Cellulosome systems from anaerobic bacteria for biorefinery

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ABSTRACT:

To develop a bio-based economy for sustainable economic growth, lignocellulosic materials have been used as a renewable resource to produce biofuel and high value-added chemicals. Lignocelluloses are complex mixture of cellulose by the highly crystalline structure, hemicellulose and lignin which together encouragement a rigid structure to solidification the plant cell wall, making it highly recalcitrant to physical, chemical and biological attacks. As we known, the major bottleneck of lignocellulosic biomass processing is fiber saccharification that the conversion of biomass into fermentable sugars to production of high value-added chemicals. To overcome of this state, it is necessary to improve efficiency of enzyme and still seeking for the saccharification process. Several anaerobic cellulolytic microorganisms are known to produce extracellular polysaccharolyticmultienzyme complex known as cellulosome, in which several cellulolytic-xylanolytic enzymes are tightly bound to a scaffolding protein via highly specific interaction between the cohesion and dockerin modules, which affords their catalytic activities to work synergistically and high degradation efficiency toward crystalline cellulose. Here we show that newly *Clostridium thermocellum* strain S14 was isolated from bagasse paper sludge that exhibited faster degradation of microcrystalline cellulose, and 3.4- and 5.6-fold greater Avicelase activity than the high efficient cellulose-degrading strains, *C. thermocellum* ATCC27405 and *C. thermocellum* ATCC31449, respectively. Subsequently, cellulosome produced from strain S14 were used for saccharificationassessment.Thecellulosome of *C. thermocellum* S14 was combined with the recombinant □Glucosidase (rCglT) from anaerobic bacterium *Thermoanaerobacterbrockii,* and then compared with a combination of fungal cellulases (*Trichoderma reesei*cellulase: Celluclast 1.5L and *Aspergillus niger*□glucosidase: Novozyme-188) to hydrolyze pretreated rice straw. The result revealed that a combination of anaerobic microbe enzyme was loaded 10-times lower than a combination of fungal cellulases to achieve the same level of saccharification (91% glucan convert to glucose). It indicated that the cellulosome combination has great potential as a cellulolytic system to be an alternative to fungal cellulases. Additionally, anaerobic bacteria were able to utilized not only effective enzymes but also microorganism itself. This approach relies on anaerobic microbes to ferment substrate to desired products in one step without adding externally produces enzymes i.e. biological simultaneous enzyme production and saccharification (BSES)to make biofuel, or enhancing of biogas production from lignocellulosic waste in anaerobic digestion. Therefore, anaerobic microbes are a key biological cutting-edge technology that can be used forbiorefinery economically feasible in the future.

KEYWORDS:
Anaerobic bacteria; biomass conversion; biorefinery; cellulosome.