

FOOD SCIENCE AND INDUSTRIES NO. 14
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Yeasts and Molds

YEASTS

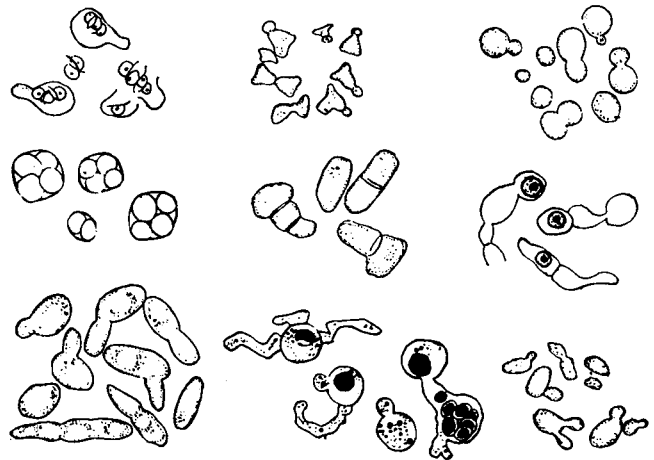
Yeasts, like bacteria, are single-celled living organisms. They usually are larger than bacteria. The average length of yeast cells ranges between 5-10 microns (1 micron=1/25,000 inch), whereas most bacteria are less than 5 microns long. (For a discussion of bacteria, see Food Microbiology Fact Sheet No. 2, Bacteria.) Most yeast cells are oval or ellipsoidal in shape.

The presence of yeast cells in food can be useful or harmful. The presence of actively growing yeasts is desirable in the manufacture of many foods, such as bread, beer, wines, vinegar, and cheese. In some foods, yeast cells are a source of high protein. Yeasts may cause spoilage of sauerkraut, fruit juices, sirups, molasses, honey, jellies, meats, wines, beers, and other foods.

How Yeasts Grow

The most common means of yeast reproduction (growth) is by a process called budding. After a cell reaches a certain size and maturity, a small bulge, or bud, forms on one side of the cell. Part of the cell nucleus passes into the bud. When the bud becomes sufficiently large, a cell wall is formed between the bud and the mother cell, and the bud breaks off from the cell. The bud is a typical yeast cell capable of reproducing by the same process.

Unlike bacteria cells, yeast cells contain a definite nucleus that can be observed easily when



Typical microscopic yeasts.

cells are stained and examined under a microscope. Yeast cells also contain a fairly well-defined cell wall and reserve food granules. Some yeasts reproduce by forming endospores. In most instances where spores are present the cell contains 4 spores, although the number may vary from 1 to 16. Spores are not resistant to adverse conditions; both spores and yeast cells are easily killed by heat.

Yeasts are divided into two principal groups: true yeasts and false yeasts. True yeasts reproduce by forming spores within the cell. False yeasts do not form spores under any conditions. The common bread or baker's yeast, Saccharomyces cereviriae, and the wine yeast, Saccharomyces cereviriae var. ellipsoideus, are examples of true yeasts. Cryptococcus yeasts, commonly found in cream and butter, and Mycoderma, which cause the grayish-white scum on pickle brines, are examples of false yeasts.

Factors Affecting Growth

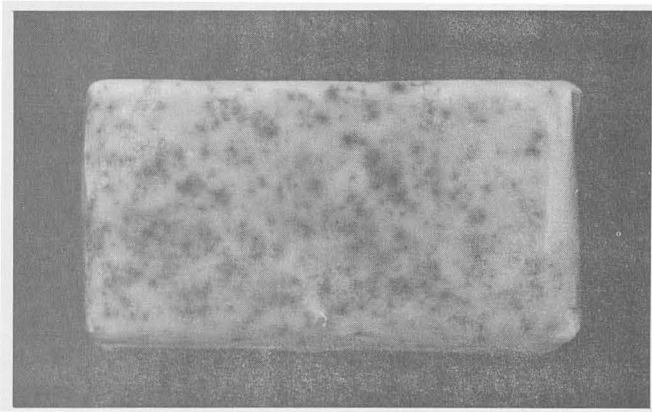
Temperature. Most yeasts grow best at room temperature (70° to 85° F.), though some kinds can grow at 32° F. Most yeast growth is inhibited above 100° F.

Moisture. Most of the common yeasts require a plentiful water supply for growth. However, many yeasts will grow in the presence of high sugar or salt concentrations. In general, yeasts require less water than bacteria but more than molds.

Foods. Sugars and acids are good food sources for yeasts. Growth is abundant in food substances containing carbohydrate (sugar or starch) and varying amounts of acid. Typical end products of yeast growth in this type of environment are gas (carbon dioxide) and ethyl alcohol. Yeasts also require nitrogenous foods varying from simple compounds such as ammonia and urea to the more complex amino acids, polypeptides, and proteins. Accessory growth factors such as vitamins also are required.

Oxygen. Yeasts grow best in the presence of free oxygen (aerobically), but some can grow slowly anaerobically (without oxygen).

pH. The growth of most yeasts is favored by an acid reaction. Yeasts grow well at a pH of 4-4.5 and lower but do not grow well in an alkaline medium (above a pH of 7.0).



Mold growing on butter.

Distribution of Yeasts

Yeasts are widely distributed, but they are less numerous than bacteria. They are present in nature wherever a good source of carbohydrate (sugar or starch) is available. Yeasts commonly are found on the surfaces of fruits, on the leaves of plants, and in fertile soil.

MOLDS

Molds differ from bacteria and yeasts in that they have many cells. The fuzzy or cottony appearance of mold on foods is familiar to everyone. Usually, moldy or "mildewed" foods are considered unfit to eat. Their growth on a food or other nutrient source results in a mass of loosely entwined filaments collectively called mycelium. Individual filaments are called hyphae.

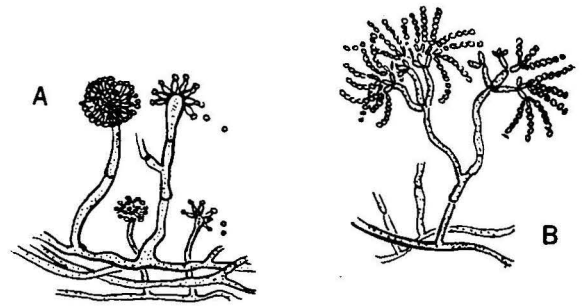
Though many molds spoil foods, some molds are useful in the manufacture of food. Several types of cheeses are ripened by molds. Oriental foods such as soy sauce, miso, *sonti*, and *tempeh* are produced by molds. Molds also are used in the manufacture of chemicals. The antibiotic penicillin is produced by certain molds of the genus Penicillium.

General Characteristics

The term mold is applied to multi-cellular, filamentous, living organisms whose growth on foods usually can be recognized. The main part of the growth commonly is white, but it may be colored, dark, or smokey. Colored spores are typical of some types of mature mold growth and may give color to part or all of the growth.

Molds normally reproduce by spore formation. The spores can be considered the "seeds" of the mold; they will actively produce additional mold under favorable conditions. Most common molds also can be grown by transferring any part of the mold to a fresh medium, but growth conditions must be favorable. Mold spores are not heat resistant, and both the spores and vegetative hyphae can be easily destroyed by heat.

When a mold spore encounters favorable growth conditions such as abundant moisture, suitable food, and a favorable temperature, the spore germ-



A--Aspergillus; B--Penicillium.

inates and vegetative hyphae develop. As growth continues, the hyphae branch and rebranch, forming a tangled network of filaments. Some of the filaments remained submerged or on the surface of the substrate. Others may grow out like the trunk or branches of a tree, and spores may develop on these branches.

Factors Affecting Growth

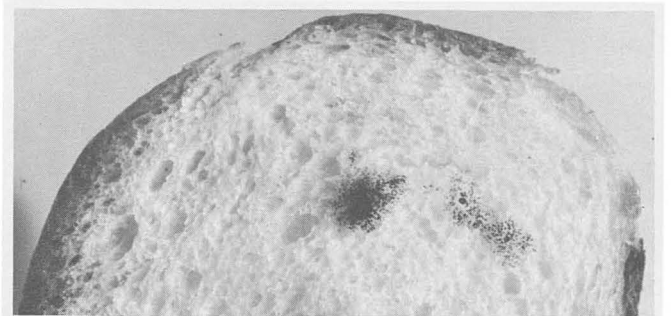
Most of the factors that influence yeast growth also influence the growth of molds. However, there are exceptions. Molds can grow in an environment with less available moisture than yeasts, and molds are much less fastidious in their food requirements. There are very few materials on which some type of mold can't grow.

Mycotoxins

Under proper growth conditions, certain molds can do more than spoil a product by rendering it moldy. They can develop highly poisonous metabolic byproducts. These toxic substances are called mycotoxins. Molds that produce these poisons have been found in the genera Fusarium, Cladosporium, and Aspergillus. One mold that has been found to produce mycotoxins most consistently is Aspergillus flavus. The poisons produced by this organism are called aflatoxins. Moldy feeds fed to livestock have been found to contain aflatoxin. Serious illness and, in some cases, death may result from feeding rations contaminated with mold.

Distribution Of Molds

Mold spores are extremely small and very light. Consequently, they are spread quite easily by air currents, insects, and animals. They are widely distributed in nature and perform a very useful function in the decomposition of organic matter in soil.



Mold growing on bread.