Chapter 59
Biotechnology of Microbial Xylanase: Overview

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ABSTRACT

Xylanases are inducible enzymes responsible for the complete hydrolysis of xylan into xylose. Both solid state fermentation (SsF) and submerged fermentation (SmF) are used in the production of xylanase. SsF has become a popular approach due to its economic value. In fact, higher biomass and lower protein breakdown are among the factors involved in determining the production of xylanases in SsF. Agricultural extracts which are abundantly available in the environment such as rice bran and wheat bran are commonly used as the potential carbon source in xylanases production. Xylanase is indeed one of the valuable enzymes which show immense potential in vast industrial applications. The demand for xylanase is increasing because of its prodigious utilization in pulp and paper, bakery, food and beverage, detergents, textile, and animal feed. Xylanase has therefore become one of the important commercial enzymes in recent years.

INTRODUCTION

Xylanases are inducible enzymes which responsible for the complete hydrolysis of xylan into simpler compounds, mainly xylose (Gupta & Kar, 2009). Xylanases are genetically single chain glycoproteins with molecular weight of 6 kDa to 80 kDa. Xylanases are active between pH 4.5 to 6.5 from 40°C to 60°C. Xylanases are produced by numerous numbers of different fungi.Various strains of filamentous fungi such as *Aspergillus niger*, *Aspergillus oryzae* and *Trichoderma spp*have been reported to be the potent producers of xylanases. However, xylanases production is typically restricted to *Aspergillus spp* and *Trichoderma spp* in the industrial scale (Dietmar, Bernd, Kulbe, Walter, & Silvia, 1996). Meanwhile, *Aspergillus spp* are normally selected and optimised for xylanases production. Apart from xylanases, *Aspergillus spp* also produce huge variety of extracellular enzymes including amylase, cellulase and protease

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(Pandey, Nigam, Soccol, Soccol, Singh, & Mohan, 2000). Xylanase shows tremendous potential in many industrial processes especially in textiles, leather, detergents and baking (Bhatnagar, & Imelda-Joseph, 2010). Both solid state fermentation (SsF) and submerged fermentation (SmF) are used in the production of fungal xylanase. SsF has become a popular approach to produce xylanase due to its economical value that does not involved complicated technology. Viniegra-Gonzalez et al. (2003) studied the comparison between SsF and SmF in terms of enzymes production. In fact, they identified out that higher biomass and lower protein breakdown were among the factors involved in determining the production of enzymes in SsF. Besides that, the utilization of inexpensive agricultural extracts in SsF is environmentally sound because besides providing sufficient nutrients as carbon source, it reduces pollutions to the surroundings. Hence, SsF is more economical compared to SmF. Indeed, SsF is in fact, an attractive and economical method for xylanases production especially for fungal cultivations. SsF produces higher enzymes productivity using lower operation and capital cost (Lonsane, Ghildyal, Budiatman, & Ramakrishna, 1985). Malaysia with abundant natural rainforest will be of great advantage in xylanase production using SmF and SsF. Natural resources and agricultural extracts which are abundantly available in the environment such as rice bran, wheat bran, palm kernel cake and soybean hulls are used as potential carbon sources in xylanases production under SmF and SsF (Pang & Ibrahim 2005).

Nonetheless, only a few studies on the optimization of medium formulation for the maximum microbial xylanases production have been conducted. The application of agricultural wastes as the carbon source for the industrial xylanases production are scarce and not comprehensively studied compared and reported in SmF and SsF. Being the simple, non-toxic and cost-effective carbon source to yield xylanases, the replacement of xylan as the substrate with agricultural extracts in SmF and SsF is of great interest particularly in industrial production. Agricultural extracts are the good alternative carbon source due to their similarity in the polymers structure of xylan, as a result, these lignocellulose residualsare suitable to use as the prime carbon source for xylanases production. Besides that, the lack of precise information of the optimum growth conditions on the microbial xylanases production in SmF and SsF also lead to the vast studies over the past few years. There are several crucial fermentation parameters including carbon source, temperature, pH medium and agitation speed used to elucidate and optimize the production of xylanases in SmF and SsF. These parameters are determined by the types of microorganism that yield xylanases. Precisely, suitable parameters allow the proper proliferation of microorganisms to produce high concentration of xylanases. Carbon source provides prerequisite nutrients for growth of microorganisms in SmF and SsF. In order to enhance the xylanases production, cheap but effective carbon source such as agricultural extract is generally added to supply as the prime nutrient. SsF has become a known interest to produce xylanases because of its economical process of using agricultural extracts. Thus, lower cost production of xylanases is easily achieved. Therefore, proper optimization of fermentation parameters would able to produce the desirable xylanases at the maximum level. Additionally, optimum pH medium and temperature possess huge positive impact on the growth of microorganisms and xylanases production. Indeed, optimal pH and temperature in agitated culture show greater xylanases activity compared to non-agitated culture. Nonetheless, further increase of the optimum agitation speed would cause irregular morphology of microorganisms that ultimately lead to xylanases interference. Nevertheless, continuous research and development efforts are being given to SsF to be as compatible as SmF, making it more practicable especially for industrial production.

All in all, xylanase is one of the valuable enzymes which show immense potential in both biotechnological and industrial applications. Notably, filamentous fungi of *Aspergillus spp* have always been the preference choice because they produce higher activity of xylanase than other fungi, yeast and bacteria.