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Comparison of three screening methods to select mixed-microbial inoculum for mixed-acid fermentations

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HIGHLIGHTS

- ▶ Carboxylate platform converts biomass into hydrocarbons and chemicals.
- ▶ Developed method to identify highest performing inoculum.
- ▶ Five bacterial communities were screened and ranked by three fermentation performance tests.
- ▶ Three screens are a useful and predictive method for choosing optimal inocula sources.
- ▶ Three screens do no predict worst-performing communities.

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ABSTRACT

Using a mixed culture of microorganisms, the carboxylate platform converts biomass into hydrocarbons and chemicals. To develop a method that identifies the highest performing inoculum for carboxylate fermentations, five bacterial communities were screened and ranked by three fermentation performance tests: (1) 30-day batch screen, (2) 28-day continuum particle distribution model (CPDM), and (3) 5-month continuous countercurrent fermentation trains. To screen numerous inocula sources, these tests were used sequentially in an aseptic environment. For the batch-fermentation screen, Inoculum 1 achieved the highest conversion. For the CPDM evaluation, the operating map for Inoculum 1 had the highest performance. For the continuous countercurrent fermentation, the train resulting from Inoculum 1 was among the best performers. This study suggests that the three screens are a useful and predictive method for choosing optimal inocula sources. The bacterial community with optimal performance in these three screens could be considered for use in commercial-scale fermentations.

1. Introduction

From 2004 to 2009, gross energy production increased 10% and global population increased 5% (IEA, 2011). To create a sustainable future, a new energy path is necessary. One approach is to convert over a billion tons of agricultural, municipal, and industrial biowastes generated annually in the United States into liquid biofuels (Perlack et al., 2005). Currently, bioethanol and biodiesel production are the primary biomass-to-liquid fuel routes; they provide about 3% of global road transport fuels (REN21, 2011). Unfortunately, these fuels are produced from high-value food crops. An alternative is the carboxylate platform, which can convert waste lignocellulose into liquid fuels (Agler et al., 2011; Holtzapple et al., 1999).

The carboxylate platform is a low-cost, nonsterile, flexible, and continuous technology that does not need added enzymes to convert nearly any biomass feedstock into chemicals and liquid fuels (Forrest et al., 2010; Granda et al., 2009). The carboxylate platform employs a mixed culture of naturally occurring microorganisms to ferment biomass into carboxylic salts, which are subsequently converted into a wide array of chemicals (e.g., ketones, alcohols) and hydrocarbons (e.g., jet fuel, gasoline) (Aiello-Mazzarri et al., 2006; Landoll and Holtzapple, 2011). To respond to varying market demands, the acid spectrum in the fermentations can be varied by using temperature as a control variable (Chan and Holtzapple, 2003). A commercial example of the carboxylate platform is the MixAlco™ process[1].

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[1] MixAlco™ is a registered trademark of Terrabon, Inc. Unless otherwise noted in this document, inclusion of such trademark in this document does not imply support or endorsement by Terrabon, Inc.

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