ILLINOIS ARCS ADVANCED RESEARCH CENTER AT SINGAPORE

PreFerS CENTRE FOR PRECISION FERMENTATION AND SUSTAINABILITY

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THRUST 1
MICROBIAL CELL ENGINEERING

Focusing on genome-editing food-safe host strains to maximize target product production while minimizing byproduct formation.

The Microbial Cell Engineering thrust is one of the core components of precision fermentation. It focuses on selecting, characterizing, and engineering high-performing host strains that are safe for food production and fermentation. Developing genome-editing methods for food production-friendly Generally Recognized as Safe (GRAS) microorganisms, such as non-conventional yeast strains, fungi, and food-fermenting bacteria, are used to maximize the production of target products namely, proteins, lipids, and nutrients, while minimizing the byproduct formation from cost-effective substrates.

The Challenge

One of the key challenges of precision fermentation involves managing consumers' perceptions and safety concerns of the use of microorganisms and genetic engineering. Traditional genetic engineering methods utilize antibiotic resistance genes for microbial selection, and they are not viable for large-scale operations, as the potential release of engineered microorganisms poses possible downstream effects on human and environmental health.

Another challenge is the commercialization of microbial strains, which are often restricted by intellectual property rights. A technical concern exists in strain development where, despite the availability of basic genetic toolkits and biological parts, a more in-depth understanding and precise engineering are required for high-yield, proprietary industrial strains.

The Solution

To resolve the complexity of consumer perceptions and safety concerns, precise genome-editing method is essential to safely produce food ingredients and fermented foods via precision fermentation. This process ensures only heterologous metabolic pathways for target molecule production while removing endogenous metabolic pathways that produce toxic metabolites and anti-nutrients.

Adaptive laboratory evolution (ALE) and high-throughput screening (HTS) serve as alternative strategies, complementing targeted genome editing with non-targeted host engineering approaches. As this approach does not introduce foreign DNA into microbial hosts, the end product is not classified as genetically modified organisms, thus bypassing the regulatory barriers. Together with the integration of the HTS platform, it identifies high-performing strains among the generated production pool.

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