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Application of lignocellulolytic enzymes produced under solid state cultivation conditions

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ABSTRACT

In this paper, cellulose from brown-rot fungus *Fomitopsis* sp. RCK2010, thermostable and alkalostable xylanase from *Bacillus pumilus* MK001 and laccase from *Ganoderma* sp. rckk-02 were evaluated for (i) saccharification of alkali pretreated rice straw and wheat straw, (ii) upgradation of chick feed and (iii) decolorization of dyes, respectively. The cellulose from brown-rot fungus resulted in a sugar release of 151.48 and 214.11 mg/g, respectively, from rice straw and wheat straw, which was comparatively higher than the earlier reports. While xylan, one of the main anti-nutritional factors (ANFs) present in the chick feed was removed to an extent of 11.6 mg/g xylose sugars at 50 °C using the thermostable xylanase. Besides, the treatment with thermostable xylanase also brought about a release of 0.85 (mg/g) of soluble phosphorous. Moreover, the laccase when used for the decolorization of Remazol Brilliant Blue R (RBBR) and xylidine ponceau cause almost complete decolorization in 2 and 4 h, respectively, depicting high rate of decolorization.

1. Introduction

Enzymes have always played a substantial role in the production of variety of commercial products from many industries viz. food processing, beverage production, animal feed, leather, textile and detergent (Gavrilescu and Chisti, 2005; Kuhad and Singh, 2007). These enzymes not only make the process environmentally benign but also play an important role in improving the productivity and eventually the cost of product formation. Since last two decades, among various industrial enzymes, celluloses, xylanases and laccases (lignocellulolytic enzymes) are gaining enormous attention for their potential applications in bioconversion of cellulosic materials into value added commodities, biostoning and biopolishing of jeans, improving efficacy of detergents, maceration and color extraction from juices, enzymatic deinking, pulping, wastewater treatment, to improve the nutritional properties of animal feed, retting of flax, production of oligosaccharides, clarification of juices, biotransformation, treatment of dyes and other organic pollutants and development of biosensors, etc. (Xu, 2005; Kuhad and Singh, 2007; Kuhad et al., 2011).

Specially for more than a decade, hydrolysis of crop-byproducts such as rice and wheat straw, etc. by celluloses has picked up momentum for their conversion into sugars for ethanol production (Kuhad et al., 2010a; Deswal et al., 2011). The information on hydrolysis of crop byproducts (lignocellulosics) by celluloses from soft-rot and white-rot fungi is available in plenty, while the reports on hydrolysis of cellulosics with celluloses from brown-rot fungal celluloses are scanty (Baldrian and Valaskova, 2008). The brown rot-fungi differ substantially from soft-rot and white-rot fungi with respect to the cellulolytic enzymes produced and the pattern of cellulose degradation. These fungi are generally reported to lack the exoglucanases that can hydrolyze crystalline cellulose, yet they cause the most destructive type of wood decay and are important contributors to biomass recycling (Kuhad et al., 1997). However, recently we have observed that *Fomitopsis* sp. RCK2010, a brown-rot fungus, produces exoglucanases (Deswal et al., 2011).

In addition to prominent usage of xylanase in pulp and paper industry (Beg et al., 2001), they have been reported to improve feed value and performance of monogastric animals (Sinha et al., 2011). Xylanases have potential in improving chick feed by hydrolyzing the anti-nutritional factors present in the feed grains i.e. non-starch polysaccharides such as arabinoxylans. Other advantages of using xylanases as feed supplements are dehulling of cereal grains, better emulsification and flexibility of feed materials (Galante et al., 1998).

Textile effluents containing synthetic dyes constitute one of the most problematic wastewaters to be treated not only for their high chemical and biological oxygen demands, suspended solids and toxic compounds but also for their color (Diwaniyan et al., 2010). Biological decolorization by means of ligninolytic enzymes is considered to be a suitable and eco-friendly method to dye degradation and color removal. Among ligninolytic enzymes, laccases have received much attention due to their ability to oxidize both

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