Biocatalytic potential of an alkalophilic and thermophilic dextranase as a remedial measure for dextran removal during sugar manufacture

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1. Introduction

Dextran is a high molecular weight homoglycan comprising of α-1→6 linked glucose units with significant diversity in the branching of glucose (Khalikova et al., 2005). Due to this extensive branching in the glucose units, the physiochemical properties of the dextran are considerably affected in terms of viscosity and solubility. Although dextran has a number of biotechnological applications, it poses a major problem to the sugar industry. Dextrans are not indigenous to sugarcane juice but are formed from sucrose by resident microflora of sugarcane or by strains contaminating the juice during extraction process. Leuconostoc mesenteroides and Lactobacillus species are primarily responsible for these activities (Cuddihy et al., 2000). The presence of dextran in the sugarcane juice used for sugar manufacture is undesirable as they impose a number of deleterious effects like increased viscosity of the sugar syrup. On the contrary, high amounts of dextranase are required during molasses processing (Jiménez, 2009).

During sugar manufacture the sugarcane juice is subjected to elevated temperatures and varying pH conditions indicating need of dextranases active and stable in wide pH and temperature ranges. Although a number of fungal and bacterial dextranases have been successfully purified, only few have reached industrial application. This can be attributed to various factors like high cost of the enzyme and insufficient harvesting techniques (Cuddihy and Day, 1999; Jiménez, 2005). Limitations in application of dextranase in sugar industry are also due to the cumbersomeness during culture preparation and dextranase purification (Decker et al., 2003).

Extracellular dextranases have been previously reported from Streptomyces sp. NK458 with potential to remove dextran formed during sugar manufacture. The dextranase had molecular weight of 130 kDa and hydrolyzed 15–25 and 410 kDa dextran. Dextranase production was optimized using statistical designs and the enzyme was purified 1.8-fold with 55.5% recovery. It displayed maximum activity at pH 9.0 and 60 °C and was stable over a wide range of pH from 5.0 to 10.0. The Km and Vmax values were 3.05 mM and 17.97 mmol/ml/h, respectively. Ten units of dextranase could reduce dextran content by 67% in 24 h and 56% in 72 h from sugarcane juice of cane variety CoS 86032. The enzyme was stable up to 3 days at 30 °C beyond which its activity decreased and dextran removal could be retained by supplementation of 5 U of dextranase. These properties make it a promising biocatalyst for sugar industry.

The present study is focused on dextranase from Streptomyces sp. NK458 with potential to remove dextran formed during sugar manufacture. The dextranase had molecular weight of 130 kDa and hydrolyzed 15–25 and 410 kDa dextran. Dextranase production was optimized using statistical designs and the enzyme was purified 1.8-fold with 55.5% recovery. It displayed maximum activity at pH 9.0 and 60 °C and was stable over a wide range of pH from 5.0 to 10.0. The Km and Vmax values were 3.05 mM and 17.97 mmol/ml/h, respectively. Ten units of dextranase could reduce dextran content by 67% in 24 h and 56% in 72 h from sugarcane juice of cane variety CoS 86032. The enzyme was stable up to 3 days at 30 °C beyond which its activity decreased and dextran removal could be retained by supplementation of 5 U of dextranase. These properties make it a promising biocatalyst for sugar industry.

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