3 Production of Beer and Wine

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I. Introduction

Biotechnology is the technical use of organisms or parts thereof for large-scale application or services. Thus, wine and beer can be regarded as biotechnological products. Both beverages result from the cultivation of yeast cells. However, these traditional alcoholic drinks were enjoyed long before fermenting yeasts as micro-organisms became known (after the discovery of the microscope). We can assume that wine and beer as alcoholic beverages are nearly as old as the history of human cultures. From Babylonia, Mesopotamia, Egypt and other regions, we have archaeological evidence that wine and beer-like beverages were already well known and commonly used thousands of years before Christ.

With Louis Pasteur (1822–1895), Emil Christian Hansen (1842–1909) and other scientists, a more rational basis for alcoholic fermentation was introduced after 1850 and further developed so that the biochemistry of the process – from active transport of fermentable sugar into the cells, intracellular conversion to ethanol, followed by excretion – is well-understood today (Fig. 1). Techniques of DNA recombination, as carried out for the first time in 1973 (Cohen et al. 1973), even offer the opportunity for genetic engineering of the yeast genome and therefore to targeted improvements in technological and other properties.

Wine results from fruit, e.g. grape, juice submitted to an alcoholic fermentation. Most wines are made from grapes belonging to the botanical genus *Vitis*, which includes nearly 60 wild species. A recent technique for the identification of grape varieties is the use of artificial neuronal networks (Manusco et al. 1998). This method uses, for example, the phyllometric data of 450 leaves, which are submitted to a computer to build up a network which is typically organised in layers for incoming, processing and output of the data.

For large-scale wine production, only the grape species *Vitis vinifera* is of importance. This species is the result of a selection process which has been running for thousands of years with the aim of producing good wines. For many years, yeast strain and grape improvement has also been possible by using recombinant genetic techniques (Pretorius and van der Westhuizen 1991).

Wine quality results from grape properties, on the one hand, and the wine making process, on the other. The science and technology which deals with the grapes is viticulture, an important part of
Fig. 1. Simplified scheme of alcoholic fermentation in a yeast cell

II. Beer Brewing

Details of the brewing process depend very much on the type of beer to be produced and can also differ considerably from country to country and even from brewery to brewery (Kunze 1996; Benson et al. 1997). In the following, emphasis is given to the major production routes of top- and bottom-fermented full beers. For further details, and to get a better insight into other brewing techniques, we recommend you consult one of the more comprehensive textbooks, e.g. Hardwick (1995), Heyse (1995), Narziß (1995) or Russell and Stewart (1995).

A. Raw Materials

In Germany, the so-called Reinheitsgebot (purity law), existing since 1516, prescribes that only barley in malted form, hops, water and yeast as a processing aid are allowed to make beer. Other materials coming into contact with beer, e.g. filter aids, must be harmless and insoluble, and they are not tolerated in the finished beer. Those processing aids must not be declared (O’Rourke 1999). For beers exported from or imported to Germany, as well as for special beer types, e.g. wheat beer or sorghum beer, ingredients other than barley malt, e.g. various unmalted cereals, adjuncts, enzymes (Bendler and Lemaire 1999), sugar etc., may be allowed. Also, for English-style ales, cereals other than barley are used (Taylor et al. 1998).