Chapter

Introductory Chapter: Yeasts in Biotechnology

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1. Introduction

Yeasts are very important for many reasons. These microorganisms were the first species to be domesticated by man, although not intentionally. For millennia they were used in fermented beverages and foods without knowing their existence. Biochemistry as a science was born when physiologists looked deeper in sugar fermentation in the final of nineteenth century.

Today yeast takes a place in several fields of science and technology. As long as yeast genes and mammal cells encode very similar proteins, these microorganisms are useful as a model to understand and interpret human DNA sequences. Indeed, yeast genetic manipulation is much easier and cheaper than mammalian systems. So yeast has turned out to be a useful model for eukaryotic biology [1, 2].

Furthermore yeasts such as *Saccharomyces cerevisiae*, *Picchia pastoris*, and *Schizosaccharomyces pombe* have been used as model organisms to study cancer biology, including research and development of tumorigenic mechanisms and production of anticancer drugs [3].

Particularly, *Saccharomyces cerevisiae* is a model organism to study epigenetic traits that can be characterized as a stably heritable phenotype resulting from changes in a chromosome without alteration in the DNA sequence. As a result of yeast small eukaryotic genome, short generation time and easy genetic manipulation [4].

Additionally yeasts are very important players in many economical relevant bioprocessing as bakery, brewery, distilling, food industry, and biofuel, leading yeasts to be considered the most explored and studied eukaryotic microorganism.

2. Yeast application

Since 8000 years ago in our history, humans have been using microorganisms to produce fermented foods and beverages. More recently chemicals and fuels have been produced by bioprocesses. The development of cell factories has been incentivized for the industrial production of new chemicals. However the development of new yeast platform cell factory is costly and time-consuming. The difficulty to develop new cell factories to produce a specific metabolite is due to metabolism which has evolved to allow cell growth and maintenance to keep homeostasis [5].

Yeasts from phyla of ascomycetes and basidiomycetes have diverse biotechnological application on food industry. They are responsible for a wide range of fermented products such as alcoholic beverages (e.g., beer, wine, and “cachaça”), fermented milk, cheese, bread, and so on. Yeast also has an application in the functional food industry as probiotics and nutraceutical products [6].

Saccharomyces cerevisiae has been metabolically engineered for the production of first-generation and second-generation bioethanols, advanced biofuels, and chemicals [7–11].

Recently, new tools for genome editing as CRISPR-Cas9 technology have the advantage to allow introduction of many genes into any chromosome location [12, 13]. On the other hand, high-throughput methods as transcriptomic, proteomic, and metabolomic analyses support the introduction of metabolic pathway over cellular physiology metabolism. Indeed next-generation sequencing allows the identification of any genome modification responsible for desirable phenotype [5].

3. Conclusion

In conclusion, we believe that the yeasts are a nearly ideal model system for eukaryotic biology at the cellular and molecular level. Additionally their use in increasingly technological applications will augment the importance of yeast for human well-being.

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Conflict of interest

The authors confirm there is no conflict of interest.

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References

[1] Botstein D, Fink GR. Yeast: An experimental organism for modern biology. Science. 1988;**240**:1439-1443. DOI: 10.1126/science.3287619

[2] Botstein D, Chervitz SA, Cherry JM. Yeast as a model organism. Science. 1997;**277**:1259-1260. DOI: 10.1116/science.277.5330.1259

[3] Ferreira R, Limeta A, Nielsen J. Tackling cancer with yeast-based technologies. Trends in Biotechnology. 2018;**1735**:1-12. DOI: 10.1016/j.tibtech.2018.11.013

[4] Fuchs SM, Quasem I. Budding yeast as a model study epigenetics. Drug Discovery Today: Disease Models. 2014;**12**:1-16. DOI: 10.1016/j.ddmod.2014.04.004

[5] Nielsen J, Keasling JD. Engineering cellular metabolism. Cell. 2016;**164**:1185-1197. DOI: 10.1016/j.cell.2016.02.004

[6] Rai AK, Pandey A, Sahoo D. Biotechnological potential of yeasts in functional food industry. Trends in Food Science and Technology. 2019;**83**:129-137. DOI: 10.1016/j.tifs.2018.11.016

[7] Zhou H, Cheng JS, Wang BL, Fink GR, Stephanopoulos G. Xylose isomerase overexpression along with engineering of the pentose phosphate pathway and evolutionary engineering enable rapid xylose utilization and ethanol production by *Saccharomyces cerevisiae*. Metabolic Engineering. 2012;**14**:611-622. DOI: 10.1016/j.ymben.2012.07.011

[8] Nielsen J, Larsson C, van Maris A, Pronk J. Metabolic engineering of yeast for production of fuels and chemicals. Current Opinion in Biotechnology. 2013;**24**:398-404. DOI: 10.1016/j.copbio.2013.03.023

[9] Basso TP. Improvement of *Saccharomyces cerevisiae* by hybridization for increased tolerance towards inhibitors from second-generation ethanol substrate [thesis]. Piracicaba-SP: University of Sao Paulo; 2015

[10] Jin YS, Cate JHD. Metabolic engineering of yeast for lignocellulosic biofuel production. Current Opinion in Chemical Biology. 2017;**41**:99-106. DOI: 10.1016/j.cbpa.2017.10.025

[11] Kim SR, Skerker JM, Kong II, Kim H, Maurer MJ, Zhang GC, et al. Metabolic engineering of a haploid strain derived from a triploid industrial yeast for producing cellulosic ethanol. Metabolic Engineering. 2017;**40**:176-185. DOI: 10.1016/j.ymben.2017.02.006

[12] Estrela R, Cate JHD. Energy biotechnology in the CRISPR-Cas9 era. Current Opinion in Biotechnology. 2016;**38**:79-84. DOI: 10.1016/j.copbio.2016.01.005

[13] Jakociunas T, Jensen MK, Keasling JD. CRISPR/Cas9 adbances engineering of microbial cell factories. Metabolic Engineering. 2016;**34**:44-59. DOI: 10.1016/j.ymben.2015.12.003