

## MICROBES IN INDUSTRIAL PRODUCTS

In industrial settings, microbes play a crucial role in synthesizing numerous products that are valuable to humans, such as beverages and antibiotics. To produce these products on a large scale, microbes are cultivated in expansive vessels known as fermenters.

### 1. Fermented Beverages

Microorganisms, particularly yeast, have long been employed in the production of various beverages such as wine, beer, whisky, brandy, and rum. *Saccharomyces cerevisiae*, commonly known as brewer's yeast, is utilized in bread making. *Saccharomyces cerevisiae* is also employed in fermenting malted cereals and fruit juices to yield ethanol. Another strain, *Saccharomyces ellipsoideus*, is specifically designated as wine yeast.

The type of raw material utilized and the processing method employed—whether with or without distillation—determine the specific characteristics of the resulting alcoholic drinks. Wine and beer are examples of beverages produced without distillation, whereas whisky, brandy, and rum are derived from fermented broths subjected to distillation.

Various nutrient mediums are employed based on the desired beverage: barley malt for beer, rye malt for gin, potatoes for vodka, cereals for whisky, molasses for rum, and fruit juices for wine and brandy.

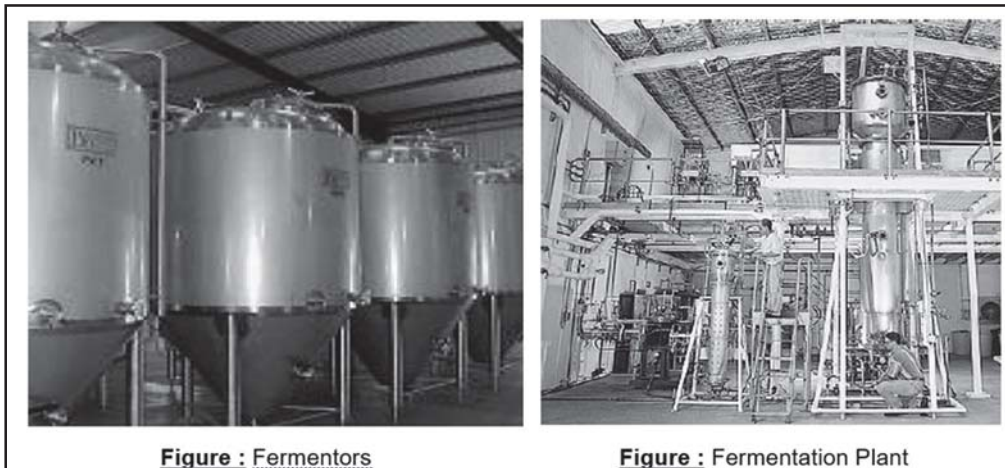


Figure : Fermentors

Figure : Fermentation Plant

### 2. Antibiotics

The discovery of antibiotics produced by microbes stands as one of the most groundbreaking advancements of the 20<sup>th</sup> century. Antibiotics are chemical substances synthesized by certain microbes capable of either killing or inhibiting the growth of disease-causing microorganisms.

Chloromycetin, for instance, is derived from *Streptomyces venezuelae*. The term "antibiotic" was coined by Selman Waksman. The first antibiotic to be discovered was penicillin, a serendipitous finding by Alexander Fleming while conducting research on *Staphylococcus* bacteria. Notably, the presence of penicillin inhibited the growth of *Staphylococcus*, as observed around the perimeter of a Petri dish.

Fleming bestowed the name "penicillin" upon this newfound substance. The potential of penicillin as an antibiotic was further elucidated by Ernest Chain and Howard Florey, leading to their joint receipt of the Nobel Prize in 1945.

During World War II, antibiotics were extensively utilized to treat wounded soldiers, significantly improving our ability to combat deadly diseases such as plague, whooping cough, diphtheria, and leprosy. Mentalism plays a crucial role in the production of antibiotics.

### 3. Chemicals, Enzymes, and Other Bioactive Molecules

Bioactive molecules are defined as compounds that exhibit functionality within living systems or have the capacity to interact with their constituents. Microorganisms play a pivotal role in the commercial and industrial synthesis of specific chemicals, known as bioactive molecules, such as organic acids, alcohols, enzymes, cyclosporin A, and statins.

- (i) Organic acids: Certain microbes possess the capability to metabolize carbohydrates, converting them into organic acids.
  - (a) *Aspergillus Niger*, a type of fungus, is involved in the production of citric acid, which is employed across various industries such as dyeing, ink production, pharmaceuticals, flavoring, and food preservation.
  - (b) *Acetobacter aceti*, a bacterium, is utilized in the production of acetic acid, commonly known as vinegar, in food preparation processes.
  - (c) *Clostridium butylicum*, another bacterium, contributes to the production of butyric acid, which is used in the production of rancid butter.
  - (d) *Lactobacillus*, a genus of bacteria, plays a crucial role in producing lactic acid, which is a key component in the fermentation process involved in making curd.
  - (e) *Aspergillus Niger* and *Penicillium*, both types of fungi, are involved in the production of gluconic acid. This acid serves as a source of calcium in various applications, including infant formula, cow feed, and supplements for lactating mothers.
- (ii) Alcohols: *Saccharomyces cerevisiae*, commonly known as yeast, is employed in the industrial production of ethanol, a type of alcohol.
- (iii) Enzymes: Only a small fraction, approximately 1.0-1.5%, of total enzymes are utilized in industrial and medical applications.
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  - Lipases: These enzymes, sourced from *Candida lipolytica* and *Geotrichum candidum*, play a crucial role in detergent formulations, aiding in the removal of oily stains from laundry.
  - Pectinases and proteases: These enzymes contribute to the clarification of fruit juices, making them clearer than homemade varieties. Pectinases are produced by *Aspergillus Niger* and *Byssoschlamys fulvo*, while proteases are obtained from *Mortierella renisporea*, as well as various species of *Aspergillus* and *Bacillus*.
  - Streptokinase: This enzyme, derived from the bacterium *Streptococcus* and modified through genetic engineering, is utilized as a "Clot buster" to dissolve clots in the blood vessels of patients who have experienced myocardial infarction, commonly known as a heart attack.
  - Amylase: These enzymes, obtained from species such as *Aspergillus*, *Rhizopus*, and *Bacillus*, degrade starch molecules.
- (iv) Cyclosporin A: This compound, employed as an immunosuppressive agent in organ transplant recipients, is produced by the fungus *Trichoderma polysporum*.
- (v) Statins: Produced by the yeast *Monascus purpureus*, statins are commercialized as agents for lowering blood cholesterol levels. They function by competitively inhibiting the enzyme responsible for cholesterol synthesis, resembling mevalonate and acting as a competitive inhibitor of  $\beta$ -hydroxy- $\beta$ -methylglutaryl CoA reductase, also known as HMG CoA reductase.

**Example:** What is the bacterium responsible for the production of butyric acid?

**Solution:** *Clostridium butylicum*.