CENTENARY OF THE OIV
45th WORLD CONGRESS OF VINE AND WINE
14-18 OCTOBER 2024 FRANCE-DIJON
OIV
Available on IVES Conference Series vine & wine
DOI : https://doi.org/10.58233/enrWZMn4

Oenological potential of wines and agronomical characterisation of grapes from five white resistant Italian varieties at Serra Gaúcha, Southern Brazil

Leonardo Silva Campos[1], Juliane Barreto de Oliveira[2], Carolina Ragoni Maniero[1], Leonardo Augusto Cerutti[2], Carlos Artur Nascimento Alves[3], Yolanda Selum Diogo[4], Leo Duc Haa Carson Schwarzhaupt da Conceição[2], Adeliano Cargnin[2], Mauro Celso Zanus[2], Giuliano Elias Pereira[2]

[1] São Paulo State University (UNESP), School of Agricultural Sciences, Av. Universitária, n° 3780, 18610-034, Botucatu – SP, Brazil.

[2] Brazilian Agricultural Research Corporation (Embrapa Uva e Vinho), St. Livramento, n° 515, 95701-008, Bento Gonçalves – RS, Brazil.

[3] Federal University of Ceará (UFC), Food Engineering Department, Ac. Público, 856 - Pici, 60020-18, Fortaleza - CE, Brazil ; University Center Inta - UNINTA, Center for Human and Exact Sciences, R. Antônio Rodrigues Magalhães, 359 - Dom Expedito, 62050-100, Sobral - CE, Brazil.

[4] Federal University of Viçosa (UFV), Av. P H Rolfs, w/n, Campus Universitário, 36570-900, Viçosa - MG, Brazil.

Abstract. The main vitivinicultural region in Brazil, is Sera Gaúcha, that presents high rainfall during the maturation, with risk of attacks by fungal pathogens. The use of resistant varieties can focus in a sustainable vitiviniculture. The objective of the study was to evaluate the potential of white grapes varieties resistant to downy mildew. The experiment was performed in a randomized trial with two blocks, with 12 plants each, spacing of 1.15m per 2.30m. The varieties were Fleurtai, Soreli, Sauvignon Nepis, Sauvignon Kretos, Sauvignon Rytos, grafted onto the Paulsen 1103. Agronomic and oenological potential were evaluated. Individual phenolic compounds were analyzed by UPLC/MS. The results were submitted to analysis of variance (ANOVA) and comparison of means using the Tukey test at 5% probability level. Fleurtai presented the highest productivity. There were significant differences for total acidity and pH at harvest. Sauvignon Kretos presented higher levels of flavanols+stilbenes in skin+pulp and seed, while Soreli presented higher levels of flavanols in skin+pulp extracts. In wines, Fleurtai showed higher concentrations of: isoquercetin, trans-resveratrol, epicatechin gallate, catechin, caftaric acid and flavonols+stilbenes. Exept for Nepis, all other varieties showed good adaptation and productivity in the region and can be recommended for winemaking of different styles of wines.

1. Introduction

Brazil presents a great diversity and types of viticulture combined with different terroirs, which cultivated area is around 75,000 ha of vineyards [10]. Traditional viticulture concentrated in the southern States of the country, in regions with a temperate and subtropical humid climate, with one pruning and one harvest per year. The State of Rio Grande do Sul-RS is the main national wine producer, representing 90% of national production of wines and juices, and 85% of sparkling wines. RS is responsible for more than 60% of the Brazilian wine-growing area, producing more than 500.00 million liters of wines, juices and other derivatives [10, 17]

Serra Gaúcha is the main wine producing region, where the first Geographical Indication was implemented (Vale dos Vinhedos). Part of its production is mainly focused on the production of table grapes, juices and derivatives, using *Vitis labrusca* varieties, in addition to the production of grapes with *Vitis vinifera* L., intended for production of fine and sparkling wines [1, 10]. One of the most important problems faced in the cultivation of *Vitis Vinifera* L. in the region is susceptibility to fungal diseases, as downy mildew [2].

In RS state, during the grape maturation period, which covers the months of December to March, the historical average rainfall tends to be veru excessive (between 1,000

and 1,200 mm), with temperatures ranging between 16 and 32°C, which makes fungal disease control time-consuming and delicate for the producer [15].

Under favorable conditions, fungal pathogens have a high capacity to cause great damage in a short period, as downy mildew, main disease that attacks the vines, reducing and compromising productivity and consequently the quality of the grapes at harvest [13]. Losses due to pathogen incidence, when under favorable conditions, can reach 100% [27]. To control the disease, spraying is necessary during the season to control downy mildew [26].

In the climatic conditions of Serra Gaúcha, an average of 14 phytosanitary sprays are required, 64% of these sprays are for downy mildew control, and there may also be weekly sprays to prevent other fungal diseases [6, 8].

With the expansion of the viticulture in the region, there is a demand for studies of new technologies to improve the vine cultivation, trying to get high quality grapes and wines, in a humid climate condition. An alternative to minimize the effects caused by pathogens is the use of resistant varieties focusing on a sustainable viticulture [4, 9, 20, 25]. This varieties are obtained through backcrossing and genetic studies, combined with selection assisted by genetic markers between different varieties to obtain genes for resistance to attack by fungal pathogens, mainly downy mildew [2, 5, 16]

The resistant varieties, called PIWI, from the German "*Pilzwiderstandsfahige"*, have a high percentage of *V. vinifera* in their pedigree, greater than 85% [22].

The use of these varieties can bring a significant reduction in production costs, since spending on agricultural pesticides is reduced of up to 58% in the costs of phytosanitary treatments and a 15% reduction in the vineyard's operating costs [25].

Furthermore, the producer will have new varieties in its portfolio that can diversify the styles of wines produced, generating more revenue and adding value to the final product and making it more sustainable.

The objective of this work was to evaluate the agronomic characteristics of vines and the oenological potential of grapes and wines from five new resistant Italian white varieties introduced in Serra Gaúcha.

2. Material and methods

The study was developed in an experimental vineyard located at Embrapa Grape and Wine (29°16'S and 51°52'W, 640 m altitude), in Bento Gonçalves city, Rio Grande do Sul State. The region's climate is Cfb, according to the Köppen climate classification, characterized by temperate humid and warm summers. The experimental design was installed in 2016 in randomized blocks, with two plots of 12 plants each, spaced 1.15m between vines and 2.30m between rows.

The white varieties were Fleurtai (TOCAI FRIULANO X KOZMA 20-3), Soreli (TOCAI FRIULANO X KOZMA 20-3), Sauvignon Nepis (SAUVIGNON X BIANCA), Sauvignon Kretos (SAUVIGNON X KOZMA 20-3), Sauvignon Rytos (SAUVIGNON X BIANCA), grafted onto the Paulsen 1103 rootstock.

Vines were pruned in a bilateral spur-pruned cordon, and trained in vertical shoot positioning-VSP. Agronomical characterization was carried out by determining the cycle duration (days after pruning-DAP), weight per plant (kg), and productivity/yield (kg/ha). At harvest, 100 berries were collected per plot, of which 40 berries were used for physical-chemical analyses, namely total soluble solids (°Brix), total acidity (g L^{-1} of tartaric acid) and pH [3]. The remaining 60 berries were used to characterize individual and total phenolic compounds by UPLC-MS, by extracting with ethanol skin+pulp and seeds separately, in triplicate (20 berries each) [11]. Wines were elaborated using 20 kg of grapes from each plot, following standard protocols for whites, without maceration, just pressing, controlling alcoholic fermentation (18±2ºC) [7]. After cold stabilization, wines were bottled and after 30 days were analyzed.

2.1. Determination of individual phenolic compounds of grapes and wines by UPLC-MS

Extracts of skins and pulps or seeds were obtained according to Pereira et al., (2021), after using ethanol for extraction. Then, 1.5 ml of samples were dried using a concentrator, at a temperature of 30 ºC, for approximately 3 hours (skins and pulps) and 2 hours (seeds). They were resuspended using 2 ml of the phase mobile A for seeds and 5ml for skins and pulps, filtered through a 0.45µm filter and stored in a vacuum until analysis in UPLC-MS.

For white wine analyses, a direct 1:2 v/v dilution was performed using mobile phase A.

A Waters Acquity UPLC system (Milford, MA, USA) equipped with a quaternary solvent pump, an autoinjector, column oven, and a single quadrupole mass detector (MS) was used. Data analysis was performed using Empower 3 software. A C18 column (50 × 2.1 mm, 5 µm) protected with a protective pre-column of the same material (5 × 2.1 mm, 5 µm) was used.

Mobile phase A (aqueous) consisted of formic acid and water (2:98 v/v) and mobile phase B (organic) consisted of methanol, formic acid and water (90:2:8 v/v). The linear gradient used was: 0 min (min), 15% B; 1.35 min, 40% B; 2.65 min, 65% B; 3.55 min, 90% B; 3.90 min, 90% B; 4.25 min, 30% B; 4.50 min, 15% B. Chromatograms were recorded for 4.5 min and at the end of each injection, the column was equilibrated with the mobile phase in its initial condition (15% B) for 3 min. The flow rate was 0.45 mL/min and the injection volume was 10 µL.

The MS detector (Waters QDa) was equipped with an electrospray ionization (ESI) source. Detection was performed based on the molecular weight (monoisotopic mass) of each compound in single ion recording (SIR) monitoring mode. The ESI mode (positive or negative) and cone voltage were selected to obtain high selectivity for

each compound. The probe temperature was set to 600 °C, the capillary voltage was −0.8 kV in negative mode and +1.5 kV in positive mode.

Quantification was performed using a standard curve with the following compounds: epicatechin (flavanols), quercetin (flavonols and stilbenes) and caftaric acid.

2.2. Statistical analysis

Results were subjected to analysis of variance (ANOVA) and comparison of means using Tukey test at 5% probability level, using the Action stat statistical program.

3. Results and discussion

3.1. Agronomic characterisation of the vines

The agronomic characterization of the white cultivars is presented in Table 1. With regard to productivity, the Fleurtai variety obtained the highest value with 17,246.3 kg ha^{-1}. In studies with the Fleurtai variety in Italy, Testolin et al. (2020) identified high vigor and high productivity values. In Serra Gaúcha, this variety weighed 4.6 kg per plant, a value higher than that found by Testolin et al. (2020)..

The Sauvignon Rytos variety presented weight per plant values (2.5 kg/plant) higher than those found by Frioni et al., 2021 in Italy, for the same variety grown in a unilateral guyot system of pruning, whereas the Soreli and Sauvignon Kretos varieties presented weight per plant smaller than those found in the same variety studied by Frioni et al. (2021).

The Sauvignon Nepis variety presented the lowest value for all agronomic parameters analyzed. This characteristic was observed in the study by Testolin et al. (2020), whose authors described this variety as having a tendency to average to low productivity and good plant vigor. The variety was not vinified in this study due to its low productivity.

3.2. Classical analysis and oenological potential of grapes

The oenological potential of the white cultivars are presented in Table 1. There was no statistical difference for TSS, with Sauvignon Rytos presenting the highest pH and TSS values (3.87 and 23.1 °Brix, respectively) and the lowest value of total acidity (4.7 g L^{-1}) and the longer cycle after pruning 183 days. The high pH and TSS values, and low acidity values are consistent with those described by Mota et al. (2006) where, during maturation, there is a tendency for acidity to decrease, there is an accumulation of sugars and an increase in pH, due to the later harvest and the drop in rainfall in February, in addition to greater solar radiatio that promotes greater accumulation of sugars in the fruit.

The Soreli and Sauvignn kretos varieties had a higher total acidity content (6.1 and 6.7 g L^{-1} respectively) than that found by Frioni et al, 2021 with the same varieties in Italy.

The Sauvignon Nepis variety presented the lowest pH and TSS values (3.02 and 20.0 °Brix respectively) and the highest total acidity value (9.7 g L^{-1}), such characteristics may be related to the early harvest due to high rainfall during the ripening period.

3.3. Individual phenolic composition of seed and skin+pulp extracts from grapes

The characterization of phenolic compounds from skin+pulp extracts, seeds by UPLC/MS can be seen in Table 2.

In the skin+pulp extracts (Table 2), the Sauvignon Kretos variety presented the highest content and the Soreli variety the lowest content of total flavonols+stibenes (16.23 and 4.22 mg kg^{-1}, respectively). For total flavanols, the levels varied from 140.02 mg kg^{-1} (Sauvignon Kretos) to 220.89 mg kg^{-1} (Soreli), it was possible to observe higher levels of catechin

Caftaric acid is a phenolic acid, one of the major compounds in white wines and is important for the color of white wine. The derivatives of its oxidation give rise to the golden yellow color in white wines [14, 21, 23], in the analyzed wines the caftaric acid content varied from 66.22 mg kg^{-1} (Soreli) to 27.55 mg kg^{-1} (Sauvignon Kretos).

In the seeds extracts (Table 3), higher levels of flavanols were observed, ranging from 1225.60 mg kg^{-1} for the Soreli variety to 2699.26 mg kg^{-1} in the Sauvignon Nepis variety, with higher levels of monomeric tannins (catechin).

For caftaric acid, concentrations ranged from 8.21 mg kg^{-1} Fleurtai to 16.20 mg kg-1 in the Sauvignon Kretos variety.

3.4. Classical analysis of wines and individual phenolics composition

The white wines in this study were made without pre-fermentative maceration, that explained the total flavanol levels observed are much lower than those found in the skin and seeds.

The alcoholic (Table 4) content in wines varied from 12.58% Sauvignon Kretos to 14.10% Sauvignon Rytos, with the highest content found in Sauvignon Rytos, and is related to the higher concentration of TSS observed in the grapes.

The pH values ranged from 2.99 (Sauvignon Kretos) to 3.58 (Sauvignon Rytos), the low pH values of the Soreli, Fleurtai and Sauvignon Kretos varieties are interesting for wine conservation, as according to Ribéreu-Gayon et al. (2006) low pH values inhibit bacterial growth as well as limit the production of volatile acidity.

For acidity parameters, total acidity levels varied from 6.0 g L^{-1} (Sauvignon Rytos) to 8.9 g L^{-1} (Sauvignon Kretos). Acidity is, like pH, capable of giving longevity to wines, as the high level of total acidity prevents possible microbiological deterioration or possible contamination [19].

Volatile acidity levels ranged from 0, 53 g L^{-1} (Soreli) to 1.31 g L^{-1} (Sauvignon Rytos), this can be explained by the bird and insect attacks, and also due to its high pH value (3.58) which can favor microbial development by increasing the volatile acidity of the wine [19].

In the individual phenolic compounds (Table 5), the fleurtai variety presented higher levels of total flavanols+stilbenes, total flavanols and caftaric acid, 12.44 mg kg^{-1}, 39.22 mg kg^{-1}, 28.94 mg kg^{-1} respectively.

The concentration of caftaric acid tends to decrease during fermentation, with the levels observed in the wines being lower than those observed in the must. These levels vary between varieties, climatic conditions, processing, and are important in the evolution of the color of white wines [14, 18, 21, 23].

For further researches, pre-fermentation maceration in white wines can be an option for obtaining more structured wines with greater aging potential.

4. Conclusion

The varieties studied, with the exception of the Sauvignon Nepis, showed high agronomic and oenological potential, presenting adequate productivity and wines with characteristics of low pH and high acidity, and also typicality, providing aging potential. The other varieties could be used by wineries in the region, trying to get quality grapes and wines, in order to adopt a sutainable viticulture with these resistant varieties.

5. References

1. A. De Oliveira Fogaça, C. E. Daudt. OENO One. Copigmentation and color of Brazilian Merlot wines. Influence of skin contact time. 46, 51–56 (2012).
2. A. L. K. De. Souza, A. F. Brighenti, E. Brighenti, V. Caliari, M. Stefanini, O. Trapp, J. P. P. Gardin, M. A. Dalbó, L. J. Welter, S. S. Camargo. BIO Web of Conf. Performance of resistant varieties (PIWI) at two different altitudes in Southern Brazil. 12, 1-4 (2019)
3. AOAC – Association of Official Analytical Chemistry. Official Methods of Analysis of the Association of the Agricultural Chemistis. 18th ed. Washington (DC), 2002.
4. C. Van Leeuwen, G. Sgubin, B. Bois, N. Ollat, D. Swingedouw, S. Zito, G. A. Gambetta. Nat. Rev. Earth Environ. Climate Change Impacts and Adaptations of Wine Production. 5, 258–275 (2024)
5. D. Merdinoglu, C. Schneider, E. Prado, S. Wiedemann-Merdinoglu, P. OENO One. Mestre. Breeding 460 for durable resistance to downy and powdery mildew in grapevine. 52, 203–209 (2018).
6. D. S. Lattuada, R. Anzanello, A. M. R. De. Oliveira, M. Botton, H. P. Dos Santos. Circular Técnica. Embrapa Uva e Vinho. Cultivo protegido de videiras: um panorama em municípios da Serra Gaúcha. 5 (2020).
7. E. Peynaud. Ed. Dunod. Connaissance et travail du vin. 341, 1997.
8. G. Chavarria, H. P. Dos Santos, O. R. Sônego, G. A. B. Marodin, H. Bergamaschi, L. S. Cardoso. Rev. Bras. de Frut. Incidência de doenças e necessidade de controle em cultivo protegido de videira. 29, 477-482 (2007).
9. G. Duley, A. T. Ceci, E. Longo, E. Boselli. Compr. Rev. Food Sci. Food Saf. Oenological potential of wines produced from disease-resistant grape cultivars. Comprehensive. 1–20 (2023).
10. G. E Pereira, J. Tonietto, M. C. Zanus, H. Pessoa, D. Santos, J. Fernando Da Silva, P. Loiva, M. R. De Mello. Embrapa Uva e Vinho. Vinhos no Brasil: contrastes na geografia e no manejo das videiras nas três viticulturas do país. 1-22 (2020).
11. G. E. Pereira, E. M. T. Padhi, M. R. Sudarshana, F. B. Fialho, C. M. Plaza, R. C. Girardello, D. Tseng. R. C. Bruce, J. N. Erdmann, C. M. Slupsky, A. Oberholster. Food Chem. Impact of grapevine red blotch disease on primary and secondary metabolites in Cabernet Sauvignon grape tissues. 342 (2021).
12. J. C. Fioravanço. Rer. Bras. de Viti. e Eno. Evolução da participação dos cultivares lançados pela Embrapa na viticultura do Estado do Rio Grande do Sul. 10, 3 (2018).
13. K. Koledenkova, Q. Esmaeel, C. Jacquard, J. Nowak, C. Clément, E. Ait Barka. Front. Microbiol. Plasmopara viticola the Causal Agent of Downy Mildew of Grapevine: From Its Taxonomy to Disease Management. 13, 1-29 (2022).
14. Kennedy, J. A.; Saucier, C. Glories, Y. AJEV. Grape and Wine Phenolics: History and Perspective. 57 (2005).
15. L. Da R. Garrido. Comunicado. Técnico. Embrapa Uva e Vinho. Redução da adição ambiental de cobre utilizando outras formulações cúpricas em relação à calda bordalesa para o controle do míldio tardio da videira. 195 (2017).
16. L. Linhart, B. Moretti, J. C. Herrera, A. Forneck. OENO One. Maximum stomatal conductance rather than stomatal sensitivity to drought differentiates the PIWI grapevine cultivar

Souvignier gris from Muscaris and Donauriesling. 57, 129–138 (2023).

17. L. M. R. De Mello, C. A. E. Machado, A. R. Farias, S. M. R Da Silva, L. C. Guzzo, R. Zanesco. Anais do XV Congresso Latino-Americano de Viticultura. Denominação de Origem Vale dos Vinhedos: base de dados do cadastro vitícola. 1, 171-171 (2015).
18. N. G. Penna, C. E. Daut, J. A. P. Henriques. Tecn. de Alim. Pesq. Agro. Bras. Comportamento de ésteres hidroxicinâmicos durante a vinificação de vinhos brancos. 36 (2001).
19. P. Ribéreu-Gayon, Y. Glories, A. Maujean, D. Dubourdieu. Handbook of Enology. John Wiley & sons Ltd. The chemistry of wine, Stabilization and treatments. 2, 172, (2006).
20. P-L. Teissedre. OENO One. Composition of grape and wine from resistant vine varieties. 52, 211-217 (2018).
21. R. Hornedo-Ortega, M. R. González-Centeno, K. Chira, M. Jourdes, P. L. Teissedre. Winemaking - Stabilization, Aging Chemistry and Biochemistry. Phenolic Compounds of Grapes and Wines: Key Compounds and Implications in Sensory Perception. (2020).
22. R. N. Giovanni, A. L. K. De. Souza, V. Caliari, F. Brighenti, A. Bender, M. B. Malgarim. Rev. Bras. Frutic. Performance of resistant grape varieties (PIWI), 'Felicia', 'Calardis Blanc' and 'Helios' in two locations of Santa Catarina State (BR). 45 (2023).
23. R. S. Jackson. California: Academic Press. Wine Science: Principle and Aplication. 3ed, 751 (2008).
24. R. Testolin, E. Peterlunger, S. Collovini, S. Castellarin, G. Di GAspero, F. Anaclerio, M. Colautti, M. De Candido, E. De Luca, A. Khafizovar, E. Sartori. Technical bookelets VCR. The disease-resistant varieties. 4, 2-29 (2020).
25. R. Vecchio, E. Pomarici, E. Giampietri, M. Borrello. PLoS ONE. Consumer acceptance of fungus-resistant grape wines: Evidence from Italy, the UK, and the USA. 17 (2022).
26. T. Frioni, C. Squeri, F. Del Zozzo, P. Guadagna, M. Gatti, A. Vercesi, S. Poni. Horticulturae. Investigating Evolution and Balance of Grape Sugars and Organic Acids in Some New Pathogen-Resistant White Grapevine Varieties. 7 (2021)
27. V. F. Pereira, M. L. V. De Resende, A. C. A. Monteiro, P. M. Ribeiro Júnior, M. de A. Regina, F. C. L. Medeiros. Pesq. Agro. Bras. Produtos alternativos na proteção da videira contra o míldio. 45, 25-31 (2010).

Table 1. Agronomical and oenological characterization of white Italian varieties in 2021 vintage.

Varieties	Weight per plant (Kg)	Yield (Kg ha-1)	Cycle duration (DAP)	Total soluble sugars-TSS (°Brix)	Total acidity (g L-1 tartaric acid)	pH
Fleurtai	4.6a±0.1	17,246.3a±236.3	160	20.7a±0.5	5.2ab±0.9	3.37ab±0.18
Soreli	2.7ab±1.0	10,221.8ab±3764.3	160	21.0a±0.1	6.1ab±0.1	3.23ab±0.02
Sauvignon Nepis	0.4c±0.1	1,529.2ab±360.8	160	20.0a±0.4	9.7a±0.1	3.02b±0.02
Sauvignon Rytos	2.5ab±0.1	9,450.0ab±315.0	183	23.1a±0.9	4.7b±0.1	3.87a±0.00
Sauvignon Kretos	2.4ab±1.5	9,187.5ab±5617.5	160	20.2a±1.0	6.7ab±1.7	3.28ab±0.20

*Averages followed by the same lowercase letter in the line do not differ by the Tukey test at the 5% probability level. DAP: days after pruning.

Table 2. Characterization of total and individual phenolic compounds from skin+pulp extracts by UPLC/MS of Italian red varieties resistant, 2021 vintage.

Parameters*	Fleurtai	Soreli	Sauvignon Nepis	Sauvignon Kretos	Sauvignon Rytos
			Flavonols + stilbenes		
Rutin (Quercetina-3-*O*-rutinisídeo)	0.01^{d}±0.00	0.04^{a}±0.00	0.01^{d}±0.00	$0,02^{c}$±0,00	$0,03^{b}$±0,00
Myricetin 3-O-glucoside	0.10^{b}±0.10	0.15^{b}±0.02	0.99^{a}±0.03	$0,15^{b}$±0,01	$0,26^{b}$±0,02
Quercetin-3-O-glucoside	0.11^{c}±0.01	0.45^{b}±0.10	0.14^{c}±0.01	$0,24^{c}$±0,01	$0,61^{a}$±0,01
Kaempferol-3-O-glucoside	1.26^{bc}±0.89	0.24^{c}±0.02	2.54^{ab}±0.18	$2,10^{ab}$±0,09	$2,79^{a}$±0,08
Isoquercitin	5.30^{c}±0.34	2.43^{d}±0.32	10.34^{a}±0.48	$10,35^{a}$±0,27	$8,05^{b}$±0,56
Taxifolin	0.11^{c}±0.01	0.38^{bc}±0.06	0.62^{b}±0.03	$1,13^{a}$±0,08	$1,23^{a}$±0,16
Trans-resveratrol	1.75^{a}±0.37	0.53^{b}±0.07	1.01^{b}±0.05	$2,24^{a}$±0,17	$0,83^{b}$±0,05
Total flavonols + stilbenes	8.65^{c}±0.87	4.23^{d}±0.55	15.66^{ab}±0.72	$16,24^{a}$±0,12	$13,81^{b}$±0,84
			Flavanols		
(-)- Epicatechin gallate	12.23^{c}±0.60	16.94^{b}±1.12	$22,30^{a}$±0,37	12.27^{c}±0.53	$10,08^{c}$±0,86
(+)-Catechin	51.87^{c}±4.31	96.01^{a}±5.16	64.99^{b}±3.22	42.74^{c}±1.23	54.11^{bc}±2.58
(-)- Epicatechin	17.00^{c}±3.17	47.26^{a}±5.88	30.43^{b}±1.01	12.89^{c}±1.39	20.82^{bc}±1.71
Procyanidin B1	6.53^{d}±1.16	30.29^{c}±3.85	46.31^{a}±1.70	35.30^{bc}±2.68	41.17^{ab}±2.41
Procyanidin B2	12.38^{c}±3.83	19.88^{ab}±2.74	24.66^{a}±0.37	24.29^{a}±1.14	15.58^{bc}±1.34
(-)- Epigallocatechin	20.45^{b}±3.79	10.51^{c}±1.23	29.94^{a}±1.21	12.53^{c}±0.18	8.41^{c}±0.77
Total flavanols	120.46^{b}±12.48	220.88^{a}±19.04	218.63^{a}±6.24	140.01^{b}±3.77	150.16^{b}±8.16

			Phenolic acids		
Caftaric acid	44.09^{b}±3.18	66.22^{a}±7.33	30.53^{c}±1.00	27.55^{c}±0.65	28.89^{c}±2.08

*Averages followed by the same lowercase letter in the line do not differ by the Tukey test at the 5% probability level. ** For skin+pulp, results are expressed in mg Kg^{-1} of grapes; flavanols and stilbenes (expressed in mg Kg^{-1} of quercetin-3-O-glucoside) and total flavanols (expressed in mg Kg^{-1} of epicatechin).

Table 3. Characterization of total and individual phenolic compounds from seed extracts by UPLC/MS of Italian white varieties resistant, 2021 vintage.

Parameters*	**Fleurtai**	**Soreli**	**Sauvignon Nepis**	**Sauvignon Kretos**	**Sauvignon Rytos**
			Flavonols + stilbenes		
Rutin (Quercetina-3-*O*-rutinisídeo)	0.20^{a}±0.02	0.12^{b}±0.02	0.15^{ab}±0.01	0.17^{ab}±0.00	0.19^{a}±0.01
Myricetin 3-O-glucoside	0.08^{c}±0.01	0.08^{c}±0.01	0.18^{b}±0.01	0.40^{a}±0.00	0.38^{a}±0.03
Quercetin-3-O-glucoside	0.14^{bc}±0.01	0.09^{d}±0.02	0.22^{a}±0.01	0.18^{b}±0.01	0.11^{cd}±0.01
Kaempferol-3-O-glucoside	0.59^{a}±0.05	0.40^{b}±0.05	0.61^{a}±0.04	0.57^{a}±0.02	0.53^{ab}±0.04
Isoquercitin	1.00^{b}±0.11	0.68^{c}±0.14	1.31^{a}±0.06	1.48^{a}±0.01	1.50^{a}±0.08
Taxifolin	0.06^{b}±0.00	0.08^{b}±0.01	0.06^{b}±0.00	0.06^{b}±0.00	0.15^{a}±0.01
Trans-resveratrol	0.15^{b}±0.01	0.15^{b}±0.02	0.23^{a}±0.02	0.22^{a}±0.00	0.21^{a}±0.02
Total flavonols + stilbenes	2.21^{bc}±0.21	1.61^{c}±0.27	2.77^{ab}±0.14	3.08^{a}±0.02	3.07^{a}±0.20
			Flavanols		
Epicatequina galato	188.99^{d}±21.70	222.58^{cd}±27.69	545.59^{a}±24.63	364.10^{b}±1.09	277.28^{c}±16.14
Catequina	474.14^{c}±45.55	460.67^{c}±31.56	939.02^{a}±39.71	701.24^{b}±27.08	580.42^{bc}±41.51
Epicatequina	414.68^{cd}±43.73	365.37^{d}±13.41	752.60^{a}±21.56	575.90^{b}±26.07	502.65^{bc}±20.17
B1	99.88^{c}±6.98	97.04^{c}±10.05	198.35^{a}±5.01	147.92^{b}±3.34	107.74^{c}±5.14
B2	92.87^{b}±7.74	39.02^{c}±4.76	167.03^{a}±4.26	93.79^{b}±5.40	94.88^{b}±7.18
Epigalocatequina	45.35^{c}±6.20	40.92^{c}±3.75	96.67^{a}±6.08	70.13^{b}±3.32	52.90^{c}±5.40
Total flavanóis	1,315.91^{d}±129.02	1,225.60^{d}±89.58	2,699.26^{a}±91.72	1,953.07^{b}±43.85	1,615.87^{c}±69.30
			Phenolic acids		
Ácido caftarico	8.21^{b}±1.10	10.53^{b}±1.05	14.46^{a}±0.74	16.20^{a}±0.50	10.29^{b}±0.81

*Averages followed by the same lowercase letter in the line do not differ by the Tukey test at the 5% probability level. ** For seeds, results are expressed in mg Kg^{-1} of grapes; flavanols and stilbenes (expressed in mg Kg^{-1} of quercetin-3-O-glucoside) and total flavanols (expressed in mg Kg^{-1} of epicatechin).

Table 4. Classical analyses of wines from Italian red varieties resistant to fungal pathogens, 2021 vintage.

Parameters*	Fleurtai	Soreli	Sauvignon Nepis**	Sauvignon Kretos	Sauvignon Rytos
Density (20°C)	0.9905^{b}±0.0000	0.9897^{c}±0.0000	-	0.9921^{a}±0.0001	0.9893^{d}±0.0000
Alcoholic Content (%)	13.24^{b}±0.00	13.22^{b}±0.01	-	12.58^{c}±0.00	14.10^{a}±0.08
pH	3.18^{b}±0.01	3.23^{b}±0.02	-	2.99^{c}±0.01	3.58^{a}±0.01
Total acidity (g L^{-1})	7.2^{b}±0.0	6.3^{c}±0.1	-	8.9^{a}±0.1	6.0^{c}±0.1
Volatile acidity (g L^{-1})	0.53^{c}±0.02	0.56^{bc}±0.00	-	1.31^{a}±0.02	0.65^{b}±0.02

*Averages followed by the same capital letter in the column do not differ according to the Tukey test at the 5% probability level. * Total acidity expressed in g.L-1 of tartaric acid and volatile in g.L-1 of acetic acid. ** The Sauvignon Nepis variety did not present significant productivity for winemaking.

Table 5. Characterization of total and individual phenolic compounds from wines extracts by UPLC/MS of Italian white varieties resistant, 2021 vintage.

Parâmetros	**Fleurtai**	**Soreli**	**Sauvignon Kretos**	**Sauvignon Rytos**
		Flavonols + stilbenes		
Rutin	0.05^{b}±0.00	0.02^{c}±0.00	0.07^{a}±0.01	0.05^{b}±0.00
Myricetin 3-O-glucoside	0.16^{a}±0.01	0.09^{b}±0.01	0.14^{a}±0.01	0.16^{a}±0.00
Quercetin-3-O-glucoside	0.36^{b}±0.00	0.61^{b}±0.12	0.42^{b}±0.01	1.89^{a}±0.01
Kaempferol-3-O-glucoside	0.36^{a}±0.01	0.45^{a}±0.00	0.40^{a}±0.04	0.35^{a}±0.01
Isoquercitin	7.11^{a}±0.09	2.42^{c}±0.11	4.81^{b}±0.02	4.68^{b}±0.01
Taxifolin	1.43^{b}±0.08	2.06^{a}±0.12	2.06^{a}±0.01	0.97^{c}±0.04
Trans-resveratrol	2.97^{a}±0.10	1.34^{b}±0.05	1.19^{bc}±0.15	0.76^{c}±0.00
Total flavonols + stilbenes	12.44^{a}±0.10	6.99^{c}±0.09	9.09^{b}±0.08	8.86^{b}±0.02
		Flavanols		
(-)- Epicatechin gallate	5.67^{a}±0.46	2.61^{b}±0.30	1.23^{b}±0.13	2.01^{b}±0.09
(+)-Catechin	20.10^{a}±1.70	9.88^{b}±0.22	14.16^{ab}±2.58	10.11^{b}±0.29
(-)- Epicatechin	8.82^{bc}±0.77	6.31^{c}±0.39	10.80^{ab}±0.63	13.48^{a}±0.32
Procyanidin B1	1.38^{b}±0.08	1.05^{b}±0.10	1.32^{b}±0.09	1.92^{a}±0.03
Procyanidin B2	1.01^{b}±0.01	1.24^{b}±0.05	1.10^{b}±0.07	5.34^{a}±0.32
(-)- Epigallocatechin	2.24^{b}±0.12	2.28^{b}±0.03	3.63^{a}±0.28	2.39^{b}±0.22
Total flavanols	39.22^{a}±3.13	23.37^{b}±0.29	32.24^{ab}±2.89	35.25^{ab}±0.76
		Phenolic acids		
Caftaric acid	28.94^{a}±0.21	25.32^{ab}±2.06	19.02^{b}±0.57	26.22^{ab}±1.72

*Averages followed by the same lowercase letter in the line do not differ by the Tukey test at the 5% probability level. ** For wines, results are expressed in mg L^{-1}; flavanols and stilbenes (expressed in mg L^{-1} of quercetin-3-O-glucoside) and total flavanols (expressed in mg L^{-1} of epicatechin).