Immobilization of cellulase enzyme onto iron oxide nanoparticles to improve thermal and pH stability

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Lignocellulosic enzymes have been used in the pretreatment and hydrolysis of the biomass, are getting special attention to produce the sustainable green biofuel. However, free enzymes not only difficult to separate from reaction media but also highly temperature and pH sensitive, so a controlled environment is required to maintain. A proper immobilization support material needs to adopt to improve their stability and reusability. In this research, cellulase immobilized magnetic nanoparticles were prepared to improve thermal and pH stability and reusability of enzyme.

The magnetic iron oxide nanoparticles (IONPs) were prepared by the chemical co-precipitation method and modified with 3-aminopropyl triethoxysilane (APTES) for amino functionalization. Glutaraldehyde was used as a cross-linker between enzyme and functionalized nanoparticles. The amino groups and aldehyde groups can form stable covalent immobilization that can improve the stability of immobilized magnetic nanoparticles.

The transmission electron microscopy (TEM) demonstrates spare shape nearly monodisperse nanoparticles with a size of 20±5 nm. After cellulase immobilization, a vibrating sample magnetometer (VSM) measured strong 62.8 emu/g magnetizations. Fourier-transform infrared spectroscopy (FTIR) confirmed the immobilization of cellulase onto nanoparticles The prepared nanomaterials demonstrate very high, 97% immobilization efficiency confirmed by the Lowry protein assay. The highest activity of immobilized cellulase was achieved at 40℃ and pH 5. The immobilized nanoparticles exhibit 64% and 47% relative activity at higher pH and temperature, respectively. Immobilized cellulase relative activity was achieved 83% after five cycle of reusability study. Overall, the pH and thermal stability were improved, and higher reusability of enzyme immobilized nanomaterials was achieved.