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Review

Application of rumen microorganisms for anaerobic bioconversion of lignocellulosic biomass

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HIGHLIGHTS

- Review the current status of rumen bioconversion process and the fundamental facets.
- Highlight major technological challenges for the application of rumens.
- Provide an overview of the application of rumens for lignocellulsoic biomass conversion.

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ABSTRACT

Rumen in the mammalian animals is a natural cellulose-degrading system and the microorganisms inside have been found to be able to effectively digest lignocellulosic biomass. Furthermore, methane or volatile fatty acids, which could be further converted to other biofuels, are the two major products in such a system. This paper offers an overview of recent development in the application of rumen microorganisms for lignocellulosic biomass conversion. Application of recent molecular tools in the analysis of rumen microbial community, progress in the development of artificial rumen reactors, the latest research results about characterizing rumen-dominated anaerobic digestion process and energy products are summarized. Also, the potential application of such a rumen-dominated process is discussed.

1. Introduction

Climate change, energy insecurity and fossil fuel depletion are driving the rapid development of renewable energy, specifically biofuels, in recent years. Of the various options of feedstock for bioenergy production, the abundantly available lignocellulosic materials present an attractive and promising source (Thanakoses et al., 2003; Hendriks and Zeeman, 2009). Lignocellulosic biomass, consisted of cellulose, hemicelluloses and lignin, can be converted to ethanol, butanol, iso-butanol, hydrogen, methane or other energy products through physicochemical approaches or by biological processes (Thanakoses et al., 2003; Hu and Yu, 2005; Yue et al., 2007; Hendriks and Zeeman, 2009). Anaerobic digestion of lignocellulosic materials offers an attractive avenue for simultaneous recovery of methane as renewable energy source and residual solids or liquid as green fertilizers (Thanakoses et al., 2003).

Cellulose, hemicelluloses and lignin, which are the major components of lignocellulosic biomass, interact with each other and form a rigid structure that increases the difficulty of degradation of lingocellulosic biomass. Despite of the biologically recalcitrant nature of lignocellulosic biomass, it can be efficiently digested by rumen microorganisms in natural eco-systems. This has attracted increasing interests among the researchers worldwide. Rumen microorganisms have been successfully employed to digest a variety of lignocellulosic biomass, including agricultural residues, organic fraction of the municipal solid wastes and aquatic plants (Barnes and Keller, 2004; Hu and Yu, 2005; Yue et al., 2007).

This paper offers a comprehensive overview of the recent development of the rumen-microorganism-predominated digestion processes for lignocellulsoic biomass conversion. First, as the reactor configuration is vital for promoting the activity and growth of rumen microorganisms and for enhancing anaerobic digestion efficiency of lignocellulosic biomass, several reactor configurations and systems are introduced and compared. Second, the characteristics of rumen-predominated processes, based on a series of spectral and chemical analysis methods, are analyzed to explain why

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