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A versatile and robust aerotolerant microbial community capable of cellulosic ethanol production

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HIGHLIGHTS

- A cellulolytic aerotolerant microbial community was enriched from compost.
- Cellulolytic activity was observed in non-reduced as well as pre-reduced media.
- Ethanol and acetate were major fermentation products.
- Cellulolytic activity continued when sterile wastewater was provided as nutrient.
- The culture consisted of both facultative anaerobic and anaerobic members.

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ABSTRACT

The use of microbial communities in the conversion of cellulosic materials to bio-ethanol has the potential to improve the economic competitiveness of this biofuel and subsequently lessen our dependency on fossil fuel-based energy sources. Interactions between functionally different microbial groups within a community can expand habitat range, including the creation of anaerobic microenvironments. Currently, research focussing on exploring the nature of the interactions occurring during cellulose degradation and ethanol production within mixed microbial communities has been limited. The aim of this study was to enrich and characterize a cellulolytic bacterial community, and determine if ethanol is a major soluble end-product. Cellulolytic activity by the community was observed in both non-reduced and pre-reduced media, with ethanol and acetate being major fermentation products. Similar results were obtained when sterile wastewater extract was provided as nutrient. Several community members showed high similarity to *Clostridium* species with overlapping metabolic capabilities, suggesting clostridial functional redundancy.

1. Introduction

Fossil fuels are unsustainable, finite resources and their production and consumption has caused widespread environmental impacts and led to rapid climate change. With such a dramatic increase in the global energy demand over the last century, the complete depletion of fossil fuel reserves is predicted to occur within 50 years (Rodolfi et al., 2009). Consequently, there is an undeniable need for better renewable energy sources.

Bio-ethanol has garnered significant attention as a potential long-term replacement for fossil fuels. Currently, bio-ethanol is produced mainly from sugars derived from food crops such as corn and sugarcane. Because the use of edible crops for fuel production puts a burden on agricultural lands and contributes to rising food prices (Inderwildi and King, 2009), cellulose is an attractive alternative feedstock for bio-ethanol production, due to its abundance and renewability.

To date, much attention has been paid to utilizing pure cultures of anaerobic cellulose-degrading bacteria such as *Clostridium thermocellum* to overcome the challenges related to cellulose recalcitrance (Lynd et al., 2002; Xu et al., 2010). This organism is capable of simultaneously hydrolyzing cellulose and fermenting the resulting sugars to produce ethanol in a process known as consolidated bioprocessing (CBP) (Lynd et al., 2005). Pure culture systems, however, often persist within a narrow range of growth conditions (pH, temperature, oxygen content) and their activity

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