Novel cellulase recycling method using a combination of Clostridium thermocellum cellulosomes and Thermoanaerobacter brockii β-glucosidase

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Abstract

This report describes a novel recycling method utilizing a combination of Clostridium thermocellum cellulosomes and Thermoanaerobacter brockii β-glucosidase (CglT). To recover cellulosomes and CglT through re-binding to additional cellulose, a chimeric CBM3–CglT was created by fusing carbohydrate binding module (CBM3) from the scaffolding protein CipA into the N-terminal region of CglT. When a recycling test using cellulosomes and CBM3–CglT was performed on microcrystalline cellulose, the process was capable of 4 rounds of recycling (1% w/v cellulose/round). Although irreversible absorption of cellulosomes and CBM3–CglT into the residues was observed when ammonia-pretreated rice straw and delignified rice straw was used as substrates, a maximum of 2 and 4 recycling rounds (1% w/v glucan/round) were achieved, respectively, consistent with a 70% saccharification rate. This novel recycling method using cellulosomes and CBM3–CglT has great potential as an effective lignocellulose degradation system.

1. Introduction

Lignocellulose consists of three major polymers, cellulose, hemicellulose and lignin, and is expected to be utilized as an abundant renewable resource. However, the plant cell wall is difficult to hydrolyze because the cellulose is surrounded by a lignin seal that is covalently associated with hemicellulose, and cellulase can occur as a tightly packed crystalline structure (Harris and Stone, 2009). Thus, the rate-limiting step in lignocellulose conversion to useful end products, such as bioethanol, is the hydrolysis of cellulose and hemicellulose polymers to sugars.

Among cellulolytic microorganisms, Clostridium thermocellum, an anaerobic, thermophilic, and spore-forming bacterium, is the