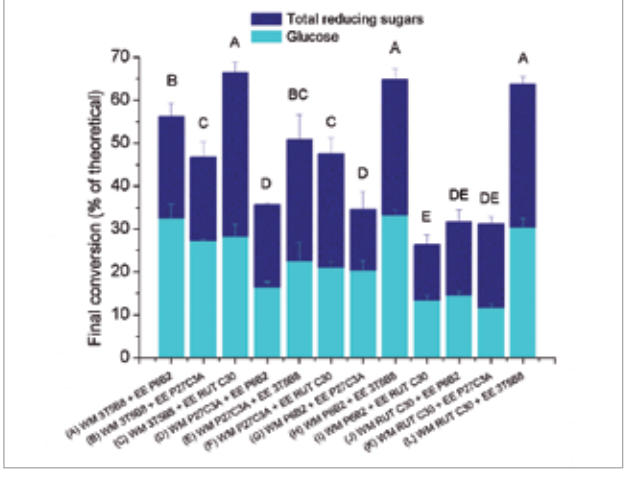

Figure 2. Total conversion of steam-exploded sugarcane bagasse (SESB) after 72 h of hydrolysis using enzymes from the different combinations of whole medium and enzymatic extract. Means with different letters are significantly different (Tukey's test, $p<0.05$) (Pirota et al., 2014).

MAIN PUBLICATIONS

Farinas CS. 2015. Developments in solid-state fermentation for the production of biomass-degrading enzymes for the bioenergy sector. *Renewable & Sustainable Energy Reviews*. **52**: 179-188.

Pirota RDPB, Delabona PS, Farinas CS. 2014. Simplification of the biomass to ethanol conversion process by using the whole medium of filamentous fungi cultivated under solid-state fermentation. *BioEnergy Research*. **7**: 744-752.

Pirota RDPB, Baleeiro FC, Farinas CS. 2013. Saccharification of biomass using whole solid-state fermentation medium to avoid additional separation steps. *Biotechnology Progress*. 29: 1430-1440.

Cristiane Sanchez Farinas

Embrapa Instrumentação
Rua XV de Novembro, 1452
CEP 13560-970 - São Carlos, SP - Brasil

+55-16-2107-2908
cristiane.farinas@embrapa.br