Adsorption and recycling of heavy metal ions by cell-surface-engineered yeasts

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Global pollution of the environment has become a major issue and has attracted a great deal of public attention. Heavy metal ions are released into the natural hydrosphere from industrial processes. Interest in bioremediation using microorganisms as bioadsorbents has increased considerably in recent years owing to its low cost and high efficiency compared with physicochemical techniques. In microorganisms, heavy metal adsorption arises from metabolism-independent interaction of heavy metal ions with cell-surface components, and from metabolism-dependent uptake followed by intracellular sequestration. Conventional studies on bioadsorbents for the removal of heavy metal ions have focused on metabolic accumulation such as compartmentalization, exclusion from cells and sequestration using metallothionein or phytochelatin with the ability to bind metal ions. In this study, cell surface characteristics were improved as the novel strategy of enhancement of adsorption ability by cell surface engineering.

Cell surface engineering, in which functional proteins are displayed on the cell surface of a microorganism in order to endow intact cells with new functions, has been applied to various fields. In *Saccharomyces cerevisiae*, α -agglutinin has been well studied and used successfully for anchoring various proteins to the cell wall. For the adsorption of heavy metal ions, histidine oligopeptide (hexa-His) or metallothionein was displayed on the yeast cell surface by α -agglutinin-based yeast display system. The constructed cell-surface-engineered yeasts showed not only the enhanced adsorption of heavy metal ions, but also tolerance to toxic heavy metal ions. It was possible to recover the heavy metal ions adsorbed by cell-surface-engineered yeasts with EDTA treatment without disintegrating the cells. Therefore, cells that are used for bioadsorption once can be repeatedly used as a bioadsorbent of metal ions, and the system can be operated for adsorption, recovery, and recycling of heavy metal ions with ease. This is important in considering how to treat the adsorbed heavy metal ions after their removal from contaminated water.