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Yeast: Characteristics and Economic Significance

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Abstract

The word yeast has come from English language and it means foam or bubble. The yeasts have wide use in industries such as cooking, wineries, breweries, antibiotic production. About 1500 species of yeasts have been discovered till date. Their isolation and identification are of very importance. Morphological, physiological, biochemical characteristics are easier to detect and are equally necessary for classification. They are generally found in a wide range of marine, terrestrial, aquatic ecosystems and seldom occur in the absence of either molds or bacteria. The cells are about 3-4 µm in diameter and may become multicellular by forming pseudohyphae. Most yeasts reproduce asexually by mitosis mainly by an asymmetric division called as budding. Yeasts multiply as single cells that divide by budding (e.g., *Saccharomyces*) or direct division (fission, e.g., *Schizosaccharomyces*), or they may grow as simple irregular filaments (mycelium).

Keywords: Yeast; Budding; Fission; Mycelium

Introduction

Yeasts are chemo-organotrophs as they can use inorganic chemicals as a source of energy. Thus, considering all these characteristics, growth media can be formulated to isolate only yeasts and eliminating bacteria as well as molds. Yeast can be isolated from the skins of fruits and berries like grapes, apples, peaches, and exudates from plants such as plant saps or cacti. Some yeast is found in association with soil and insects. Yeasts, including *Candida albicans*, *Rhodotorularubra*, *Torulopsis* and *Trichosporon cutaneum*, have been found living in between people's toes as part of their skin flora. Yeasts are also present in the gut flora of mammals and some insects and even in deep-sea environments.

Yeasts best grow at temperature ranging between 20 to 28°C, at an acidic pH of 3.5 to 4. Wickerham's YM agar, malt agar, potato dextrose agar, yeast peptone dextrose agar, yeast mould agar, gyp agar, Sabouraud's agar are several growth media used for yeast isolation. For enrichment purposes yeast extract malt extract broth can be used. The use of dilute HCL or phosphoric acid is recommended to lower bacterial population. Also, mixture of broad-spectrum antibiotic against bacteria but inactive against yeast can be incorporated in the media (e.g., *Chloramphenicol*, *Ampicillin*). For isolating yeasts from moulds, growth of moulds can be restricted by putting paraffin oil on inoculated liquid media by removing all air. In yeast extract malt extract medium, malt extract acts as an energy source, peptone as nitrogen source yeast extract as source of c, n, vitamins and co-factors. Glucose is the fermentable carbohydrate. Acidic pH favors growth of yeast and restricts bacterial growth.

For maintenance and preservation of yeast cultures YM agar slants with 2% $CaCO_3$ can be used. Yeast cultures with their ascogenous forms are generally maintained on YM agar at 4-5°C, supplemented with 1% (v/v) of sterile, hundredfold concentrated vitamin stock solution. For preservation at long period of time cultures can be lyophilized in sterile blood serum.

Classification of yeast can be done using its morphological characteristics, cultural characteristics, sexual characteristics and physiological characteristics [1].

Morphological Characteristics

The characteristics of vegetative reproduction and vegetative cells can be used to classify yeast [2]. Vegetative reproduction is done either by fission or by budding or by formation of conidia. Reproduction by fission is a typical characteristic of *Endomycetaceae* and *Schizosaccharomycoides* (Figure 1). Genera *Saccharomyces*, Candida shows budding pattern (Figure 2). Reproduction by formation conidia is a characteristic of the genus *Sterigmatomyces* (Figure 3). Characteristics of vegetative cells are formation of pseudo and true mycelium. If yeast reproduces exclusively by budding it forms *pseudomycelium*. Candida, *Brettanomyces anomalus* etc., show presence of *Pseudomycelium*. If yeast which reproduces solely by fission forms filamentous cells thus constitute true mycelium. *Rhodosporidium*, *Leucosporidium* etc. show true mycelium. The morphology of the vegetative cells grown in liquid and solid media is based on whether the cells are spherical, subglobus, ovoid, cylindrical etc. The apiculate cells of *Nadsonia*, the bottle-shaped cells of *Pityrosporum*, the triangular cells of *Trignopsis* are typical examples. Formation of chlamydosporem involves chlamydospore which has been defined as thick-walled, nondeciduos, intercalary or terminal, asexual spore formed by the rounding of a cell or cells. Chlamydospore formation is a characteristic feature of ascomycetous genus *Metschnikowia* and in cultures of genus *Debaryomyces*. Formation of endospores is the formation of vegetative cells delimited within cells or hyphae. This phenomenon is uncommon in yeast domain, but has been observed in genera *Trichosporon*, Cryptococcus, *Syringospora* and *Oosporidium*. Formation of ballistospores which are produced on sterigmata that protrude from vegetative cells and are ejaculated into the air by the drop mechanism.

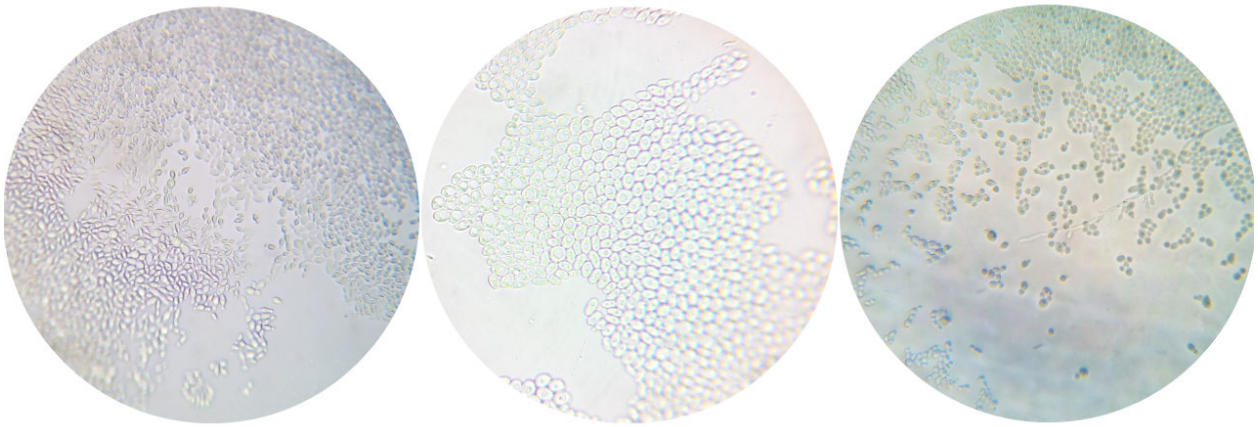

Figure 1: Budding Yeast.

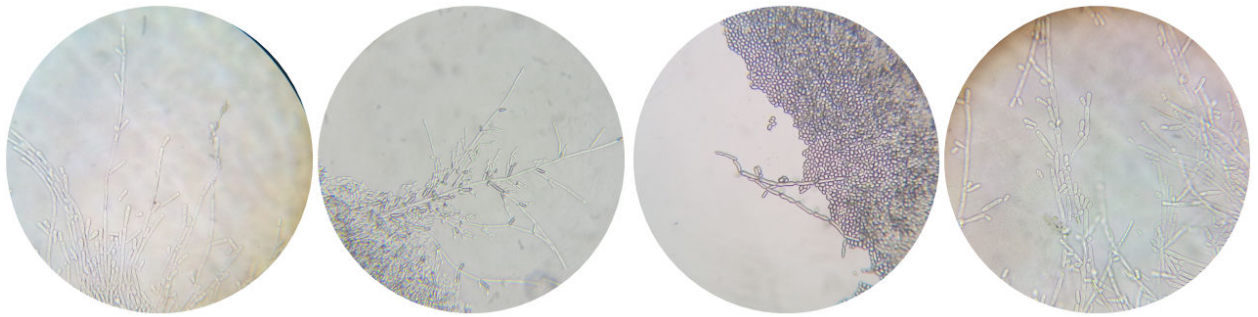

Figure 2: Fission in yeast.

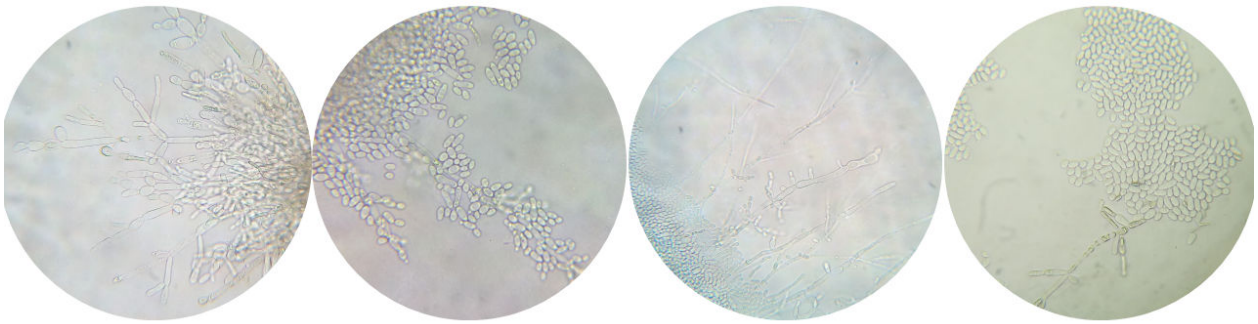

Figure 3: Conidia formation in yeast.

Cultural Characteristics

In case of cultural characteristics, growth in liquid media and solid media is observed [3]. Yeast grown in liquid media may result in the formation of sediment, a ring, a pellicle. Pellicle formation on a liquid medium is a property associated with oxygen demand of yeast. Growth on solid media maybe either mucoid, butyrous, friable, pigmented and mat. *Lipomyces* shows characteristically mucoid growth. Pigment is for instance highly characteristic of genera *Rhodotorula* and *Sporobolomyces*.

Sexual Characteristics

Sexual characteristics involve presence of the ascus and ascospores. Mode of ascus formation is characteristic of haploid and homothallic species. Ascospores are present in ascus. *Kluyveromyces*, *Hansenula*,

Pichia show presence of ascospores. The basidiomycetous yeast genera show formation of teliospores for example, *Rhodosporidium*. The spores are thick walled, frequently rich in lipid, maybe fuscous or spheroidal.

Physiological Characteristics

Yeast developing on a carbon source must either be able to ferment it or utilize it by respiration. It has been found that when yeast utilize carbon source fermentatively it is also able to utilize it oxidatively. But reverse does not occur. The ability or inability to ferment carbohydrates to ethanol and carbon dioxide is most important for differentiating species. Variety of sugars is fermented by a variety of yeast. Saccharomyces is known to show vigorous fermentation whereas genera like *Rhodotorula* and *Lipomycesare* strictly non-fermentative. Carbon assimilation tests are more sensitive than fermentative tests for detecting the presence of enzyme systems. Utilization of inositol is characteristic of genus Cryptococcus and inability to utilize lactose appears to be a feature of Saccharomyces. Splitting of arbutin is done to see ß-glucosidase activity in yeasts. If a yeast strain hydrolyzes arbutin, hydroxyquinone is formed, which gives a brown color with any soluble ferric salts incorporated in the medium.

Since nitrogen metabolism is a basic feature of growth, the ability or inability to utilize different sources of nitrogen can be made use of in classifying yeasts. Except for genus Saccharomyces which only grows in media containing certain yeast or protein hydrolysates all yeast can utilize a variety of nitrogen sources. The utilization of nitrate depends upon the sequential action of reductase enzymes which mediate reduction of nitrate to more reduced compounds. Potassium nitrate is generally used in medium as a nitrate source. *Hansenula*, *Pachysolen* and *Citeromyces* utilize nitrate. Species which utilize nitrate also utilize nitrite. In testing for assimilation, toxic effects due to nitrous acid maybe formed. So, testing of nitrite must be done at low concentrations. Sodium nitrite is generally used as a nitrite source. It has been found that aliphatic amine nitrogen can be utilized as a source of nitrogen. *Kluyveromyces* and *Saccharomyces* are known to utilize amini alkanes. Creatine is nitrogenous organic acid and creatinine is phosphorylated creatine. Utilization of creatine and creatinine by *Cryptococcus neoformans* and three species of genus *Debaromyces* is reported. Amino acids in general are a good source of nitrogen but they differ in their usefulness. L-amino acids (for example l-lysine) are utilized by *Brettanomyces*, Candida, *Hansenula*, *Saccharomycodes*, etc.

The use of the ability or inability to grow in a synthetic medium devoid of vitamins like biotin, folic acid, niacin, inositol, riboflavin etc. was introduced by Wickerham. The value of the ability to grow in a vitamin free medium as a taxonomic criterion is variable. A variety of yeast species grow well in sugar concentration up to 40-70%. Saccharomyces, *Dekkera* can tolerate high sugar concentration. In general ability to grow above 37°C finds limited application. Certain species of genera *Kluyveromyces* and *Hansenula* are capable of growing at 45°C or even 48°C. Most yeast produce traces of volatile as well as non-volatile acids. It is seen when excess of acetic acid is produced. Some species of *Kloeckera*, *Hansenula*, *Trichosporonare* known to produce considerable amounts of acids. Under suitable cultural conditions several yeast strains elaborate extracellular polysaccharides. *Bullera*, *Trichosporon* produces certain amyloid compounds. Practically all yeast utilizes urea at low concentrations as a sole source of nitrogen provided that adequate amounts of vitamins are supplied. It is particularly marked in the genera *Cryptococcus* and *Rhodotorula*. Lipase activity has been demonstrated in several yeast species. It is usually employed as a confirmatory test. *Candida lipolytica*, *C. rugosa* and *Trichosporon pullulans* show lipase activity. The formation of distinctive pigments can be used for differentiation. Three main types of pigments maybe distinguished, carotenoids, pulcherrimin and rybosylaminoimidazole. Pigment is for instance highly characteristic of genera Rhodotorula and *Sporobolomyces*.

Fermentative yeasts form a variety of esters in varying amounts. Ethyl acetate has been found to be the commonest and most readily detectable ester formed by yeast. *Hansenula* and *Kluyveromyces* show strong ester formation. Yeast varies in sensitivity towards the antibiotic actidione. *S. cerevisiae* is markedly sensitive (inhibited by 1 µg/ml), *Schizosaccharomyces* pombe is moderately sensitive (inhibited by 25 µg/ml), *Kluyveromyces lactis* is tolerant (not inhibited by conc. as high as 1000 µg/ml). It is accepted that the ability of yeast to liquefy gelatin is of very limited taxonomic value as very few yeasts are strongly proteolytic.

Economic Importance

Yeast is used in brewing and baking industries [4,5]. It is also used as nutritional supplements for e.g., *S. cerevisiae* is excellent source of proteins and vitamins. Dried yeast cells contain 40 to 50% protein. Yeast cells are rich source of vitamin B complex. Medical importance of yeast is due to its ability in lowering high cholesterol. Research showed that taking a specific red yeast product for two to three months could significantly lower total and "bad cholesterol" i.e., low-density lipoprotein (LDL). Yeast belongs to traditional biotechnology. In the industry of fermentation, yeast is used not only in food industries to make bread, wine and beer, but also in non-food industries, such as the biofuel industry, to produce ethanol. Yeasts are the model organism for studying genetics and cell biology. Used in preparation of yeast extract in biological media. Some yeasts can find potential application in the field of bioremediation. For e.g., *Yarrowia lipolytica* degrades palm oil, and other hydrocarbons, such as alkanes, fatty acids, fats and oils. *Saccharomyces cerevisiae* has potential to bioremediate toxic pollutants like arsenic from industrial effluent. Some probiotic supplements use the yeast *S. boulardii* to maintain and restore the natural flora in the gastrointestinal tract.

Some species of yeasts are opportunistic pathogens and cause infections in humans. *Cryptococcus neoformans* and *C. gattii* cause *cryptococcsis* in immunocompromised humans. Yeasts such *Candida albicans* cause oral and vaginal infections in humans called as candidiasis.

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