



Review

Role and significance of beta-glucosidases in the hydrolysis of cellulose for bioethanol production

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ABSTRACT

One of the major challenges in the bioconversion of lignocellulosic biomass into liquid biofuels includes the search for a glucose tolerant beta-glucosidase. Beta-glucosidase is the key enzyme component present in cellulase and completes the final step during cellulose hydrolysis by converting the cellobiose to glucose. This reaction is always under control as it gets inhibited by its product glucose. It is a major bottleneck in the efficient biomass conversion by cellulase. To circumvent this problem several strategies have been adopted which we have discussed in the article along with its production strategies and general properties. It plays a very significant role in bioethanol production from biomass through enzymatic route. Hence several amendments took place in the commercial preparation of cellulase for biomass hydrolysis, which contains higher and improved beta-glucosidase for efficient biomass conversion. This article presents beta-glucosidase as the key component for bioethanol from biomass through enzymatic route.

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1. Introduction

Depletion of fossil fuel at enhanced rate and its effect on global economic and environment has accelerated the research on alternative fuels like bioethanol. Lignocellulosic bioethanol has been looked as a potential alternative fuel; as the raw material for it is cellulose, which is the main component of the plant cells and is renewable, abundant as well as ubiquitous. Plant biomass is expected to perform the same role in coming years as that of oil in 20th century (Lynd et al., 2002). Biomass can be hydrolysed enzymatically to produce glucose which can be converted to liquid fuel; ethanol. Hydrolysis of biomass can be accomplished by fungal and bacterial biomass hydrolyzing enzymes. There are several enzymes which are required for complete hydrolysis of biomass such as cellulase, xylanase, ligninase, pectinase, etc., among which cellulase is the most important one as biomass contains about 40% or above cellulose. Cellulase is a multi-enzyme complex of three different enzymes; exoglucanase, endoglucanase and beta-glucosidase (BGL) which acts synergistically for complete hydrolysis of cellulose. Cellulose fibers are firstly cleaved in between by endoglucanase releasing small cellulose fragments with free reducing and non reducing ends which are attacked by exoglucanase to release small oligosaccharides, cellobiose; and is finally hydrolysed into glucose monomers by beta-glucosidase. Beta-glucosidase completes the

final step of hydrolysis by converting the cellobiose (an intermediate product of cellulose hydrolysis) to glucose, hence; is the rate limiting enzyme. Most of the fungal cellulases contain these three components at different ratios. *Trichoderma reesei*, a potential cellulase producer, produces cellulase with all the components but it lacks the optimum amount of BGL required for efficient biomass hydrolysis and is further glucose sensitive too. Thus during the process, cellobiose gets accumulated due to less BGL which converts it into glucose, moreover once glucose is accumulated in the medium it also causes feedback inhibition which together exhibits inhibiting effect on the enzymatic hydrolysis of biomass. It could be desirable to construct a genetic modified strain of *T. reesei* producing optimum amount of BGL with desirable properties along with other cellulase component in it, so as to obtain cellulase with all the components in optimal amount. So BGL is the bottleneck in the overall bioethanol production technology from biomass through enzymatic route. The efficient hydrolysis of biomass necessitates the need of glucose tolerant BGL to be active at higher glucose concentration. This article presents a discussion on the significance of BGL especially on bioethanol programme.

2. Beta-glucosidases

Beta-glucosidase (beta-D-glucoside glucohydrolase, EC 3.2.1.21) is one among the earlier discovered and widely studied enzyme due to its universal distribution and well defined wide variety of substrate and simple nature of enzyme assay (Shewale, 1982).

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