Enhancing enzyme stability and metabolic functional ability of β-galactosidase through functionalized polymer nanofiber immobilization

Abstract

A functionalized polystyrene nanofiber (PSNF) immobilized β-galactosidase assembly (PSNF-Gal) was synthesized as a nanobiocatalyst aiming to enhance the biocatalyst stability and functional ability. The PSNF fabricated by electrospinning was functionalized through a chemical oxidation method for enzyme binding. The bioengineering performance of the enzyme carriers was further evaluated for bioconversion of lactose to galacto-oligosaccharides (GOS). The modified PSNF-Gal demonstrated distinguished performances to preserve the same activity as the free β-galactosidase at the optimum pH of 7.0, and to enhance the enzyme stability of PSNF-Gal in an alkaline condition up to pH 10. The PSNF assembly demonstrated improved thermal stability from 37 to 60 °C. The nanobiocatalyst was able to retain 30 % of its initial activity after ninth operation cycles comparing to four cycles with the unmodified counterpart. In contrast with free β-galactosidase, the modified PSNF-Gal enhanced the GOS yield from 14 to 28 %. These findings show the chemically modified PSNF-based nanobiocatalyst may be pertinent for various enzyme-catalysed bioprocessing applications.