

Wine spoilage by microorganisms

Winemaking results of the biological activity of numerous yeast and bacteria, that simultaneously, or successively multiply in grape must and wine. The very diverse indigenous microflora is transferred into the fermentation tanks by the grapes. It comprises the necessary yeast and bacteria involved in alcoholic and malolactic fermentation, that mainly belong to the *Saccharomyces cerevisiae* and *Oenococcus oeni* species. In addition, a great variety of Non-*Saccharomyces*, of lactic acid bacteria such as *Lactobacillus sp.*, *Leuconostoc sp.*, and *Pediococcus sp.*, and finally acetic acid bacteria grow, compete, decline or survive depending on their ability to cope with the continuously changing ecosystem. The appropriate change of the microbial system results in wine, characterised by its basic composition (ethanol, glycerol, carboxylic acids, ...) and aromas, depending on the grape variety and the microbial metabolic pathways.

Winemakers know how to control the general evolution of yeast and bacteria in order that yeast then lactic acid bacteria successively dominate the ecosystem, and that acetic acid bacteria are always inhibited. To this aim they observe general oenological practices such as sulfiting, pumping over and others means. In addition, more and more they use starters of *Saccharomyces cerevisiae* and *Oenococcus oeni* so that, at least for the period of winemaking, these selected strains usually dominate the microbial system. However, even in this case, the indigenous microflora and, among it, spoiling yeast and bacterial strains are not completely discarded. Most of the time they are just transitorily inhibited and cannot multiply because of the massive invasion of the system by the starters. Some of them are in so low concentration that they only can be detected by very sensitive methods. Others may also survive at

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notable concentration all the time. This depends on many factors comprising the adaptation of the strains to the environment, the initial composition of the grape must, its evolution during the fermentations and the usual wine treatments. Briefly, wine spoilage results of the multiplication of banal strains at an unsuitable step of the process, or most of the time, of the growth of undesirable strains.

WINE SPOILAGE BY YEAST

Saccharomyces cerevisiae is rarely implied in wine spoilage during winemaking, excepted in the particular case of grape musts with very high sugar concentration. In this circumstances, they can produce abnormal volatile acidity due to the deviation of the metabolic pathway. However, some specific strains of *Saccharomyces cerevisiae*, besides *Saccharomycodes ludwigii* and *Zygosaccharomyces bailii* strains are responsible for the “re-fermentation” of sweet wines. The problem occurs in tank, barrels during aging, or even in bottles during storage. In spite of sulfiting and due to the general high SO₂-binding power of these wines, the microbial stabilisation is difficult. These particular strains tolerate the very hostile conditions including high ethanol concentration (even more than 15%), high residual sugar concentration (up to 85g/L), acidity and SO₂ (more than 300mg/L total).

However the most worrying yeast spoilage is due to *Brettanomyces bruxellensis* mainly recognized for its ability to produce off flavours. The best known reaction is the successive decarboxylation and reduction of cinnamic acids to volatile phenols. However other undesirable components seem to participate to the depreciation of sensorial quality.

WINE SPOILAGE BY BACTERIA

In the past, wines were often spoiled by acetic acid bacteria that produce high concentration of acetic acid and ethyl acetate (“piqure acétique”). However, now the better knowledge of winemakers on their presence and on the technological ways to prevent their development has almost totally eliminated the problem. Contrarily to other spoilage, that one is precisely due to a real defect in the cellar practices. Acetic acid bacteria are always present but they only grow if oxygen is dissolved in appreciable concentration. In that condition ethanol is oxidised to acetic acid, providing energy for cell growth.

Lactic acid bacteria are necessary in the winemaking process but their main activity is restricted to the decarboxylation of malic acid to lactic acid and the *Oenococcus oeni* species seems to be the only admitted. However, like the other lactic acid bacteria species, *Oenococcus oeni* may induce an increase of volatile acidity, in case of early growth before the end of alcoholic fermentation: this problem is named "piqûre lactique". This spoilage also occurs in fortified wines where *Oenococcus oeni*, or more frequently *Lactobacillus hilgardii*, *Lactobacillus fructivorans* and even *Lactobacillus plantarum* ferment sugars to lactic and acetic acid, in spite of very high level of ethanol.

Other "wine diseases" are produced by very specific strains of any bacterial species. They can depreciate more or less the sensorial quality. The "ropy disease", the "bitterness" and the "tourne" are the best characterized. They are respectively due to glucane synthesis responsible for abnormal viscosity, degradation of glycerol and of tartaric acid. Only ropy wines can possibly be recuperated after spoilage by applying suitable treatments. The other cannot be marketed if bacteria have degraded a significant part of the glycerol and tartaric acid content.

In addition some lactic acid bacteria strains produce biogenic amines. Generally there is no real impact on the sensorial point of view. However due to possible health concerns these components are more and more considered in wine trading. In some countries the absence of biogenic amines is needed. These bacterial strains, like all the others, belong to the indigenous microflora. Fortunately molecular tools, based on the sequence of genes responsible for these specific metabolic pathways, are now available and help for detecting the presence of the undesirable strains.

CONCLUSION

The indigenous microflora coming from the grapes themselves is the primary source of microorganisms in wine. During aging or storage, contaminations can also be due to poor hygiene conditions in the cellar. Wine spoilage happens when some of them multiply in uncontrolled way. The most frequent sources of microbial spoilage have been identified. In general the reason is either the growth of a given species (e.g. *Brettanomyces bruxellensis*), or the growth of specific strains. In the latter case for example, some *Saccharomyces cerevisiae* strains are highly resistant to SO₂, and only some lactic acid bacteria strains can produce glucane or biogenic amines, whatever the species. During winemaking, optimizing the alcoholic and malolactic fermentation is

the best way to prevent spoilage. During aging, several stabilisation protocols are used; they must be carefully chosen after a microbial analysis has given the level of contamination and the identification of the microorganisms.