Application of thiolated silica nanoparticles in food industries

[1]Shakeel Ahmed Ansari* and [2]Rukhsana Satar

[1]Department of Biochemistry, Medicine Program, Batterjee Medical College, Jeddah-21442, Saudi Arabia

[2]Department of Biophysiology, Division of Biochemistry, Medicine Program, Ibn Sina National Medical College, Jeddah, Saudi Arabia

***Corresponding Author**

Associate Professor

Mobile: 00966-581482720

E-mail: shakeel.ansari@bmc.edu.sa

ABSTRACT

This study demonstrates the synthesis of silica nanoparticles (Si-NPs) using sol-gel method, followed by thiolation via mercaptopropyl tri-methoxy-silane to encourage covalent binding of *Aspergillus oryzae* β-galactosidase on the developed nanosupport. A higher yield of 89% for enzyme immobilization was obtained on the obtained surface functionalized nanobiocatalyst. The pH and temperature optima of the immobilized and soluble enzymes were found to be 50 °C and pH 4.5, respectively. Nevertheless, when compared to soluble β-galactosidase (SβG), β-galactosidase bound to thiolated Si-NPs (IβG) demonstrated a marked increase in activity under extreme temperature and pH variations. This was due to the improved tolerance towards harsh pH ranges and the limitation of the enzyme's thermal movement at higher temperatures. Furthermore, it was noted that even after an hour, IβG still retained 58% activity at 5% galactose concentration. However, SβG displayed 23% activity in similar experimental conditions. The immobilized enzyme was found to be reusable, retaining 63% of its activity even after six repeat uses. According to the batch reactor experiment, IβG showed 86% and 79% lactose hydrolysis at 50°C and 60°C, respectively, whereas the soluble enzyme showed 71% and 60% lactose hydrolysis under the same conditions after 8 hours. Further investigation into the stability of the generated nanobiocatalyst will be necessary to produce lactose-free dairy products in continuous reactors and to produce galacto-oligosaccharides.

Keywords: β-galactosidase; biotechnological applications; silica nanoparticles; surface modification

Abbreviations: Si-NPs, silica nanoparticles; SβG, soluble β-galactosidase; IβG, β-galactosidase covalently bound to thiolated Si-NPs