Synthetic Yeast Based Cell Factories for the Production of Plant Natural Colors

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Poster Session

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The vast majority of today's consumers prefer natural over chemically synthesized pigments in their food products and the global market for natural colors is increasing and expected to reach $2.3 billion by 2019. Among the industry's preferred natural food colors are anthocyanins, which are pigments extracted from edible fruits and vegetables, such as grape, elderberry, red radish and black carrot. Being polyphenols, increasing attention has been paid to their health benefits as potent antioxidants.

Anthocyanins are a class of flavonoids that are derived from shikimic acid and acetyl-CoA. They are extensively glycosylated, acylated and/or methylated resulting in immense diversity; and up to date more than 600 compounds have been identified. These decorations with sugar, methyl, aromatic and aliphatic groups influence the molecular properties of anthocyanins, such as their solubility in water and color shade.

The complex structures of anthocyanins are difficult to mimic by chemical synthesis and their production is therefore limited to extraction from the natural resource, typically resulting in low yields, variable quality and supply, and high production costs. To serve the increasing need for plant natural food colors, it is desirable to develop cheap and reliable production methods. Our aim is therefore to transfer the production of anthocyanins to a microbial host.

The baker's yeast *Saccharomyces cerevisiae* is an intensively applied cell factory for the production of renewable fuels and chemicals. Its genetics and physiology have been extensively studied and recent publications show successful metabolic engineering of acetyl-CoA metabolism and the shikimate pathway, greatly improving yields of different classes of plant natural products. Furthermore, yeast supports heterologous production of e.g. membrane bound cytochrome p450s and glycosyltransferases and synthesis of the flavonoid naringenin, the precursor of anthocyanins, has been demonstrated previously. Therefore, we selected *S. cerevisiae* as microbial host for the production of anthocyanins.

To exploit yeast as cell factory for the biosynthesis of a wide range of natural food colors, we are applying synthetic biology tools to develop an anthocyanin production screening platform. This platform uses a combinatorial approach based on mating a library of gene candidates for decorating enzymes to strains containing the synthetic pathways for the production of defined anthocyanin scaffolds. Novel biosynthetic production systems are constructed by shuffling genes originating from different plant species, expanding the biochemical space of anthocyanins and steering required molecular properties for utilization in the food industry.

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