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0014-4754/86/080904-11$1.50 + 0.20/0

Wine technology: Current trends

by D. Dubourdieu

Institut d'Œnologie, Université de Bordeaux, 351 Cours de la Libération, F-33405 Talence Cedex (France)

Key words. Wine technology; wine-making; aging; clarification; stabilization.

Introduction

In the last decade, the consumption of wine in the world has been marked by a decreasing demand for those standard products of minimum quality which have few distinctive characteristics.

On the other hand, wines which have the specific qualities of the great cultivars on good viticultural soil are gaining a wider and wider following. The current high prices of wines from the prestigious growths are testimony to this fact. Moreover, throughout the wine-producing world, the more modest wines, whose originality and quality are recognized by the consumer, are becoming more and more popular. Modern enology has brought about this change.

Technological research initially took as its objective the elimination of major defects that might have an influence on the quality of a wine as regards its presentation, aroma and taste. Thus, the first technological work, particularly that of J. Ribéreau-Gayon from the 1930s onwards, concentrated on the chemical nature and manifestations of cloudiness and sediments of various origins that can occur in wines. Preventive techniques guaranteeing the physico-chemical stability of wines have been the result of such work. Traditional fining and racking, and the use of SO_2, were rationalized. The physical treatments of stabilization (heat, cold) and clarification (centrifugation, filtration) have become more and more a part of the technology of wine. Moreover, since the foundation work of Pasteur, the microbiology of wine has, for the last 100 years, taken as a focal point the fermentation mechanisms of yeasts and bacteria. Technology has used the results obtained in order to have better control over alcoholic and malolactic fermentation, and to prevent the development of bacterial deterioration during vinification, aging and conservation.

However, it is not enough for a wine to be limpid and for no microbial accident to have occured during its production. Quality is measured by finesse, intensity and originality in taste and smell. This necessitates the 'bringing out' of certain organoleptic potentials contained in the grape itself. Thus, the principle aims of the technology of wine nowadays are to enable the selective extraction of the different constituents of the grape which are responsible for quality; to determine and conduct fermentation under conditions which preserve and underline the qualitative potential of the grape; and finally, to develop methods of aging which will assure that the consumer is offered a properly finished product with all types of wine. Technological progress is the result both of the refinement of enological knowledge and the improvement of the wine-producer's tools.

In this presentation of the most widespread production methods of the present moment, we will show through examples how recent results in enological research now orient wine technology.

1. Grapes and harvesting

The degree of maturity of the grape is an essential factor in wine quality. Maturation is influenced by the climatological conditions of each region. However, for a given region, these are variable from one year to the next, thus causing differences in the constitution of grapes which are responsible for the particular characteristics of each vintage. Harvesting may be conducted late or early, and the maturity of the grape at the moment of picking may be more or less complete. These differences reflect climatic conditions during maturation; good maturation requires warm, dry weather. The date at which harvesting begins must be fixed in relation to maturation and the general healthiness of the plant.

Controls of maturity

Classic controls of maturity are made on representative samples of grapes taken in the vineyard each week from veraison onwards. One must determine the weight of the grapes, their sugar level, and the pH and total acidity of the juices. These simple measurements enable the physiological maturity and the beginning of the harvest period to be determined. This procedure has been carried out in the Bordeaux vineyards for over thirty years, and such tests have undoubtedly contributed to improving wine quality[26].

However, such controls of maturity are not enough for assessing the qualitative potential of the harvest. Measures of quantity, quality and the extractability of the coloring matter of the red wines would therefore be useful to the wine producer. Certain work on phenolic compounds[24] is promising, but the analytical methods used until now have proved too delicate to be used as routine measures of control. Similarly, a simple measure of the aromatic potential of white grapes would help to define the notion of 'aromatic maturity' according to growth and vintage. Different studies[2, 45] have shown the decisive role of the monoterpenes in the aroma of Muscat. More recently, the hypothesis of Cordonnier and Bayanove[7], according to which the terpenols in Muscat occur in the grape, not only in a free volatile and fragrant form, but also in the form of non-volatile and odorless precursors, has now been largely confirmed by the remarkable work of Williams et al.[66–70]. These precursors are polyols and glucosides from which free monoterpenes can be liberated by chemical hydrolysis at the pH of the must. It is also known that osidic precursors are hydrolyzable by the exogenous enzymatic pathway. The endogenous β-glucosidase activity of the grape may constitute a pathway for freeing volatile terpenols[3]. The technological applications of this work could help the wine producer in solving the following two problems: a) At what stage, in relation to its physiological maturity, does a grape possess its maximum aromatic potential? b) What is the most appropriate technology for extracting and revealing the 'potential fraction' of the aroma?

To this end, Dimitriadis and Williams[13] and Dimitriadis and Bruer[12] have proposed a rapid analytical technique for the estimation of the free and potential monoterpenes in Muscat, which is easily applicable in the control of maturity. The conditions of application or adaptation of this test to musts and wines from non-Muscat cultivars are currently under study in other laboratories.

Assessment of the state of health of the grape

The state of health of the crop, and in particular its degree of contamination by *Botrytis cinerea* (the agent responsible for grey rot) is another critical factor in the assessment of the quality of the raw material in vinification. Indeed, a grape suffering from grey rot has its varietal aroma altered; its phenolic compounds are degraded by enzymatic oxidation, and in certain cases, wines made from rotten grapes can develop unpleasant stale, rancid or phenol smells.

Nevertheless, under certain bioclimatologic conditions, *Botrytis cinerea* can cause overmaturation of white grapes, which is a factor which helps to improve the crop, and is known in enology as 'noble rot'. This particular development in the grape gives rise to the originality of the Sauternes-type sweet white wines. Sudraud and Chauvet[62] have proposed an 'index of overripening' which should enable wine producers to recognize with greater precision the quality of their harvest.

Generally, in the vinificaton of red or white wines, *Botrytis cinerea* is always prejudicial to quality. There is still no generally used analytical method for assessing the healthiness of the harvest. In spite of its shortcomings, the only real reference point for the professional is the visual notation of the percentage of rotten grapes in relation to the number of healthy grapes. Measuring the level of the exocellular enzymatic activity of *Botrytis cinerea* in the juices, which is characteristic of the development of this fungus in grapes but which is absent from healthy grapes, constitutes one way of estimating the extent of contamination in the harvest. The laccase of *Botrytis cinerea* (E.C. 1.10.3.2) which was described for the first time by Dubernet and Ribéreau-Gayon[15] is satisfactory; it is responsible for the oxidation of red wines and differs in its properties from tyrosinase (E.C. 1.10.3.1), which is the polyphenoloxidase of healthy grapes. Dubernet[14] assayed the two forms of oxidase activity by the speed of oxygen consumption measured by polarography. However, the possible presence of both of these enzymes in fresh musts means that, for the measurement of laccase activity only, either a specific substrate is required, or a specific inhibitor of tyrosinase must be present.

The perfection of a simple means of determining laccase activity which is based on these principles has been the subject of several studies[8,14,31]. More recently, an apparatus for measuring laccase activity has been proposed by Salgues et al.[54]. It is based on the polarographic measurement of oxygen consumption in a sample of raw must, after the addition of a reagent containing the phenolic substrate and an inhibitor of the tyrosinase of the grape. Another technique for measuring laccase activity is currently being developed in Bordeaux[18]. As a specific substrate it uses syringaldazine[27]. The colored quinone which is formed by oxidation in the presence of laccase is suitable for colorimetric estimation. The method is more sensitive than polarography, and does not necessitate the inactivation of tyrosinase; however, the preliminary elimination by polyvinylpolypyrolidone of the phenolic compounds of the sample is essential, since they can act as inhibitors of the oxidation of syringaldazine.

Laccase activity which is measured in this way is then compared with the stage of development of the rot; this parameter is difficult to evaluate visually in a heterogeneous crop.

Harvesting

Traditional manual harvesting is giving way more and more to mechanical gathering. The machines straddle the rows and are equipped with beaters, which make the grapes drop on to a moving carpet which is dragged alongside the plants. The crop then passes through a sorter which eliminates most of the leaves before being placed in transportation bins. The presence of debris (leaves, petioles and twigs) in a mechanically harvested crop is not a factor favorable to quality, especially in white wines. The most famous growths will be the last to resort to such gathering techniques. However, considerable progress in the conception and handling of the machines has taken place. Moreover, they offer a certain degree of flexibility of use, in particular the possibility of stopping or continuing harvesting at will, in relation to the ripeness of the different grapes and to their state of health.

2. Vinification of red wine

Traditional maceration

In most cases, the first procedure is to remove the stems from the grapes; the grapes are then crushed and the mixture of pulp, pips and skins is put into a fermentation vat after the addition of a small quantity of sulfur dioxide for protection against oxidation and microbial contamination. From the beginning of fermentation, carbon dioxide brings to the surface all the solid particles, thus forming at the top of the vat a compact mass known as the 'cap' or 'marc'.

In the vat, alcoholic fermentation takes place at the same time as the maceration of the skins and pips in the juice. Total sugar fermentation lasts on average 5–8 days; it is assisted by aeration, in order to increase the growth of yeasts and their viability, and by the control of temperature which must be lower than 30 °C, so that the yeasts do not die. Maceration gives red wine its essential color and tannic structure. This is more or less important according to the type of wine. Wines intended for long aging must be rich in tannin and therefore undergo long maceration (2–3 weeks) at a suitable temperature (25–30 °C). However, red wines which are to be drunk young (of the 'primeur' type) must be fruity with little tannin. Here, maceration lasts only a few days.

The 'draining' or straining of the vat is when the juice, known as 'free run wine' is separated from the fruit residuum, or 'marc'. When the marc is pressed, it gives 'press wine'. The mixing of these two types of wine is a matter of taste and analytical criteria. 'Free run wine' and 'press-wine' are then put back into separate vats for secondary fermentation; this is when the remaining sugars disappear and malolactic fermentation takes place.

In the case of great red wines intended for aging, maceration is very important, and should be dealt with here in particular detail. It is important to extract from the skins and pips as many substances as possible which have a positive effect on quality, in particular the 'noble tannins', which give wines their structure and their aptitude for aging. On the other hand, one must avoid extracting compounds whose bitterness, astringency and aggressivity are excessive. Enologists refer to these substances as 'bad tannins'. Current work[24,60,63] has contributed to the characterization of the molecular structure of different categories of phenolic compounds. However, the distinction between 'noble tannins' and 'bad tannins' has not yet been totally elucidated by the chemistry of polyphenols. The factors which affect the extraction of phenolic compounds from the grape are the concentration of alcohol, the circulation of wine through the marc during 'remontages' or 'rising to the surface', and, finally, temperature. Daily tasting of the juices in the vats plays an important role in the combination of these two parameters. The winemaker may also be guided by certain simple analytic controls: determination of color intensity, the measurement of total phenolic compounds[47], and the dosage of anthocyanes and tannins are the most usual. The gelatine index of Glories[24] also provides certain information; it measures the tendency of tannin molecules to combine with proteins and reflects the astringency of the wine.

The number and manner of ways in which wine rises to the surface vary according to the quality of the harvest, and the type of wine to be produced. The current tendency with Bordeaux wines is to increase the number of 'remontages'. This may even reach as many as one a day and involve a third of the vat.

In order to enhance extraction, the suggestion in recent years has been to intervene mechanically by mixing up the marc. The machines used for this are rotary vats and vats with mixing rods[25,39].

Such procedures sometimes increase the diffusion of substances with a vegetal taste; on the other hand, the color and tannin gains obtained by this type of extraction in relation to the classical 'remontage' technique are not always stable during aging.

Temperature is another important factor in the extraction of phenolic compounds. For producing wines for aging, 30 °C is a good temperature for vinification; it makes possible the satisfactory extraction of marc, without compromising alcoholic fermention.

'Final hot maceration'[48] consists, at the end of traditional maceration, of warming the wine to 60 °C in order to raise the temperature of the whole vat to about 40–45 °C. Emptying is performed 24–48 h later. First results point to the possibility of obtaining wines which are more colored and richer in tannins.

Thermovinification and carbonic maceration

Traditional maceration is the basic method in red vinification. However, two other procedures are of particular interest in certain cases: thermovinification and carbonic maceration. In these two techniques, the dissolution of the phenolic compounds takes place in the prefermentary phase, with alcoholic fermentation occurring in the liquid phase.

Thermovinification. The grapes are macerated at a high temperature (70 °C) before alcoholic fermentation. The grapes are heated after crushing and removal of stems and macerate at a high temperature for several hours. The different components of the skin become part of the solution during pressing. This causes the must to be intensely colored and to have high levels of anthocyanins, tartaric anions, total nitrogen, potassium and calcium. During fermentation, the coloring matter and the tannins diminish greatly, and their final level at the end of fermentation is similar to that obtained in classical fermentation[36]. If this heating of the crop is performed correctly, it can lead to a red wine whose character after aging may differ little from that obtained through traditional maceration.

Carbonic maceration. This was first performed by Pasteur in 1872 and then developed by Flanzy from 1935 on[23]. Whole grapes placed in an atmosphere of CO_2 undergo intracellular fermentation, or auto-fermentation, since neither yeasts nor bacteria intervene. This produces a small amount of alcohol and secondary products accompanied by a decrease in acidity, a diffusion of the coloring matter in the pulp, and the formation of particular aromas. The second phase comprises alcoholic fermentation intervening after pressing.

This type of vinification is particularly suitable for producing the 'primeur' type of wine such as Beaujolais. However, the typicalness of the cultivar and of the vineyard is diminished; in the case of prolonged conservation, these wines lose their particular aromatic character, and aging reveals a certain structural defect. Integral carbonic maceration cannot be used for obtaining wines for aging.

3. *Vinification in white wine*

White wine is the result of fermentation of only the juice of the grape, without alcoholic maceration of the solid parts. The extraction of juices by crushing and pressing therefore precedes fermentation.

In certain cases, short prefermentary maceration of the skin or 'skin contact' is carried out. Although rare 10 years ago, this practice is now becoming more and more commonplace throughout the world. It is hoped that without causing olfactive defects, the varietal aroma of the wine can be increased, and other taste factors such as body and structure as well as aptitude for aging can be improved. Good maturity and the perfect healthiness of the grapes are indispensable factors for conducting prefermentary maceration. The grapes are moderately crushed, completely destemmed, and put into the vat with a small addition of sulfur dioxide, and possibly ascorbic acid for limiting oxidation. There has been relatively little work on the role of prefermentary maceration with respect to the composition of musts and white wines. The first studies were those of Ough[42], and Arnold and Noble[1]. The duration of optimum contact must be determined for each cultivar, in relation to vat temperature, the degree of maturity of the grape, the quality of the crop and the style of wine to be produced. It varies from 5 to 18 h. For Austria cultivars, Haushöffér[28] suggested shorter maceration times (3–5 h). Pallota[38] (1983) reports times ranging from 10 to 20 h at low temperature (5 °C). Our own observations[19] confirm the fact that prefermentary maceration in the white cultivars of the Bordeaux region, coming from the best vineyards, is of interest. This is to be associated with the observations of J. Ribéreau-Gayon et al.[46] on the good quality of the press juices of white grapes in the best growths of the Graves region.

Whether the grapes have or have not undergone prefermentary fermentation, the extraction of juices is performed with the greatest care, in order to avoid trituration of the skins. The association of pressed juices and 'free run juices' depends on the quality of the harvest and the pressing apparatus used.

Since they are very sensitive to oxidation, the juices must be protected on extraction with a sufficient level of free sulfur dioxide per liter. Certain authors have experimented with the addition of hydrogen sulfide to the musts, in order to inhibit tyrosinase activity, and to reduce the dose of SO_2 needed in the prefermentary phase[50, 51].

The clarification of musts ('racking') is normally indispensable for obtaining the finest expression of varietal aroma. It can be performed with static sedimentation, centrifugation and filtration. The general tendency is in favor of settling facilitated by the cooling down of the musts to about +5 °C. In this way, oxidation phenomena are diminished, as well as the quantity of SO_2 necessary for delaying alcoholic fermentation.

The fermentation of white wine can then take place in large capacity vats or in casks. Large volume fermentation requires the use of a refrigeration system, so that the temperature never goes above 18 °C. Several authors[4, 29] have shown that a maximum of fragrant substances (acetates of higher alcohols, and ethylic esters of fatty acids) is formed by the yeast when it ferments in clear juice and at a temperature lower than 18 °C. Small volume fermentation in casks poses fewer thermic problems. The limpidity of juices and low fermentation temperatures induce slow fermentation which may lead to a halt in fermentation. This risk is the major concern of the

wine producer. The work of Lafon-Lafourcade, which is discussed in the section entitled 'Applied Microbiology', is now providing an essential contribution to explaining these phenomena; this author demonstrates the inhibitory role for the yeast of certain by-products of alcoholic fermentation, such as decanoic acid.
Certain observations[37] have shown that for each level of clarification of the must, the conditions of extraction of the juices and the maturity of the grapes have an influence on the later stages of fermentation. The composition of the must probably affects both the nutrition of the yeast and the quantity of inhibitors formed. It may therefore be suggested that the colloidal fraction of the must (glycoproteins, polypeptides, polysaccharides) is capable of adsorbing certain inhibitors. Houtman and Duplessis[30] have indeed observed that the fraction stimulating fermentation is retained by filters of the sterilizing type EK while it seems to pass through under-set fitters of clarifying type (K3). Today, it is clear that under difficult conditions, certain strains of *Saccharomyces cerevisiae* are more sensitive than others to halts in fermentation during the vinification of white wine.
Many recent studies have confirmed the diversity in ability of strains of yeasts as regards the production of esters and higher alcohols[59,61]. On the other hand, nobody has yet clearly demonstrated an interaction between the strain of yeast and the aroma of white cultivars. Certain observations[9,30] do, however, point to the fact that such interactions could exist; this is certainly a future research subject.
Vinification in white wine is often complete when alcoholic fermentation has finished. In many cases malolactic fermentation is not an objective, since white wines tolerate an acid freshness rather well, and because this secondary fermentation causes the typical aromas of the cultivars to be lost. However, certain white wines do undergo malolactic fermentation; this provides heaviness and volume in wines which are aged in oak casks and are destined for long aging (Burgundy); moreover, it ensures biological stability (Champagne).
Vinification of sweet wines requires grapes rich in sugars, which are concentrated by climatic drying or noble rot. During alcoholic fermentation, a part of the sugar is transformed into alcohol, but fermentation is stopped before it is completely finished. Sulfur dioxide is used here and is combined with cooling of the wines and with the elimination of the yeasts by racking or centrifugation; heat (pasteurization) can also kill yeasts. Recent work on the thermoresistance of yeast in enology has been carried out by Deveze[10], Deveze and Ribéreau-Gayon[11], and Bidan et al.[5].

4. *Aging of wines, clarification, stabilization*

New wine is raw, cloudy and gaseous; the aging phase takes it from here to the finished bottled product.
It is a phase which varies in duration according to the type of wine. The 'primeur' wines (Beaujolais) are bottled only a few weeks or even a few days after vinification. However, the great aging wines are matured from 18 months to 2 years. Aging comprises clarification, stabilization, and quality improvement.

Clarification

Wine limpidity is measured by nephelometry. Turbidity is expressed in N.T.U.; this unit now replaces the milligram of silica per liter which was used in earlier work[34]. 1,1 N.T.U $\neq$ 3,5 mg of silica per liter.
According to Romat[49], wines ready for bottling should have a level of turbidity lower or equal to 2.0 N.T.U. for red wines, and 1.1 N.T.U. for white wines. They may then be judged as 'brilliant' by the taster.
Clarification may be obtained by sedimentation and decantation if the wine is kept in small-volume containers (225-liter wooden casks). Racking is not sufficient when wine is kept in large volumes. Fining, centrifugation and filtration then become necessary. Nowadays, fining is more a process of stabilization than of clarification.
Centrifugation has developed extensively in those wine-producing companies which possess equipment on an industrial scale. The most recent centrifugation machines function with no risk of oxidation, and can eliminate particles or microorganisms of a diameter of 0.5 µm.
Filtration is used more than centrifugation and can be carried out using different supports: kieselguhr, cellulose sheets and synthetic membranes.
Filtration on kieselguhr is performed with continuous alluvian filters. With this technique, wines of low turbidity (< 1 N.T.U.) and a low microbial level (< 100 living cells/ml) can be obtained.
Such a technique of first filtration makes possible the sterilizing filtration of the wine at the moment of bottling, and this is done with cellulose sheets; in this way, there is no fear of the filter blocking up[55].
Filter sheets currently used in enology have cellulose-kieselguhr or cellulose-polyethylene as a base. Asbestos has been completely abandoned for health reasons. Serrano et al.[56] have compared the filtration quality of clarifying and sterilizing sheets of various origins. Most brands tested guaranteed the biological stability of the wines filtered; that it is say, a number of viable cells lower than 1 per 100 ml, and turbidity levels lower than 1 N.T.U.
In order to obtain perfect microbiological safety, many bottling plants have been equipped with membrane filtration systems. However, preliminary filtration of wines on close-set sheets or through a prefilter is indispensable for avoiding excessive blocking-up[53,55].
Finally, since 1983, several experiments on the tangential microfiltration of wines have been carried out[52,58]. The process enables one to obtain, in only one step, a brilliant, sterile product which guarantees against proteinic instability, and this from a wine which, at the outset, is very turbid. However, the level of macromolecules (in particular polysaccharides) is greatly diminished in such wines. The first results from wine-tasting seem to indicate that the organoleptic characteristics of the wines are also modified.
It therefore seems clear that filtration of wines, particularly through sterilizing filters, has to be performed with caution. The limpidity and microbiological stability of wines must be obtained with techniques which modify as little as possible the colloidal structure of wines, whose organoleptic role seems to be more than probable.
Certain wines which are produced from grapes attacked by *Botrytis cinerea* may offer serious clarification diffi-

culties. The substance which is responsible for the blocking-up of filtration bases is a $(1\rightarrow3:1\rightarrow6)$-β-D-glucan, whose molecular structure and localization in the grape have been studied by Dubourdieu et al.[17,20].
The mechanical conditions under which the grape is handled play an important role in the diffusion of the glucan of the grape in the musts. The brutal treatment of rotten grapes should therefore be avoided in order to limit glucan levels in wines. However, when the wine contains glucan despite the precautions taken, it can be eliminated by enzymatic treatment with a preparation of exo-β-$(1\rightarrow3)$-glucanase[16,21].

Stabilization
The stabilization of a wine aims to prevent the formation, during conservation in bottles, of cloudiness or deposits having a chemical origin: tartaric salt, proteins in white wines, colloidal coloring matter in red wines.
Stabilization with respect to tartaric precipitation is classically obtained by stabulating wines for a week at a temperature near the freezing point. This process which is slow and costly is not always totally efficacious, since certain constituents of wine, of a colloidal nature, are inhibitors of crystallization. Müller-Späth[37] has proposed a new method of stabilization by using cold: this is the 'contact process'. The addition of a large quantity (4 g/l) of potassium bitartrate (of a defined crystal size and purity) to a wine cooled to about 0 °C, enables the oversaturation of this salt to be broken in 4 h. Wine treated in this way then has very good stability.
These results have been confirmed by several authors[6,43,44]; Vialate[64] and Serrano et al.[57] have experimented with 'continuous tartaric stabilization'. Under certain conditions of use, these procedures lead to good stability in wines.
In white wines, the proteins which are produced mainly by the grape are eliminated by fixation on a colloidal clay called bentonite.
The use of fining to stabilize the colloidal coloring matter in red wines is a traditional well-established technique. Fining consists of adding to the wine a protein substance (egg albumin or gelatine) which flocculates while adsorbing the particles in suspension and colloidal coloring. There has been little recent work on the mechanisms of fining[65].

Quality improvement
The technology of vinification has made great progress during the last decade. On the other hand, the conditions under which aging is best achieved remain an area for empirical judgement. And yet the period of aging has an effect on organoleptic characteristics and on the evolution of wine during aging in bottles.
Recent work on the aging of red wines[40,41] has concerned the role of oxidation and that of oak wood.
The transformation of the coloring matter during the aging of red wines necessitates the intervention of oxygen to guarantee the formation of traces of ethanal by coupled oxidation with ethanol and phenolic compounds. Ethanal makes possible the polymerization of anthocyanins, and other phenolic substances also play a role here. The result is an increase and a stabilization in color, despite a decrease in the level of anthocyanins.
During the traditional conservation in 225-l casks, about 45 mg of O_2/l, per year, penetrate into the wine through the wood and during the 4 rackings. When wine is conserved in airtight tanks, it is only through racking that oxygen may be introduced; this is then of the order of 7 mg/l when racking is performed with intensive aeration. Under these conditions, 6 to 7 rackings per year are necessary to reach the same level of oxygen as during cask aging.
However, the use of new oak casks also transmits to red wine a group of tannic and aromatic elements which modify the organoleptic characteristics. The origin of the wood, the way in which it was dried (natural or artificial), and the technique of coopering (steam or flame) play a role in the nature and the quantity of substances transmitted by the cask. The richest wines tolerate a high oak character best of all, and are the least sensitive to differences due to the origin of the cask.
Publications on quality adjustment in white wines during aging deal only with the autolysis of yeasts in effervescent wines[27,35]. The autolysis of yeasts intervenes after a few months of conservation: to be noted here is an enrichment in free amino acids, total nitrogen, ammoniacal nitrogen, ribose, phosphate and group B vitamins.
In the case of still wines, the role of aging on lees has been studied only a little although it is a traditional method of wine production in casks in the great white wines for aging (Burgundy, Graves). During the first months of maturing, the enrichment of the wine by polysaccharides coming from the yeast wall (mannoproteins) seems to precede autolysis itself, which necessitates prolonged contact (our own unpublished results).

5. *Bottling and aging*

Bottling requires much care and microbiological cleanliness. The wine must not be contaminated during this procedure. The daily sterilization of bottling equipment, either by steam or hot water, and microbiological control on bottling conveyor belts, have become common policy. Cork is still the first choice material for the closing of bottles of great wines; thanks to its elasticity, it ensures good hermeticity. Lefebvre[33] has specified the bottling conditions limiting the two difficulties of using cork; these are leaky bottles and backtaste in the wine.
During the aging of certain bottled wines, there appears a specific 'bouquet'. This is due to complex transformations whose chemical modes of action remain unknown. All that has been shown is that the process of reduction in the absence of oxygen is a decisive factor in the acquisition of 'bouquet'.

Conclusion

Current enological research does not aim at developing 'technological wines' whose organoleptic characteristics are basically determined by the methods used in the transformation of grape wine, but rather to refine methods which will highlight the original qualities of different cultivars and viticultural conditions.

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The potential role of *(vinifera × rotundifolia)* hybrids in grape variety improvement

by H.P. Olmo

University of California, Department of Viticulture and Enology, Davis (California 85616, USA)

Key words. Grape; breeding; pest resistance; *vinifera-rotundifolia.*

Introduction

The objective of this review is to present some examples of work in progress that emphasizes the great potential of using the gene resources of the *Vitis rotundifolia* (now *Muscadinia rotundifolia* Small) as a donor to introduce resistance or immunity to a wide range of pests that cause extensive loss in yield and quality of the *vinifera* grape. Examples cover a whole range of organisms; fungi, bacteria, insects, nematodes and, most important, soil borne viruses causing vine degeneration. The reciprocal approach to introduce the high fruit quality of the *vinifera* has been hindered by the lack of cross compatibility when *rotundifolia* is used as the female parent.

The vinifera grape[27]

The *vinifera* grape, still found in the wild state as isolated relic populations around the Mediterranean Basin and the Middle East, is the most renowned of all the species in the genus *Vitis* because of the excellent quality of its fresh or processed fruit. The wide variation in morphological characters suggest an origin from a complex of subspecies. *Vinifera* has given rise to an immense number of cultivars. The wild plant, as found in the forests, produced edible and palatable fruit. Domestication was uncomplicated, only sparing and protecting the most desirable vines in place was necessary.

The fruit qualities that make the *vinifera* a standard of excellence are the thin and tender skin closely adherent to the firm and meaty pulp; large berries, some seedlessness, attractiveness in color and form, high yield of clear juice, high sugar content, medium to low acidity, low phenolics, low pH, mild or subdued flavors, large and well-filled clusters with good adherence of the berry. The importance of any one of these characteristics vary with vineyard site and the intended use of the product. For wine grapes to be harvested mechanically, good adherence of the berries is a negative factor, but for table grapes to be shipped and stored it is a positive factor. High sugar content, though generally desirable, is not sought for champagne-type wines.

Propagation of the better ones and increase were relatively easy, as this vine propagates readily by cutting segments of mature canes (cuttings) derived from the current season's growth and burying them in soil in furrows in an upright position, leaving the uppermost bud exposed to begin growth in the spring.

From its ancestral home in the Middle East, about 4000 B.C., cultivated varieties began spreading to the east and