Biosurfactant–metallothionein interactions as a basis for advanced environmental systems

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The increasing demand for sustainable environmental protection strategies has intensified interest in biologically derived molecules such as biosurfactants and metallothioneins. Owing to their unique physicochemical properties, these compounds represent promising tools for bioremediation and green technologies. A detailed understanding of their mutual interactions is essential for the rational design of efficient environmental systems. In this study, metallothionein MMT5 was overexpressed in a *Saccharomyces cerevisiae* system, purified, and subsequently investigated in terms of its interactions with selected lipopeptide biosurfactants, namely amphisin, surfactin, and pseudofactin. Surface activity measurements revealed that the presence of MMT5 does not significantly affect the critical micelle concentration (CMC) of the tested biosurfactants, indicating that initial micelle formation remains largely unaltered. However, at higher concentrations, MMT5 markedly influences micellar stability. While biosurfactants alone form stable micellar systems up to approximately 2×CMC, the addition of MMT5 leads to destabilization and aggregation phenomena. This behavior suggests the presence of competitive or cooperative interactions at the hydrophobic–hydrophilic interface. Fluorescence quenching studies demonstrated that biosurfactants induce structural changes in MMT5, which were further supported by molecular dynamics simulations, providing insight into conformational rearrangements and interaction mechanisms at the molecular level. These findings enhance our understanding of protein–biosurfactant interactions in aqueous environments and provide a foundation for the development of advanced biotechnological systems for environmental applications.

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biosurfactants, metallothionein, protein-surfactant interaction, bioremediation

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