OENO One
VINE AND WINE OPEN ACCESS JOURNAL

DOI: http://dx.doi.org/10.20870/oeno-one.

Disease resistant grapevine varieties and quality: the case of Bouquet varieties

J.M. Salmon, H. Ojeda, and J.L. Escudier

Unité Expérimentale de Pech Rouge (UE 0999), INRA, Domaine de Pech Rouge, 11430 Gruissan (France)

Abstract

The disease resistant grapevine varieties (ref A. Bouquet) were obtained by INRA from 4 or 5 generations of backcrossing between *Muscadinia rotundifolia* and *Vitis vinifera* and exhibit a high level of resistance against downy and powdery mildew. These varieties carry the resistance genes *RUN 1* and *RPV1*, with several other secondary genes at one chromosomal locus. Agronomic criteria were studied for all these selections. Among the selected grapevine species, some have high levels of polyphenols. Some (white and red) have a high aromatic potential, while others have low sugar contents (135 g/L to 150 g/L) and adapted sugar/acidity ratio. All these characteristics were combined to design a new set of vine cultivars dedicated to the production of either low-alcohol wines, grape juices, or classical wines. Since 2012, within a France Agrimer/CIVL/INRA financial framework, 10 plots (0.5 ha each) were planted at INRA Pech Rouge with 8 resistant grape varieties (ref A. Bouquet) in order to examine long-term resistance to diseases and to define quality criteria for the classification of the wines obtained from these new grape varieties.

Keywords: grapevine, Bouquet varieties, disease resistance, mildew, low-alcohol wines

Introduction

The disease resistant grapevine varieties (ref A. Bouquet) were obtained by INRA from 4 or 5 generations of backcrossing between *Muscadinia rotundifolia* and *Vitis vinifera* and exhibit a high level of resistance against powdery and downy mildew (Bouquet, 1986; Bouquet *et al*., 2000). These varieties carry the *RUN 1* and *RPV1* resistance genes (Barker *et al*., 2005), with several other secondary genes at one chromosomal locus. The aim of this paper is to show the potential of the Bouquet varieties as a source of vine diversity for the production of high quality grape juices and wines.

Results

Diversity of disease resistant Bouquet varieties

By using several different grapevine varieties (table and wine varieties) for the backcrossings in order to eliminate up to 95% of the initial genome of *Muscadinia rotundifolia*, A. Bouquet (who died in 2009) has built a very heterogeneous collection of new varieties (Figure 1). A. Bouquet used resistance to diseases (downy and powdery mildew) as well as several agronomic parameters (yield, growth parameters) to make a careful selection of the best suitable varieties for future purposes. This selection process led to a high diversity of new varieties, including some with high levels of polyphenols (6 times more than Alicante bouchet), and others with a very adapted sugar/acidity ratio particularly suitable for the production of high quality grape juices (Escudier *et al*., 2016). Some (white and red varieties) exhibit a low sugar content at maturity (135 g/L to 150 g/L), allowing the production of low-alcohol wines (between 9 and 10% vol.) by direct alcoholic fermentation (Aguera *et al*., 2010), while others possess a high aromatic potential for low-input traditional winemaking.

Corresponding author: Salmon J.M., jean-michel.salmon@inra.fr

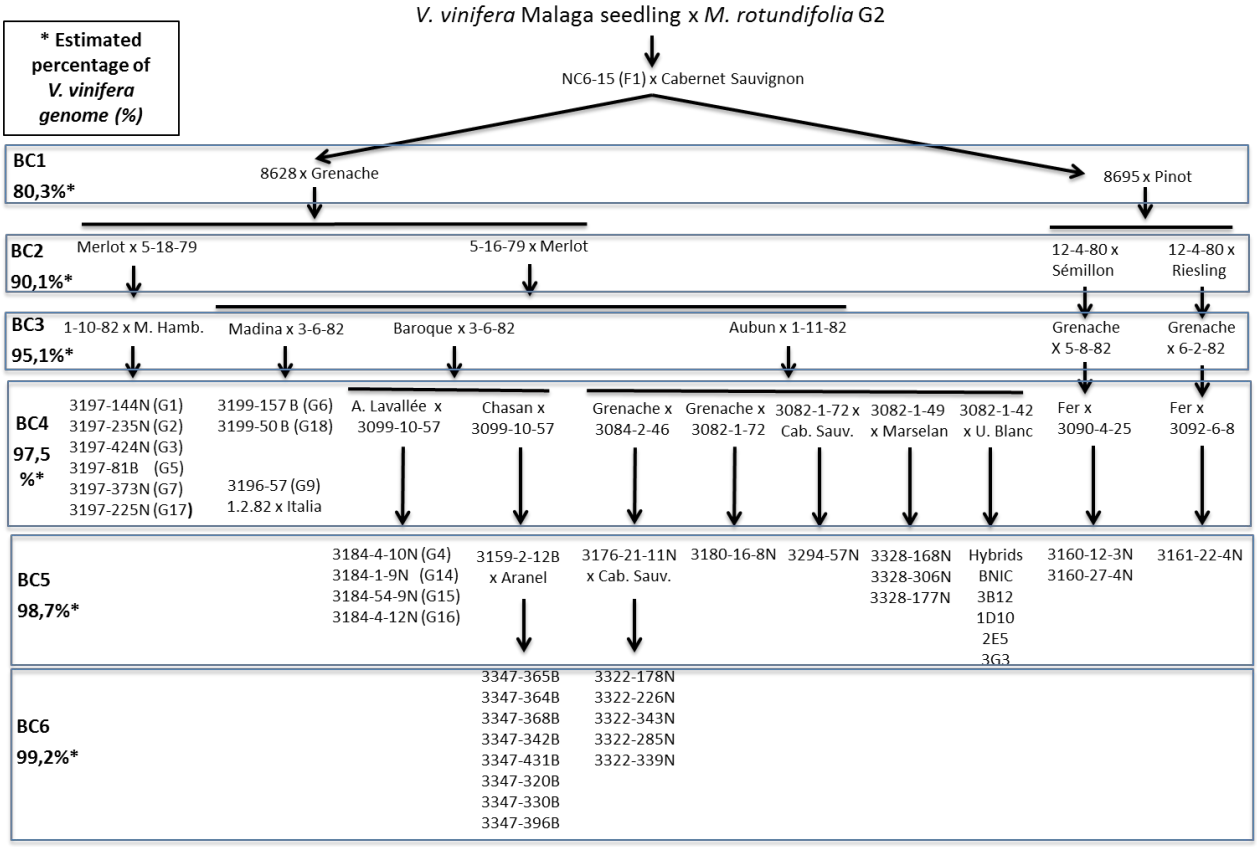

Figure 1. Scheme of the selection of varieties resistant to downy and powdery mildew performed by A. Bouquet. Interspecific backcrosses (BC) from *Vitis vinifera* x *Muscadinia rotundifolia* and estimated percentage of *V. vinifera* genome in the obtained varieties (Ojeda *et al*., 2010)

Disease resistant Bouquet varieties for the production of high quality grape juices

Through a joint research contract, INRA and the FOULON-SOPAGLY company (European leader in the production of grape juices and coordinator of the project) have been running a research program (Fijus R@isol) since 2009 dedicated to offering a range of grape juices more in line with consumers' expectations: more acidic and less sweet, with a sugar/acid ratio (evaluated as tartaric acid) from 20 to 18 (currently at less than 16). Through the different technological options available to reach these targets, the possibility of using more productive vines tolerant to the two main vine diseases (downy and powdery mildew) was evaluated at the industrial scale (Escudier *et al*., 2016).

Among the screened disease resistant Bouquet varieties (25 tested: 13 red and 12 white), three were selected for further evaluation of their quality potential (G3, G4 and G18; Table 1). The results concerning the aromatic perception of the elaborated juices show that the G3 and G4 varieties have an aromatic quality superior to Arinarnoa (control) due to the presence of Muscat aromas originating from their parents (Figure 1). The G18 variety exhibits a more important aromatic quality than Ugni blanc (control) with a stronger intensity. G18 produces also a juice of average color and quality, with a good balance between sugar and acidity, depending on the vintage. These three promising Bouquet varieties have been under a DHS (Distinction Homogeneity Stability) experimental procedure since 2016 in order to get a final inscription in the new French vine catalog for juice varieties (Figure 2).

Disease resistant Bouquet varieties for the production of low-alcohol wines

Through a French national research contract (ANR-VDQA), INRA Pech Rouge was involved in a technical, sensory and socio-economic multidisciplinary research program aiming to produce quality wines with significantly reduced alcohol content (Aguera *et al*., 2010). Through the high diversity of the disease resistant Bouquet varieties, three of them (2 white and 1 red) were selected for their ability to mature with low final fermentable sugars (Table 1). The reduction of alcohol in the corresponding wines always leads to a decrease in the sensation of warmth and persistence of the wine. Moreover, in low-alcohol red wines there is sometimes a decrease in bitterness in favor of astringency. In low-alcohol white wines, either acidity or bitterness is increased.

OENO One
VINE AND WINE OPEN ACCESS JOURNAL

DOI: http://dx.doi.org/10.20870/oeno-one.

Table 1. Main characteristics of the disease resistant Bouquet varieties described in the paper.

Average composition of the corresponding juices and wines obtained through the 2013-2016 vintages at INRA Pech Rouge

Identification	Future commercial name	Backcross numbers	Last backcross	Research target	Average values on 2013-2016 period at INRA Pech Rouge					
					Drip irrigation	Harvest date	Yield (kg/vine)	Sugars (g/L)	Potential alcohol (% Vol)	Total Acidity (g/L H2SO4)	pH
3176-21-11 N	-	BC5	Grenache x 3084-2-46	Traditional wines	none	22-sept	2.8	-	12.71	3.36	3.5
3160-12-3 N	-	BC5	Fer Servadou x 25/04/3090		none	15-sept	1.7	-	13.58	3.17	3.5
3159-2-12 B	-	BC5	Chasan x 3099-10-57		none	17-sept	2.3	-	12.70	3.08	3.3
3322-339 N	-	BC6	3176-21-11N x Cabernet-S		50-60 mm/year	20-sept	2.0	-	13.01	3.63	3.6
3197-81 B (G5)		BC4	1-10-82 x Muscat de Hambourg	Low- alcohol wines	50-60 mm/year	02-sept	4.4	-	10.16	3.26	3.4
3196-57 B (G9)	-	BC4	1-2-82 x Italia		50-60 mm/year	05-sept	5.4	-	10.64	4.08	3.2
3184-1-9 N (G14)	-	BC5	Alfonse Lavallée x 3099-10-57		50-60 mm/year	11-sept	5.1	-	10.38	2.86	3.6
3197-424 N (G3)	Reclia	BC4	1-10-82 x Muscat de Hambourg	Grape - juices	50-60 mm/year	25-aug	3.9	158.7	-	5.53	3.1
3184-4-10 N (G4)	Rebelia	BC5	Alfonse Lavallée x 3099-10-57		50-60 mm/year	27-aug	4.5	158.7	-	5.17	3.2
3199-50 B (G18)	Recybel	BC4	Madina x 3-6-82		50-60 mm/year	12-aug	2.9	136.2	-	4.76	3.0

Corresponding author: Salmon J.M., jean-michel.salmon@inra.fr

DOI: http://dx.doi.org/10.20870/oeno-one.

Disease resistant Bouquet varieties for the production of low-input traditional wines

Within a France Agrimer/CIVL/INRA financial framework, INRA Pech Rouge has developed a progressive open system of 10 plots (0.5 ha each) for observation, evaluation and demonstration from the field to the finished wine (2012-2020). This pilot scale vineyard was also dedicated to a regional observatory of disease resistant vine varieties (OsCaROC), declination of the national OsCaR project, led by INRA and CIVL (Comité Interprofessionnel des Vins du Languedoc). Among the different varieties planted in this pilot vineyard, there are 4 disease resistant Bouquet varieties (Table 1), together with two control varieties (Syrah and Piquepoul). This set of plots was not subjected to phytosanitary treatments, in order to study the effect of a decrease in input use for the preservation and sustainability of the vineyards, and the health of the winegrowers, their employees and their neighbors. The size of the planted plots also allows studying different winemaking processes. As a matter of fact, only few data were actually available on the adequacy between these new resistant varieties and specific winemaking processes.

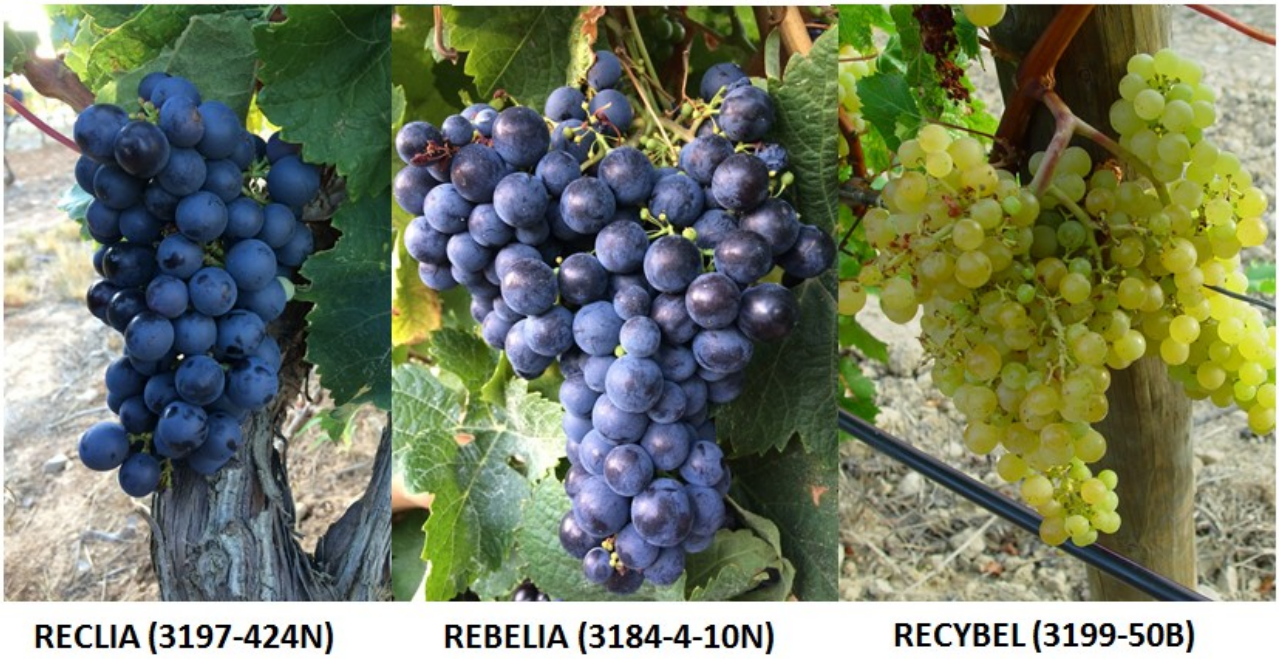

Figure 3. The three disease resistant Bouquet varieties selected for grape juice production.
Photographs performed at technological maturity (INRA UEPR)

As an example, the sensory perception by an expert sensory panel (27 professional judges from CIVL) of three different winemaking itineraries performed on the same resistant variety harvest (var 3160-12-3) is given in Figure 3. It clearly appears that the descriptors used by the panelists reflected very different and homogenous sensory perceptions, depending on the type of winemaking. This observation shows that the qualitative valorization of these new grape varieties must obviously be screened through the different winemaking methods so as not to reject or support one variety over another. From a technological point of view, rather old scientific studies have distinguished various classes of grapes differing in their molar ratio of hydroxycinnamic acids to glutathione (Rigaud *et al*., 1988). In an attempt to classify new disease resistant varieties based on their oxidation susceptibility, we quantified in a similar way caftaric acid, glutathione and ascorbic acid after anoxic pressing of the grapes and stabilization of the corresponding musts against oxidation (Frissant *et al*., 2012). The capacity of a must to oxidize during its technological processing (harvesting, crushing and pressing steps) can be indeed estimated by precisely measuring its initial contents in caftaric acid (main substrate of oxidation) and glutathione and ascorbic acid (the two main natural antioxidants in grapes) (Frissant *et al*., 2012). As presented in Figure 4, it can be stressed that there is as much potential variability in terms of susceptibility to oxidation in disease resistant varieties as in

Corresponding author: Salmon J.M., jean-michel.salmon@inra.fr

conventional varieties. This evidences the value of considering this quality marker in any selection of new resistant varieties.

INRA Pech Rouge is now involved in the VINOVERT project (http://www.vinovert.eu), which is an innovative three-year (2016-2019) project for the wine sector in the SUDOE region (wine and vineyard businesses in South-Western Europe). This European project focuses on new market requirements in terms of health and environment, and aims to anticipate the new demand for sustainable viticulture, offering guarantees of 'naturalness' and environmental responsibility. Within this research framework, INRA is providing wines produced from disease resistant Bouquet varieties, processed at the cellar with and without sulfites, in order to understand the reality of consumer and citizen arbitrations on pesticide, naturalness, and social responsibility issues.

Discussion

Scientific works performed on disease resistant Bouquet vine varieties at INRA Pech Rouge were mainly dedicated to evaluate, on an industrial scale, the quality potential of these new varieties for the production of quality juices or wines. The planting of these varieties has been carried out on a sufficient scale to carry out technological trials, demonstrating the advantages and limitations of these new varieties. Numerous technological trials have yet to be carried out on these varieties so as to fine-tune the winemaking to each of these varieties, in order to increase their true quality potential.

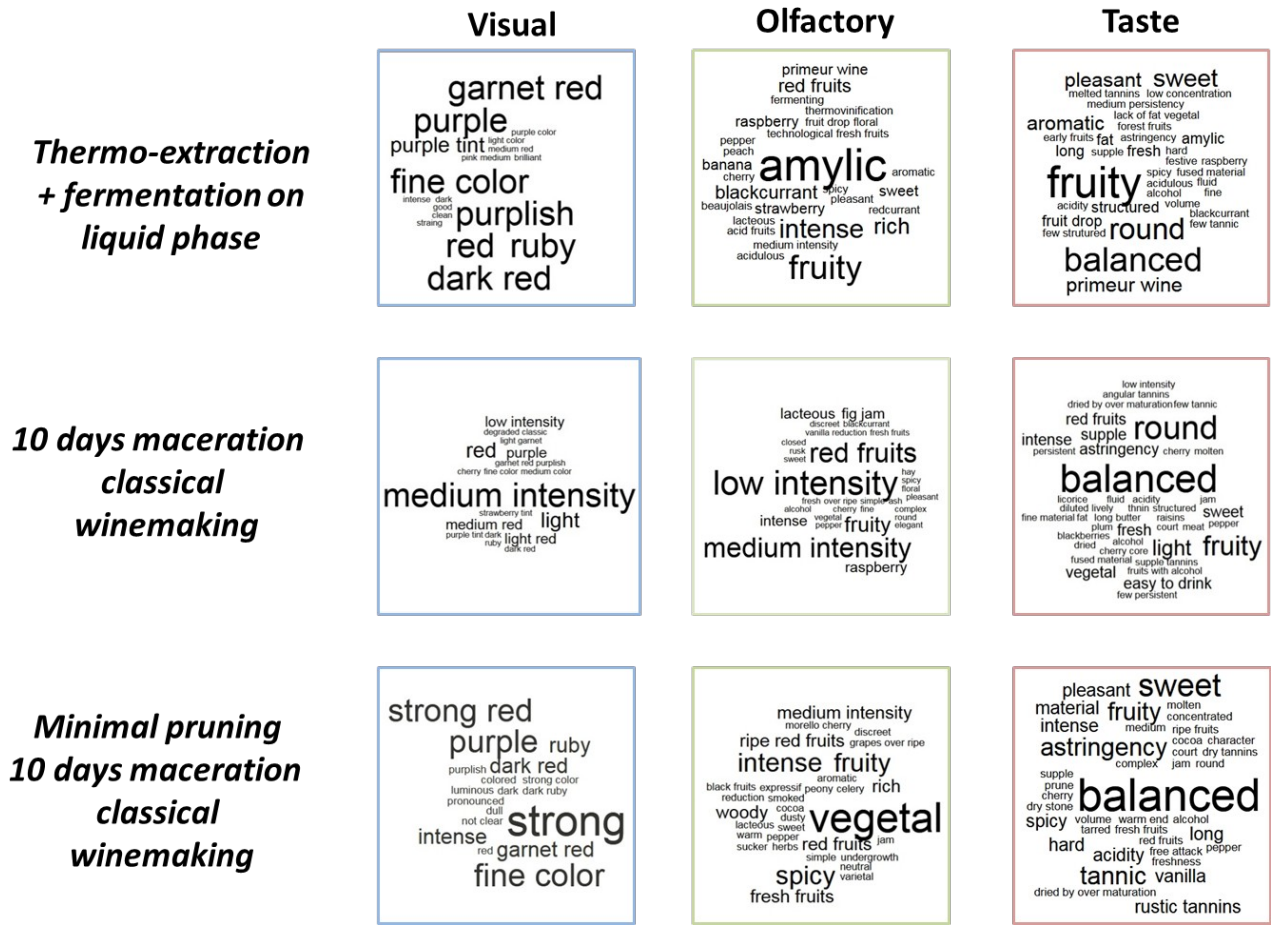

Figure 3. Sensory perception by an expert sensory panel (27 professional judges) of three different winemaking itineraries performed on the same resistant variety harvest (var 3160-12-3 N).

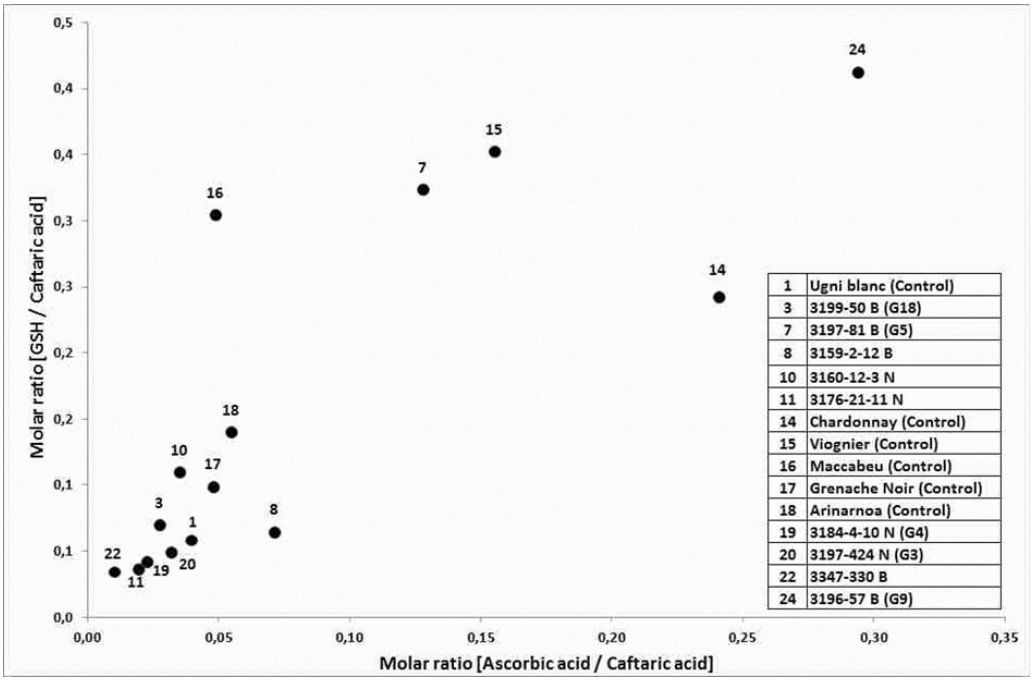

Figure 4. Estimation of the capacity of musts originated from resistant varieties to oxidize during their technological processing.
Initial contents in ascorbic acid, glutathione (GSH) and caftaric acid of different musts obtained after anoxic pressing of grapes from different wine varieties harvested at technological maturity at INRA Pech Rouge

References

Aguera E., Athès-Dutour V., Bes M., Caillé S., Cottereau P., Escudier JL., Mikolajczak M., Roy A., Sablayrolles JM., Samson A., Souchon I. and Vidal J.P., 2010. Reduction of wine alcohol content: a comparative study of different technologies. *Bulletin de l'OIV*, 83, 31–42.

Barker CL., Donald T., Pauquet J., Ratnaparkhe MB., Bouquet A., Adam-Blondon AF., Thomas MR. and Dry I., 2005. Genetic and physical mapping of the grapevine powdery mildew resistance gene, *Run1*, using a bacterial artificial chromosome library. *Theoretical and Applied Genetics*, 111, 370–377. doi:10.1007/s00122-005-2030-8

Bouquet A., 1986. Introduction dans l'espèce *Vitis vinifera* L. d'un caractère de résistance à l'oïdium (*Uncinula necator* Schw. Burr.) issu de l'espèce *Muscadinia rotundifolia* (Michx.) Small. *Vignevini*, 12, 141–146.

Bouquet A., Pauquet J., Adam-Blondon AF., Torregrosa L., Merdinoglu D. and Wiedemann Merdinoglu S., 2000. Vers l'obtention de variétés de vigne résistantes à l'oïdium et au mildiou par les méthodes conventionnelles et biotechnologiques. *Bulletin de l'OIV*, 73, 445–452.

Escudier J.L., Payraud R., Brienza E., Moreau S., Guyot P., Samson A., Mikolajczak M., Bouissou D., Veyret M., Caillé S., Souquet JM., Cheynier V., Zümstein E., Heywang M., Lacapère JN., Rousseau J. and Ojeda H., 2016. New vineyard fields: grape juice. Selection of grapevine species, juice making, stabilization. *39th World Congress of Vine and Wine*, BIO Web of Conferences, 7, 01001. doi:10.1051/bioconf/20160701001

Frissant S., Delmas C., Souquet JM., Samson A., Moutounet M. and Salmon J.M., 2012. Management de la température de la vendange depuis la vigne jusqu'à la mise en fermentation : étude quantitative de la protection obtenue contre l'oxydation. *Revue des Œnologues*, 145, 21–25.

Ojeda H., Mestre Sanchis F., Corbacho L., Bouquet A. and Carbonneau A., 2010. Reduction of cost and emissions in vineyards by the use of low input technologies adapted to productions of good quality wines: genotypes resistant to fungal diseases and minimal pruning – zero pruning – system. *Progrès Agricole et Viticole*, 21-22, 431–440.

Rigaud J., Moutounet M. and Cheynier V., 1988. Relation entre la consommation d'oxygène et la composition en composés hydroxycinnamiques de quatre moûts de raisins blancs. *Sciences des Aliments*, 8, 467–477.