

Applications of Yeast in Food Industry

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Yeast, a unicellular eukaryotic microorganism, has long been integral to food systems, with archaeological evidence indicating its role in fermented beverages such as wine and beer dating back nearly 7000 years. Among yeast species, *Saccharomyces cerevisiae* stands out for its extensive use in food biotechnology due to its fermentative efficiency and metabolic versatility. Traditionally employed in baking and alcoholic beverage production, yeast now contributes to the synthesis of high value compounds including single cell proteins, vitamins, amino acids, flavour enhancers, pigments and emulsifiers components essential to modern food formulation strategies aimed at improving nutritional quality, sensory appeal, and shelf life. Beyond its conventional roles, yeast derived products are increasingly recognized for their potential in advancing human health, particularly through the development of nutraceuticals, functional foods, and therapeutic formulations.

What are yeasts?

Yeasts are eukaryotic, single celled fungi that vary in size from 3-4 μm to as large as 40 μm depending on species and environment, and typically reproduce asexually via mitosis, most commonly through budding. Main features of typical yeast cell is shown in figure 1. The term “yeast” originates from Old English and Indo-European roots meaning “boil,” “foam,” or “bubble,” reflecting their fermentative nature. They are heterotrophs that metabolize sugars such as glucose, fructose, sucrose, and maltose, with some species also utilizing pentoses, alcohols, and organic acids, and they do not require sunlight for growth. Yeasts are obligate aerobes or facultative anaerobes, unable to grow strictly anaerobically, and thrive optimally between 30-37 °C in neutral to slightly acidic pH, though they can survive from 10 °C to 37 °C, with stress above this range and death typically beyond 50 °C, while freezing reduces viability over time. Their ability to grow in low pH and high sugar environments makes them valuable in industrial fermentations (e.g., bread, beer, wine) but also problematic in food spoilage of acidic products like juices, jams, and yoghurt, especially due to carbon dioxide production in sealed containers.

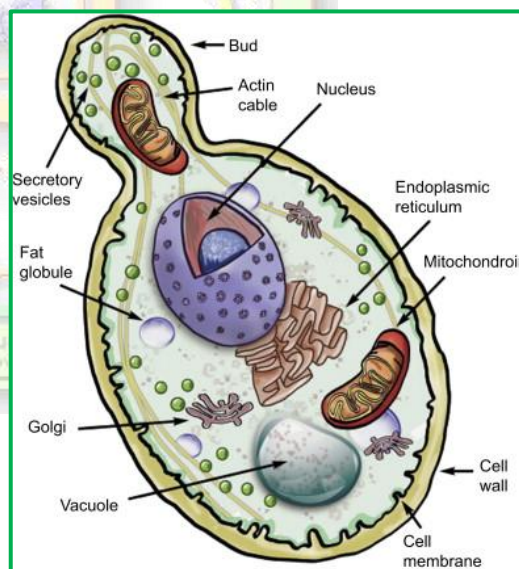


Figure 1. Main features of a typical yeast cell (Stewart & Russell, 1998).

Species of yeast

Common yeast genera include: *Saccharomyces*, *Brettanomyces/Dekkera*, *Candida*, *Cryptococcus*, *Debaryomyces*, *Hanseniaspora/Kloeckera*, *Hansenula*, *Kluyveromyces*, *Pichia*, *Rhodotorula*, *Torulaspora*, *Schizosaccharomyces*, and *Zygosaccharomyces*.

Role of yeast in food processing

1. Baker's Yeast (*Saccharomyces cerevisiae*)

Baker's yeast (*Saccharomyces cerevisiae*) plays a central role in bakery and confectionery industries due to its high fermentation efficiency, which enhances dough leavening, gluten reinforcement, and flavour generation. Commercially available in various forms such as compressed, granular, cream, dried, instant, encapsulated, and frozen yeast, ferments sugars like glucose, fructose, and maltose, producing carbon dioxide that expands dough volume while adapting to anaerobic conditions and osmotic stress from solutes. Its metabolic activity contributes to dough maturation by influencing texture through gluten development and gas retention, with compounds like ethanol and glutathione affecting rheological properties. Additionally, yeast fermentation yields over 200 volatile compounds that shape bread aroma and flavour, while sour dough and wine starter cultures utilize diverse yeast strains alongside lactic acid bacteria to achieve distinct sensory profiles and controlled fermentation under variable conditions.

2. Brewer's Yeast

Saccharomyces cerevisiae is the principal yeast species used in ethanol production due to its strong adaptation to distillery mashes, especially those based on molasses and starch, and its tolerance to ethanol and temperatures up to 30 °C. It exhibits rapid fermentation with high substrate to ethanol conversion efficiency, minimal byproduct formation, and non-agglutinating, non-sedimenting behaviour, although it cannot ferment starch, pentoses, or lactose. Ethanol can also be produced using multispecies microbial consortia including yeasts, bacteria, and moulds such as *Candida*, *Kluyveromyces*, *Monilia*, and *Clostridium*, through a process involving hydrolysis of lignocellulose into sugars followed by anaerobic fermentation. However, these mixed cultures often result in slower fermentation rates and increased byproduct formation, which can compromise ethanol quality.

3. Yeast fermented fruit beverages

Yeast fermented fruit beverages represent a significant category of traditional and modern alcoholic drinks, with wine and cider being prominent examples. Wine is produced through the alcoholic fermentation of grape juice, primarily by *Saccharomyces ellipsoideus*, followed by an aging process that enhances its flavour, aroma, and stability. Cider, on the other hand, is derived from apple juice and undergoes fermentation either spontaneously or through inoculation with selected yeast strains such as *Saccharomyces cerevisiae* or *Saccharomyces bayanus*, which are chosen for their tolerance to sugar, acidity, and ethanol. These beverages benefit from yeast metabolism, which not only converts sugars into ethanol and carbon dioxide but also generates a wide array of volatile compounds such as esters, higher alcohols, and organic acids that contribute to their sensory complexity and consumer appeal.

4. Dairy fermented foods

Several yeast species including *Candida lusitaniae*, *Candida krusei*, *Kluyveromyces lactis*, *Debaryomyces hansenii*, *Yarrowia lipolytica*, *Kluyveromyces marxianus*, *Saccharomyces cerevisiae*, *Galactomyces geotrichum*, *Candida zeylanoides*, and various *Pichia* spp. play vital roles in dairy fermentation processes. These yeasts contribute to cheese ripening, accelerate maturation, and enhance the texture and aroma of fermented milk products such as curd, koumiss, and kefir. During fermentation, they increase the pH of cheese and produce key metabolites including ethanol, acetaldehyde, carbon dioxide, amino acids, and vitamins, which collectively influence the sensory and nutritional qualities of dairy foods. Their metabolic versatility and enzymatic activity make them indispensable in developing diverse and high quality fermented dairy products.



Curd, Koumiss and Kefir

5. Meat fermented foods

Yeasts are naturally present on meat and processed meat products, and several species contribute positively to the fermentation of products such as sausages by enhancing flavour and quality. Genera commonly associated with fermented meats include *Candida*, *Debaryomyces*, *Pichia*, *Trichosporon*, *Cryptococcus*, *Rhodotorula*, and *Yarrowia*, with *Yarrowia lipolytica* and *Debaryomyces hansenii* being the most frequently isolated. These yeasts exhibit lipolytic and proteolytic activities that generate volatile compounds, enriching the sensory profile of meat products. Notably, *Debaryomyces hansenii* is widely used as a commercial starter culture in meat fermentation to improve texture, aroma, and overall product quality.

6. Cocoa fermentation

Raw cocoa beans are naturally bitter and astringent due to their high phenolic content, especially anthocyanins, which also give them a reddish purple colour. Fermentation initiates enzymatic breakdown of proteins and carbohydrates, reducing astringency and enhancing the aroma, taste, and overall quality of cacao. Yeast species such as *Saccharomyces cerevisiae* and *Hanseniaspora opuntiae* play a key role by producing ethanol and generating aroma precursors like acetate esters and fatty acid ethyl esters, which contribute to the fruity notes in chocolate. The ethanol also serves as a substrate for acetic acid bacteria, triggering biochemical reactions within the cocoa cotyledons that further shape the final flavour profile.

7. Coffee fermentation

Yeasts play a crucial role in the postharvest processing of coffee, particularly during the fermentation stages that influence bean quality and flavour development. The process typically involves two phases: an initial aerobic phase, where freshly harvested coffee berries are placed in fermentation tanks and exposed to oxygen under controlled time and temperature conditions, allowing yeast activity to initiate biochemical transformations. This is followed by an anaerobic phase, which creates a more uniform and manageable environment for fermentation, enhancing consistency and reducing variability in flavour profiles. Through these phases, yeasts contribute to the breakdown of mucilage and the formation of desirable aromatic compounds, ultimately shaping the sensory attributes of the final coffee product.



Figure 2. Coffee fermentation

8. Production of flavour enhancers from yeasts

Yeast biomass, containing around 10% nucleic acids, serves as a commercially valuable source for producing 5'- nucleotides, which are widely used as flavour enhancers. Both primary and spent yeasts are processed through autolysis or enzyme-assisted hydrolysis to release cytoplasmic contents, followed by heat inactivation, centrifugation, and evaporation to obtain yeast extract. Bitter peptides may be removed using activated carbon for improved taste. To produce flavour, active 5'- mononucleotides, the enzyme 5'- phosphodiesterase is employed, since 3'-mononucleotides generated by yeast ribonuclease lack flavour enhancing properties. This biotechnological approach enables the development of enriched extracts with desirable sensory attributes for use in savoury food formulations.

9. Yeast pigments

Certain yeast species such as *Phaffia rhodozyma* and *Rhodotorula gracilis* are rich in carotenoid pigments, notably carotenes, which are intensively produced for their vibrant colouring properties and nutritional benefits. These pigments not only impart attractive colour to food products but also serve as precursors to vitamin A, contributing to visual appeal and dietary value. Carotenoids from yeast exhibit potent antioxidant activity, helping neutralize

free radicals and protect cellular integrity. Additionally, they support immune function, offer protective effects against cancer, and play a role in preventing degenerative diseases.

10. Yeast saccharides

Yeasts produce saccharides across a wide range of molecular weights, including trehalose which is a stable disaccharide composed of two glucose units and oligosaccharides like glucans and mannans. Trehalose, naturally found in honey, mushrooms, insects, and crustaceans, is synthesized by yeast during fermentation, especially under stress conditions such as osmotic pressure, and acts as a protective agent against cold and dryness. Its multifunctional properties make it a valuable food additive, offering 45% of sucrose's sweetness, flavour release, protein stabilization, and humectant effects that enhance texture and taste in products like bread, confectionery, soft drinks, and ice cream. Most notably, trehalose protects biological molecules during freezing and drying, making it ideal for use in frozen and dehydrated food formulations.

Conclusion

Yeasts are indispensable in the food industry, contributing not only to traditional fermentation processes but also to the development of functional and value-added products. Their ability to enhance flavour, texture, and nutritional quality makes them central to a wide range of foods, including bread, beverages, and dairy products. Advances in biotechnology continue to expand their applications, from producing bioactive compounds to improving food safety and sustainability. Thus, yeasts remain both a cornerstone of traditional food processing and a catalyst for innovation in modern food science.

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