New Perspectives for a "Purple Biotechnology" by Industrial Application of Photosynthetic Bacteria

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The high potential of anoxygenic photosynthetic bacteria to produce a range of important compounds such as photosynthetic pigments (porphyrines, carotenoids), coenzymes (Q10), biohydrogen and recombinant membrane proteins is well known since many years. Most of these products are associated with intracytoplasmic photosynthetic membranes (PM) which are induced to maximal levels under anaerobic conditions at low light intensities. However, the industrial application is so far limited by the requirement for light, which inevitably becomes a limiting factor at high cell densities and is technically complicated to supply in large-scale bioreactors.

For the non-sulfur purple bacterium *Rhodospirillum rubrum* we opened a new route for industrial application based on an interdisciplinary approach of fermentation experiments and computational modeling. The key to the exploitation of the full potential is a fermentation process that allows to produce maximal levels of PM and associated products completely separated from the availability of light at microaerobic dark conditions. Computational modeling and experimental data indicate that the phenomenon can be explained as a kind a biochemical mimicking of light-signaling in the dark.

Kinetic process modeling was applied for fed-batch high cell density cultivation, yielding 60 g/L cell dry weight. To our knowledge, this value represents the highest cell concentration achieved with a phototrophic bacterium so far.

Transcriptome, proteome and metabolome profiles are now available in addition to ^{13}C metabolic flux analysis and stoichiometric modeling of central metabolic pathways. All together these approaches made a significant contribution for the rational development of *R. rubrum* as a novel cell factory.

Besides traditional applications, further recent developments will be presented, including new expression systems, controllable by environmental factors for large-scale production of recombinant proteins and biocatalytic conversion of CO_2 to value-added products using isolated compounds of purple bacteria.

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