

BIOLOGICAL PROPERTIES OF THE YEAST SACCHAROMYCES CEREVISIAE

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Annotation: It is known that yeast is an important biological object of the community of microorganisms and is widely used in various industries. Various races of the species *Saccharomyces cerevisiae* are used in yeast production. The expansion of biological resources at the expense of other promising species of yeast *Saccharomyces* is an urgent problem.

БИОЛОГИЧЕСКИЕ СВОЙСТВА ДРОЖЖЕЙ SACHAROMYCES CEREVISIAE

Аннотация: Известно, что дрожжи являются важным биологическим объектом сообщества микроорганизмов и широко используются в различных областях промышленности. В производстве дрожжей используются различные расы вида *Saccharomyces cerevisiae*. Расширение биологических ресурсов за счет других перспективных видов дрожжей *Saccharomyces* является актуальной проблемой.

INTRODUCTION

Baker's yeast, *Saccharomyces cerevisiae*, is not only a widely used model system in genetics and molecular biology, but also a promising model for research in ecology and evolution.

In recent years, it has been recognized that *S. cerevisiae* occupies numerous habitats and that populations have important genetic variations [3,10].

The synthesis of yeast toxins can be seen as an example of allelopathy and environmental competition [15].

Natural isolates of the genus *Saccharomyces* have been successfully isolated from various substrates such as bark of deciduous trees, exudates or associated soils, vineyard grapes, wild fruits, and insects such as *Drosophila* [22].

In addition to fermentations such as wine, beer, cider, sake, and bread, *S. cerevisiae* has been isolated from the environment, ranging from soil and trees to human clinical isolates. Each of these environments has a unique selection pressure to which *S. cerevisiae* must adapt [6].

Organelles in *S. cerevisiae* cells have been the subject of research by many research laboratories [4].

S. cerevisiae has a cell wall consisting of two layers, which consist mainly of polysaccharides, but it also contains lipids and proteins.

The cell wall is about 300 nanometers thick and smooth, except for the bud scars that form on the mother cell after the daughter cell buds. Other important organelles for the cell include the nucleus, vacuoles, endoplasmic reticulum, and mitochondria.

The cell wall of *Saccharomyces cerevisiae* is an elastic structure that provides osmotic and physical protection and determines the shape of the cell [8].

The wall makes up 15-30% of the dry weight of a *S. cerevisiae* vegetative cell. A yeast cell consists of a membrane, cytoplasmic membrane, and cytoplasm [21].

The yeast equivalent of mammalian lysosomes is the plant vacuole, which is mainly involved in the breakdown of complex molecules and in the storage of certain components. However, unlike plant cells, yeast lacks chloroplasts [9].

S. cerevisiae strains from genotypically different populations show great divergence of traits in terms of growth characteristics on different substrates, in the presence of toxins or effectors, and mineral and vitamin limitations.

Both plasmid vectors and chromosomal integration are widely used to introduce genes and control copy number in *S. cerevisiae*.

In addition, most *S. cerevisiae* strains carry a separate extrachromosomal DNA genetic element in their nucleus.

S. cerevisiae can be genetically manipulated, allowing both the addition of new genes and the removal of them through a variety of homologous recombination techniques. *Saccharomyces cerevisiae* was the first fully sequenced eukaryotic genome.

The use of *S. cerevisiae* as a host organism for the expression of foreign DNA introduced as plasmid DNA vectors has been an important part of the current advances in recombinant DNA technology (Botstein and Fink, 1988) [5].

In a typical haploid budding yeast cell, there are approximately 12,000 kbp. genomic DNA are subdivided into 16 chromosomes, which are believed to have arisen as a result of an ancient event of duplication of the entire genome from an ancestral set of 8 different chromosomes [20].

The abundance of *S. cerevisiae* associated with fermented beverages initially led to the concept of "artificial organism" limited to human conditions (Vaughan-Martini and Martini, 1995) [4].

Saccharomyces cerevisiae is one of the few yeasts capable of anaerobic growth, albeit only in the presence of added sterol and unsaturated fatty acids. In yeast, these compounds cannot be synthesized in the absence of oxygen [11].

It is believed that the death of yeast begins already at 45-50 ° C, and at 90-95 ° C they die completely. However, according to the latest published data, *Saccharomyces* cells do not die completely at such temperatures, but only receive sublethal damage and lose the ability to grow on nutrient media [2].

S. cerevisiae usually grows as a diploid in an artificial nutrient rich medium such as YPD (1% yeast extract, 2% peptone and 2% dextrose) and propagates clonally by budding with an optimal growth temperature of about 30°C [5].

The energy stimulus for the growth of the studied yeast *Saccharomyces Cerevisiae* are mono- (hexoses - glucose, galactose, mannose and fructose) and disaccharides (sucrose and maltose).

Saccharomyces cerevisiae preferentially produces alcohol from sugar by anaerobic fermentation even when oxygen is available for aerobic respiration [16].

Biological properties of yeast. The ecology of wild *S. cerevisiae* is relatively poorly understood (Boynton and Greig 2014), mainly due to early domestication (Sicard and Legras 2011) and widespread use of commercial strains. *S. cerevisiae* has been used for food and beverage fermentation for several thousand years due to its unique metabolic properties: enzymatic metabolism, tolerance to high concentrations of sugar and ethanol, and the production of specific aromatic compounds [4].

The biotechnological utility of *S. cerevisiae* lies in its unique biological characteristics, i.e. its ability to ferment with the formation of alcohol and CO₂, and its resistance to adverse

conditions of osmolarity and low pH. Among the most well-known applications associated with the use of *S. cerevisiae* are the production of food, beverages, especially wine, and the production of biofuels [12].

The functions of *S. cerevisiae* are mainly associated with the formation of alcohols and other aromatic compounds, but stimulation of, for example, lactic acid bacteria, nutritional enhancement, probiotic effects, inhibition of unwanted microorganisms, and production of tissue-degrading enzymes can also be observed. Several different *S. cerevisiae* isolates have been shown to be involved in fermentation, and some of the isolates exhibit pheno- and genotypic characteristics that deviate from those commonly recognized for *S. cerevisiae* [4].

Saccharomyces yeast has been found to stimulate the growth of other microorganisms, including lactic acid bacteria, by providing essential metabolites such as pyruvate, amino acids, and vitamins.

On the other hand, *S. cerevisiae* has been reported to use certain bacterial metabolites as carbon sources [17].

Saccharomyces cerevisiae is one of the most popular cell factories and is successfully used in the modern biotechnology industry to produce a wide range of products such as ethanol, organic acids, amino acids, enzymes, and therapeutic proteins [13].

The production of enzymes and recombinant proteins, as well as the development of drug screening methods, are commercial applications of yeast cells.

As the first eukaryote to have a fully sequenced genome, *S. cerevisiae* has long been at the forefront of genomic-scale research, including microarrays, systematic gene deletion, and, most recently, the creation of a fully synthetic eukaryotic genome.

Winemaking, brewing and baking are some of the oldest biotechnological processes. In all of them, the main biotransformer is alcoholic fermentation, and the primary microorganism is *Saccharomyces cerevisiae*.

In addition to bioethanol, higher alcohols, such as propanol and butanol, are synthesized by genetically modified or metabolically engineered strains of *S. cerevisiae* [18, 22].

Yeast cells can be grown on almost any scale, from laboratory cultures of a few hundred microliters to huge fermenters for biotechnological purposes.

Saccharomyces cerevisiae is the best characterized eukaryote, the preferred microbial cell factory for the largest industrial biotechnology product (bioethanol), and a reliable commercially compatible scaffold for use in various chemical industries [5,19].

The yeast *Saccharomyces cerevisiae* serves as a very important model organism for studying the molecular mechanisms underlying complex diseases such as cancer, diabetes, and various metabolic disorders.

It was concluded that the prophylactic administration of live *Saccharomyces cerevisiae* cells should be used to increase resistance to bacterial infections, in particular of the respiratory tract, or to viral infections, and also as an adjunct to antibiotic and antiviral therapy [14].

Vaccines based on *Saccharomyces cerevisiae*, in which yeast is engineered to express viral or tumor antigens, represent an ideal therapeutic approach due to their ability to stimulate tumor or virus-specific CD4⁺ and CD8⁺ T cell responses that can reduce the disease burden.

Several clinical and experimental studies have shown that *Saccharomyces cerevisiae* var. *Boulardii* is useful to a lesser or greater extent in the prevention or treatment of a number of gastrointestinal diseases [1,7].

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