Engineering the red yeast *R. toruloides*

Zongbao K. ZHAO

Division of Biotechnology, Dalian Institute of Chemical Physics, CAS,
Dalian 116023, P. R. China

Email: zhaozb@dicp.ac.cn

Microbial lipids produced by oleaginous yeasts have been recognized as important renewable resources for biofuels and oleochemicals. The red yeast *Rhodosporidium toruloides* is superb for production of neutral lipids, carotenoids and related metabolites under various conditions. However, *R. toruloides* belongs to Basidiomycetous yeast, and its genetic tools have not been well developed. To understand the molecular bases of its oleaginicity, we sequenced the genome of *R. toruloides* and performed trans-omic analysis. Our results demonstrated that triacylglycerol accumulation under nitrogen-limited conditions is tightly connected with cellular processes related to lipogenesis, nitrogenous compounds recycling, macromolecules metabolism and autophagy. Under phosphate-limited conditions, cells activate degradation of phosphorus-containing components including RNA and nucleic acids such as adenosine monophosphate, leading to reduced cell proliferation and enhanced lipid biosynthesis. Some major trans-omic observations have been verified via genetic manipulation of key genes.

To facilitate genetic modification of *R. toruloides*, we developed different transformation methods, identified many genetic elements including promoters, terminators, selectable markers and 2A sequences. Tools have also been devised tools for homologous gene targeting and RNA-interference mediated gene down-regulation. By using the Cas9 gene of *Staphylococcus aureus* origin, we successfully developed the CRISPR/Cas9 system for genome editing in *R. toruloides*. Consequently, advanced strains have been created very recently for production of various metabolites derived from the fatty acid or isoprenoid biosynthetic pathway. In this presentation, these efforts and results therewith will be briefly summarized.

Zongbao K. ZHAO

Professor

Division of Biotechnology

Dalian Institute of Chemical Physics, CAS, China

Education:

PhD, 1995 – 1998 Shanghai Institute of Organic Chemistry, CAS, Shanghai, China

MSc, 1992 – 1995 Hunan Normal University, Changsha, China

BSc, 1986 – 1990 Hunan Normal University, Changsha, China

Professional Career:

2003 – Professor, Dalian Institute of Chemical Physics, CAS, Dalian, China

2001 – 2003 Postdoc, University of Texas at Austin, Austin, USA

1998 – 2001 Postdoc, University of Minnesota-Twin Cities, Minneapolis, USA

Research Interests:

Energy biotechnology, with particular interests in microbial lipids and biodiesel

Chemical biology, with particular interests in application of chemical probes

Synthetic microbiology, with special interests in implementation of non-natural redox cofactors

Selected publications

1. Liu et al., ACS Catalysis, 2019, 9, 1833–1887.
2. Jiao et al., Biotechnology Journal, 2019, 14, 1900036.
3. Wang et al., Biotechnology for Biofuels, 2018, 11, 148.
4. Yang et al., RSC Advances, 2018, 8, 24673–24678.
5. Zhu et al., Nature Chemical Biology, 2017, 13, 360–362.
6. Wang et al., ACS Catalysis, 2017, 7, 1977–1983.
7. Gong et al. Biotechnology for Biofuels, 2015, 8, 189
8. Gong et al., Biotechnology for Biofuels, 2014, 7, 158.
9. Gong et al., Biotechnology for Biofuels, 2013, 6, 136.
10. Zhu et al., Nature Communications, 2012, 3, 1112.