Omics and Mutagenesis: Molecular Optimization Strategies for Strain Improvement in Biosurfactant Production

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Biotechnological Approaches to Sustainable Development Goals

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Abstract

Biosurfactants are bio-based surface-active agents that facilitate mixing of distinct phases using hydrophilic and hydrophobic moieties. Majorly synthesized by bacteria, particularly belonging to *Pseudomonas* and *Bacillus* genera, they are noted as the most economically sought after biotechnological products of the twenty-first century, with extensive applications in various industries as eco-friendly alternatives to chemical surfactants. Despite their numerous advantages over synthetic analogs, the high production costs of biosurfactants impede commercialization. Main aspects of production accounting for these increased costs are fermentation feedstock and downstream recovery, which amounts to 10–30% and 60–70% of accrued costs, respectively. Rhamnolipids, for instance, an industrially important biosurfactant with about 90% purity costs around \$1250 kg^{-1}, while its chemical counterpart with about 99% purity costs between \$10 and \$20 kg^{-1}. To tackle this challenge, molecular techniques have been employed to manipulate genome of producing strains for enhanced synthesis of biosurfactants. Omics-based approaches facilitate understanding of the genetic and metabolic potential of microbial communities thus providing information for improved productivity and possible discovery of novel biosurfactants. Specifically, metagenomics analyzes genomic profile of producing strains, metabolomics provides an overview of metabolites present, metatranscriptomics gives insight into gene functions and regulations, and metaproteomics identifies proteins expressed. These approaches coupled with genetic engineering techniques can reduce production costs by altering biosynthetic pathways of producing strains to utilize cheap substrates and increase yield of biosurfactants produced. Site-directed and random mutagenesis are examples of such techniques applied in creating mutant producing strains capable of utilizing low-cost substrates for biosurfactant production. Whereas both methods alter numerous pathways of cell machinery using various mutagenic agents that lead to improved strains, the site-directed approach involves targeted mutations, while the other is random.

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