He et al. BMC Biotechnology (2017) 17:22
DOI 10.1186/s12896-017-0343-8

BMC Biotechnology

RESEARCH ARTICLE Open Access

Functional expression of a novel α-amylase from Antarctic psychrotolerant fungus for baking industry and its magnetic immobilization

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Abstract

Background: α-Amylase plays a pivotal role in a broad range of industrial processes. To meet increasing demands of biocatalytic tasks, considerable efforts have been made to isolate enzymes produced by extremophiles. However, the relevant data of α-amylases from cold-adapted fungi are still insufficient. In addition, bread quality presents a particular interest due to its high consummation. Thus developing amylases to improve textural properties could combine health benefits with good sensory properties. Furthermore, iron oxide nanoparticles provide an economical and convenient method for separation of biomacromolecules. In order to maximize the catalytic efficiency of α-amylase and support further applications, a comprehensive characterization of magnetic immobilization of α-amylase is crucial and needed.

Results: A novel α-amylase (*AmyA1*) containing an open reading frame of 1482 bp was cloned from Antarctic psychrotolerant fungus *G. pannorum* and then expressed in the newly constructed *Aspergillus oryzae* system. The purified recombinant AmyA1 was approximate 52 kDa. AmyA1 was optimally active at pH 5.0 and 40 °C, and retained over 20% of maximal activity at 0–20 °C. The K_m and V_{max} values toward soluble starch were 2.51 mg/mL and 8.24×10^{-2} mg/(mL min) respectively, with specific activity of 12.8×10^3 U/mg. AmyA1 presented broad substrate specificity, and the main hydrolysis products were glucose, maltose, and maltotetraose. The influence of AmyA1 on the quality of bread was further investigated. The application study shows a 26% increase in specific volume, 14.5% increase in cohesiveness and 14.1% decrease in gumminess in comparison with the control. AmyA1 was immobilized on magnetic nanoparticles and characterized. The immobilized enzyme showed improved thermostability and enhanced pH tolerance under neutral conditions. Also, magnetically immobilized AmyA1 can be easily recovered and reused for maximum utilization.

Conclusions: A novel α-amylase (*AmyA1*) from Antarctic psychrotolerant fungus was cloned, heterologous expression in *Aspergillus oryzae*, and characterized. The detailed report of the enzymatic properties of AmyA1 gives new insights into fungal cold-adapted amylase. Application study showed potential value of AmyA1 in the food and starch fields. In addition, AmyA1 was immobilized on magnetic nanoparticles and characterized. The improved stability and longer service life of AmyA1 could potentially benefit industrial applications.

Keywords: α-Amylase, Antarctic fungus, Biochemical properties, Bread quality, Immobilization

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