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EDITED AND REVIEWED BY
Shang-Tian Yang,
The Ohio State University, United States

*CORRESPONDENCE
Vasudeo Zambare,
vasuzambare@gmail.com

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Editorial: *Saccharomyces cerevisiae* as a model organism for biochemical engineering and bioprocesses

Vasudeo Zambare[1,2]* and Mohd Fadhil Md Din[1,3]

[1]Centre for Environmental Sustainability and Water Security (IPASA), Universiti Teknologia Malaysia, Johor Bahru, Malaysia, [2]R&D Department, Balaji Enzyme and Chemical Pvt Ltd., Mumbai, India, [3]Department of Water and Environmental Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia

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Editorial on the Research Topic
Saccharomyces cerevisiae as a model organism for biochemical engineering and bioprocesses

Introduction

This Research Topic focuses on promising, recent, and unique research developments related to *Saccharomyces cerevisiae* as a model organism for biochemical engineering and bioprocess development. The call attracted 12 authors who contributed publications to the Research Topic. As a result, the Research Topic includes peer-reviewed papers, comprising four original research articles covering different aspects of *S. cerevisiae*.

Xia et al. reported *S. cerevisiae* C800 as a model organism for squalene production via strain improvement approaches of metabolic engineering and random mutagenesis. Squalene is a natural moisturizer and antioxidant with wider applications in the food, pharmaceutical, and cosmetic industries. Metabolic engineering in the yeast strain was manipulated by integration of tHMG1 (HMG-CoA reductase, HMGR) and IDI1 (isoprenoid diphosphate isomerase) into multi-copy site Ty2 in mevalonate (MVA) followed by the introduction of the ACL (ATP-citrate lyase) gene from *Yarrowia lipolytica*, for citrate lyase where the β-oxidation pathway was enhanced for overexpression of squalene synthase gene. The mutant with overexpressed squalene synthase gene for squalene production was screened using Nile red staining. Moreover, ARTP (Atmospheric and room-temperature plasma) mutagenesis of the metabolically engineered strain showed 18.4% squalene. Industrial feasibility and mass scale production studies showed 8.2 g/L squalene via two-stage fermentation of this mutant in a 5 L bioreactor. Thus, this article shows a technological development in fermentative squalene production that could be an economically and industrially viable alternative to plant-based squalene.

Beugholt et al. address common operational problems during the brewing process, as part of which Brewer's yeast *Saccharomyces pastorianus* TUM 34/70 (a genetic hybrid of *S. cerevisiae* and *Saccharomyces eubayanus*) is highly used. Brewing aeration can act as an environmental stress factor that alters the gene expressions in the yeast cells during its propagation. A target gene CTA1 for catalase A and eight reference genes for various functions in yeast propagation were selected for oxidative stress quantification using the RT-pPCR technique and flow cytometry to quantify the reactive oxygen species (ROS) using dihydroethidium (DHE) staining. The experimental results showed increased expressions of the CTA1 gene with increasing oxygen during yeast propagation and also increased ROS in yeast cells. This study thus develops a method for the quantification of oxidative stress in yeast cell propagation that could help brewers in breweries.

Muratovska and Carlquist report on a method for the production of nonivamide from non-anoic acid and vanillin using recombinant yeast (*S. cerevisiae*) co-expressing system of IpfF (Spingomonas sp. Ibu-2 CoA-ligase), CaAT (Capsicum annuum N-acyltransferase), CvTA (Chromobacterium violaceum amine transaminase), and BsAlaDH (*Bacillus subtilis* alanine dehydrogenase) for amide production. Deletion of gene ADH6 for alcohol dehydrogenase six showed avoidance of byproduct (vanillyl alcohol and vanillic acid) formation from vanillin. The fermentation process conditions, which involved limited oxygen supply, used ethanol as a co-substrate to regenerate NADH (Nicotinamide adenine dinucleotide) and suppress the endogenous expression VDH (vanillin dehydrogenase) and ADH6 (alcohol dehydrogenase). Thus, the present study showed the development of a recombinant *S. cerevisiae* strain for effective and combined transamination and amidation of vanillin for the bioconversion of a potent pain receptor modulator.

Beugholt et al. published an article on the impact of oxygen on the propagation of *S. pastorianus* sp. Carlsbergensis TUM 34/70 (a genetic hybrid of *S. cerevisiae* and *S. eubayanus*) during fermentation that is widely used in industrial brewing. The oxygen was controlled by a membrane filtration process that resulted in an increase in oxygen concentration to 36.5%. The process development showed high yeast propagation in terms of an increase in cell count in a highly saturated aerobic environment. Thus, an oxygen-enriched environment showed maximum dissolved oxygen saturation and hence required a shorter aeration period, which has the additional benefit of foam reduction. Oxygen enrichment in the fermentation showed an increase in yeast cell count and no detrimental impact on cell viability. Thus, the present study is important for mass-scale probiotic propagation in food and beverages, with further investigations on the impact of enriched oxygen on the end product and its recovery are required.

S. cerevisiae is an ideal model organism because of its robustness and adaptability (Huang et al., 2013), extensive fermentability (Parapouli et al., 2020), and promise as a host for genetic manipulation (Schindler, 2020) for advances in the fields of biochemical engineering and bioprocess.

Concluding remarks

The present editorial provides an overview of the articles collected in this Research Topic, which examine *S. cerevisiae* mediated fermentation-based products and bioprocess for the production of industrially important biochemicals (squalene, nonivamide) or improvements in the process that enable maximum cell propagation (cell count), yields, and productivity via gene expression, metabolic engineering, mutagenesis, membrane filtration, and fermentation-based tools and techniques. An examination of the most robust and multi-level applications, *S. cerevisiae* is considered a promising model organism for biotechnological products using biochemical engineering and bioprocesses. The current editorial article focuses on the Research Topic of S. cerevisiae-mediated fermentation-based products and bioprocess for the production of industrially significant biochemicals (squalene, nonivamide) or improvement in the process for maximum cell propagation (cell count), yields, and productivity via gene expression, metabolic engineering, mutagenesis, membrane filtration, and fermentation-based tools and techniques. *S. cerevisiae* is therefore regarded as a model organism for biotechnological products using biochemical engineering and bioprocesses due to its high robustness and multi-level uses.

Author contributions

VZ: Conceptualization, Investigation, Project administration, Resources, Validation, Writing–original draft, Writing–review and editing. MM: Funding acquisition, Supervision, Writing–original draft, Writing–review and editing.

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Conflict of interest

Author VZ was employed by Balaji Enzyme and Chemical Pvt Ltd.

The remaining author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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