Bread doughs are fermented for very short periods of time with a range of 30 minutes to 4 hours. They are inoculated with $300 \times 10^6$ cells per gram and there is little or no yeast growth during the fermentation. In contrast, wine, beer, and distiller's mashes are fermented for periods ranging from several days to several weeks. Inoculation levels are in the range of $2-10 \times 10^6$ cells per milliliter and there is a 5- to 10-fold multiplication of yeast cells during the fermentation. In addition, yeast cells may be recycled for use in succeeding batches of beer or wine fermentations. Baker's yeast cannot be recycled because the yeast is killed during the baking process. Consequently, the production of baker's yeast can be carried out on a very large industrial scale, and since the latter part of the nineteenth century, baker's yeast has been produced by companies that specialize in its production.

It is not quite correct to say that baker's yeast cannot be recycled. For several millenia, baker's yeast has been recycled in part by retaining a portion of the yeasted dough (generally from a third to a tenth) and blending it with fresh water and flour for formation of the next dough. This method is still practiced in some countries and is used in the United States for production of San Francisco sour dough bread. It will be discussed in Chapter 7.

In countries that produce beer it was soon found that ale yeast could be used in bread production, and prior to 1850, it was widely used for that purpose. It required only separation from the beer foam and pressing. The level of inoculation of bread doughs with this ale yeast was carried out at low levels and the fermentation times were long, generally overnight.
Since about 1848, brewers in the United States started to produce lager beer instead of ale. The lager beer yeast, *Saccharomyces carlsbergensis* (later *S. uvarum*), was not suitable for leavening doughs because it does not tolerate the high osmotic pressure. The production of baker’s yeast exclusively for the production of bread doughs dates from the latter part of the nineteenth century. It started with production of distiller’s yeast on grain mashes, which were later replaced with the least expensive source of assimilable sugar, molasses.

During the last century the major advances in the production of baker’s yeast have been the following:

1. **Aeration.** The stimulating effect of aeration on yeast growth was well known toward the end of the nineteenth century, and continuous aeration of mashes was used in Britain in 1886.
2. **Fed-batch process.** The use of incremental feeding (called Zulauf process in German) was introduced between 1910 and 1920 by Danish and German scientists. This process is used today because it is the only practical method that permits production of yeast biomass without simultaneous production of sizable quantities of ethanol.
3. **Molasses.** At the turn of the century the mash bill consisted principally of corn, malt, and malt sprouts. During the 1920s and 1930s, the grains were slowly replaced with molasses as carbon and energy source for yeast growth.
4. **Active dry yeast.** Progress was made in the late 1930s in the drying of compressed yeast (CY) to the more stable active dry yeast (ADY). In the 1940s, ADY began to penetrate the consumer yeast market. Slow but continued progress in drying methods has led to the point where ADY has replaced CY in several bakery applications, particularly in institutional baking and in pizzerias.
5. **Automation.** During the past decade there has been a rapid shift to automatic control of the fermentation.

The history of baker’s yeast production has been reviewed by Kiby (1912) and Butschek and Kautzmann (1962). The development of ADY has been reviewed by Frey (1957).

**MANUFACTURING PROCESS OUTLINE**

Cane or beet molasses supply not only sugars as a carbon and energy source but also some organic nitrogen, minerals, sulfur, vitamins, and trace elements. The liquid growth medium must be supplemented with additional nitrogen (usually ammonia or ammonium salts) and phosphate, as well as with additional minerals (Ca, Mg), vitamins, and trace elements.