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Seed train development for the fermentation of bagasse from sweet sorghum and sugarcane using a simplified fermentation process

C.C. Geddes [a,b], M.T. Mullinnix [c], I.U. Nieves [c], R.W. Hoffman [c], W.J. Sagues [c], S.W. York [a], K.T. Shanmugam [a], J.E. Erickson [d], W.E. Vermerris [e], L.O. Ingram [a,c,*]

[a] Dept. Microbiology & Cell Science, Univ. Florida, Box 110700, Gainesville, FL 32611, United States
[b] C.E. Geddes, Novozymes, Box 576, 77 Perry Chapel Church Road, Franklinton, NC 27525, United States
[c] Stan Mayfield Biorefinery Pilot Plant, Univ. Florida, One Buckeye Drive, Perry, FL 32347, United States
[d] Dept. Agronomy, Univ. Florida, Box 110965, Gainesville, FL 32611, United States
[e] Dept. Agronomy and Genetics Institute, Univ. Florida, Box 103610, Gainesville, FL 32610, United States

HIGHLIGHTS

- Seed growth using hemicellulose hydrolysate as nutrient.
- 3.6 million-fold expansion of culture.
- One pot fermentation of bagasse (cane, sorghum).
- Liquefaction + simultaneous saccharification & co-fermentation.
- Yields greater than 80 gal/US ton.

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ABSTRACT

A process was developed for seed culture expansion (3.6 million-fold) using 5% of the hemicellulose hydrolysate from dilute acid pretreatment as the sole organic nutrient and source of sugar. Hydrolysate used for seed growth was neutralized with ammonia and combined with 1.0 mM sodium metabisulfite immediately before inoculation. This seed protocol was tested with phosphoric acid pretreated sugarcane and sweet sorghum bagasse using a simplified process with co-fermentation of fiber, pentoses, and hexoses in a single vessel (SScF). A 6 h liquefaction (L) step improved mixing prior to inoculation. Fermentations (L + SScF process) were completed in 72 h with high yields (>80 gal/US ton). Ethanol titers for this L + SScF process ranged from 24 g/L to 32 g/L, and were limited by the bagasse concentration (10% dry matter).

1. Introduction

Lignocellulosic biomass is a potential non-food source of fermentable carbohydrates for the production of chemicals and fuels. Despite almost a century of research in this area, economically viable deployment of such technology at a commercial scale remains challenging (Alvira et al., 2010; Galbe and Zacchi, 2007; Geddes et al., 2011b; Harris, 1949; Hahn-Hägerdal et al., 2006; Palmqvist and Hahn-Hägerdal, 2000).

The composite structure of lignocellulose (cellulose and hemicellulose embedded in a matrix of lignin) is designed to resist deconstruction. Some form of pretreatment (acidic, basic, or physical) is essential for carbohydrate depolymerization (Lee et al., 1999). Both basic pretreatments such as AFEX with ammonia and acidic pretreatments with dilute mineral acids are quite effective in increasing the accessibility of cellulose to enzymatic hydrolysis (Lau and Dale, 2009; Wyman et al., 2009). However, both approaches form side reaction products that retard microbial fermentation (Chundawat et al., 2010; Geddes et al., 2011b; Humpula et al., 2011; Mills et al., 2009) and increase process complexity. The development of yeast-based (Almeida et al., 2007; Liu et al., 2009) and bacteria-based (Geddes et al., 2011a; Miller et al., 2009a,b; Wang et al., 2011) biocatalysts that are resistant to these

* Corresponding author. Address: Dept. Microbiology & Cell Science, Bldg. 981, Box 110700, Univ. Florida, Gainesville, FL 32611, United States. Tel.: +1 352 392 8176; fax: +1 352 846 0969.
E-mail address: ingram@ufl.edu (L.O. Ingram).

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