Trade Science Inc

Journal of Food Science Research

Short Communication

The applications of advanced metabolic engineering in food, nutraceutical and cosmetic industry

Simon ZHANG Congqiang,

Singapore Institute of Food and Biotechnology Innovation

Abstarct

Nutraceuticals and cosmetic ingredients have high values and command large markets. Currently, fermentation processes, chemical synthesis or the combination of the two approaches (or semi-synthesis) supply the bulk of these ingredients. Compared to total chemical synthesis, microbial fermentation has several benefits: efficient production of enantiopure compounds, and the use of sustainable biomaterials that are environmentally friendly, avoiding the use of toxic solvents and catalysts. However, microbial fermentation has limitations and the major one is the relatively low titers and yields in production. The challenges of biomanufacturing of natural products lie partially in the complexity of biological systems, such as intricate cellular metabolism and multilayer regulation networks at the transcriptional, translational and post-translational levels. To overcome it, we have developed some innovative methods and toolboxes (A "plug-n-play" modular biosystem, and Multidimensional Heuristic Process), that significantly increased the production yields and greatly reduced the production costs. Such approaches is gradually competing with chemical synthesis approach and outperforming traditional extraction method in both sustainability, quality and costs. Looking forward, biotechnology-inspired microbial synthesis will be a significant contributor to food, nutraceutical and cosmetic industry.

Natural products have been attracting much interest around the world for their diverse applications, especially in drug and food industries. Plants have been a major source of many different natural products. However, plants are affected by weather and environmental conditions and their successful extraction is rather limited. Chemical synthesis is inefficient due to the complexity of their chemical structures involving enantioselectivity and regioselectivity. For these reasons, an alternative means of overproducing valuable natural products using microorganisms has emerged. In recent years, various metabolic engineering strategies have been developed for the production of natural products by microorganisms. Here, the strategies taken to produce natural products are reviewed. For convenience, natural products are classified into four main categories: terpenoids, phenylpropanoids, polyketides, and alkaloids. For each product category, the strategies for establishing and rewiring the metabolic network for heterologous natural product biosynthesis, systems approaches undertaken to optimize production hosts, and the strategies for fermentation optimization are reviewed. Taken together, metabolic engineering has enabled microorganisms to serve as a prominent platform for natural compounds production. This article examines both the conventional and novel strategies of metabolic engineering, providing general strategies for complex natural compound production through the development of robust microbial-cell factories. Sustainable production of chemicals from renewable non-food biomass has become a promising alternative to overcome environmental issues caused by our heavy dependence on fossil resources. Systems metabolic engineering, which integrates traditional metabolic engineering with systems biology, synthetic biology, and evolutionary engineering, is enabling the development of microbial cell factories capable of efficiently producing a myriad of chemicals and materials including biofuels, bulk and fine chemicals, polymers, amino acids, natural products and drugs. In this paper, many tools and strategies of systems metabolic engineering, including in silico genome-scale metabolic simulation, sophisticated enzyme engineering, optimal gene expression modulation, in vivo biosensors, de novo pathway design, and genomic engineering, employed for developing microbial cell factories. Metabolic engineering is a powerful tool for the sustainable production of chemicals. Over the years, the exploration of microbial, animal and plant metabolism has generated a wealth of valuable genetic information. The prudent application of this knowledge on cellular metabolism and biochemistry has enabled the construction of novel metabolic pathways that do not exist in nature or enhance existing ones. The hand in hand development of computational technology, protein science and genetic manipulation tools has formed the basis of powerful emerging technologies that make the production of green chemicals and fuels a reality. Microbial production of chemicals is more feasible compared to plant and animal systems, due to simpler genetic make-up and amenable growth rates. Here, we summarize the recent progress in the synthesis of biofuels, value added chemicals, pharmaceuticals and nutraceuticals via metabolic engineering of microbes

Biography

Dr Conqiang ZHANG received PhD in a joint program Singapore-MIT Alliance between National University of Singapore and Massachusetts Institute of Technology. He is now leading a team in SIFBI working on multiple academic and industrial projects and initiating several international collaborations. His expertise is metabolic engineering, synthetic biology, enzyme engineering, and industrial microbiology. He has published in top journals of metabolic engineering and synthetic biology as the leading author and filed serval patents on terpenoid biosynthesis and discovery. He serves as the secretary of BioEnergy Society of Singapore and an active reviewer of many prestigious journals in biotechnology. He has received competitive AME Young Investigator Research Grant from A*STAR. He has been invited as a speaker in many international impactful conferences in Asia, EU and US. He is assisting Fermatics, a spinoff company, for the commercial development of bioingredients translated from his two patents