Sustainable Green Cell Factories for Valuable Aromatic Compounds

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The Center for Sustainable Future Technologies of the Italian Institute of Technology (CSFT-IIT), located within the Environment Park in Turin, aims at the development of cutting-edge technologies related to the environmental sustainability, circular economy and ecological transition. In this context, the Systems and Synthetic Biology research line has recently been implemented. Our mission is to design and develop microbial platform for bioproduction to ensure the reduction of anthropic carbon dioxide through capture and valorization and to improve the efficiency in the use of renewable feedstocks within a circular economy perspective.
Currently, we are developing an integrated approach of molecular and synthetic biology, multi-scale bioprocess modelling, chemical engineering and reactor design to implement sustainable green factories - based on the model cyanobacteria species, *Synechococcus elongatus* PCC 7942 and *Synechocystis* sp. PCC 6803- for the production of high-value aromatic compounds. We are carrying out metabolic engineering strategies to divert and improve the carbon flux towards the shikimate pathway, a common route for aromatic compounds synthesis and naturally synthesized molecules that could act as valuable precursors for the chemical and cosmetic industries, particularly 2-phenyl ethanol and *p*-coumaric acid.
Ongoing metabolic engineering strategies envisage the enhancement of the metabolic precursors of the target compounds by overexpression of enzymes involved in the shikimate pathway, the heterologous expression of enzymes for the production of phenylpropanoid downstream of the *p*-coumaric acid and the use of inducible promoters to control the production processes. Side by side, work is being done on optimizing the growth conditions of the mutant strains (CO_2 concentration, light spectrum and intensity and nutrients supplementation), and on the design and implementation of an innovative microfluidic photobioreactor prototype system aimed at improving light distribution, gas-liquid mass transfer and cell light absorption.
Finally, the possibility of coupling the growth of the engineered strains with nutrient recovery from dairy industry wastewaters was preliminarily assessed, in a perspective of low carbon and circular economy.