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Propagation

Rootstock-scion interaction: 4. Effect on the sensory characteristics of Cabernet Sauvignon wine

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Abstract - It is known that rootstock can induce changes on grapevine yield components and on the physicochemical composition of musts and wines. However, its effect on the sensory characteristics of wines has been scarcely studied. For this reason, an experiment was conducted to determine the effect of 15 rootstocks on the sensory characteristics of Cabernet Sauvignon wine, whose grapevines were grafted on Rupestris du Lot, 101-14 Mgt, 3309 C, 420A Mgt, 5BB K, 161-49 C, SO4, Solferino, 1103 P, 99 R, 110 R, Gravesac, Fercal, Dogridge and Isabel, which feature some genetic diversity altogether. The experimental design was in randomized blocks, with 15 treatments, three replicates, 10 vines per plot. Mature grapes were harvested, and wines were made in 20-L glass recipients. When alcoholic and malolactic fermentations were finished, the wines were bottled and stored at 18°C. Sensory analysis was performed in the next year, following international procedures. The tasting panel was formed by 12 experienced enologists, who evaluated the wines in individual cells separated by opaque glass. They were served monadically and the perception of each taster was recorded in 9-cm unstructured scale sheets. Twenty-two variables were evaluated, which were related to the visual, olfactory and taste aspects. The results show that the tasting panel was not able to detect significant differences ($p > 0.05$) of rootstocks in any variable related to the sensory characteristics of Cabernet Sauvignon wine.
Index terms: *Vitis vinifera*, grapevine, Cabernet Sauvignon, wine tasting.

Interação entre porta-enxerto e copa: 4. Efeito nas características sensoriais do vinho Cabernet Sauvignon

Resumo - Sabe-se que o porta-enxerto pode causar modificações nos componentes de produção da videira e na composição físico-química do mosto e do vinho. Entretanto, seu efeito nas características sensoriais do vinho tem sido pouco estudado. Por essa razão, conduziu-se um experimento para determinar o efeito de 15 porta-enxertos nas características sensoriais do vinho Cabernet Sauvignon, cujas videiras foram enxertadas em Rupestris du Lot, 101-14 Mgt, C 3309, 420A Mgt, K 5BB, C 161-49, SO4, Solferino, P 1103, R 99, R 110, Gravesac, Fercal, Dogridge e Isabel, os quais apresentam certa diversidade genética. O delineamento experimental foi em blocos ao acaso, com 15 tratamentos, três repetições, 10 videiras por parcela. As uvas foram colhidas quando maduras, e os vinhos foram elaborados em recipientes de vidro de 20 L. Após a conclusão das fermentações alcoólica e malolática, os vinhos foram engarrafados e armazenados a 18°C. No ano seguinte, procedeu-se à análise sensorial, que foi realizada segundo procedimentos internacionais. O painel de degustação foi formado por 12 experientes enólogos que avaliaram os vinhos em celas individuais, separadas por vidro opaco. Os vinhos foram servidos monadicamente, e sua avaliação foi registrada em fichas não estruturadas com escala de 9 cm. Avaliaram-se 22 variáveis relacionadas aos aspectos visual, olfativo e gustativo. Os resultados mostram que o painel de degustação não detectou diferença significativa ($p>0,05$) dos porta-enxertos em nenhuma variável relacionada às características sensoriais do vinho Cabernet Sauvignon.
Termos para indexação: *Vitis vinifera*, videira, Cabernet Sauvignon, degustação de vinho.

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Introduction

Studies related to the effect of rootstock on the grapevine performance have been carried out around the world. These works focused mainly on yield components (KELLER et al., 2012; MIELE; RIZZON, 2017), must composition (JONES et al., 2009; CHOU; LI, 2014) and wine composition (HARBERTSON; KELLER, 2012; STEVENS et al., 2016). Often, the results of these works are similar, but they may be different depending on how and where the studies were conducted. The differences among these works could be due to several factors most of them mainly related to scion and rootstock genetics, soil types, climatic conditions, vineyard management and winemaking practices.

However, the sensory characteristics, typicality and overall quality of wines are a complex issue. Indeed, the results of this job depends on the experience and knowledge of the judge. It should also be considered that each taster has his/her own perception about a particular wine descriptor and this perception may be different according to the time and place for the same wine (MEILGAARD et al., 1999). Lastly, it is time consuming, and because of it, there are not many studies about the effect of rootstock on wine sensory characteristics.

Most of the study emphasizes the effect of the rootstock on the overall quality of wines (OUGH et al., 1968; OLLAT et al., 2003; RENOUF et al., 2010; WOOLDRIDGE et al., 2010) and others on the wine color (WALKER; BLACKMORE, 2012; STEVENS et al., 2016). Concerning wine characteristics, there are two works, one reporting nine descriptors (SILVILOTTI et al., 2007) and the other one describing appearance, aroma and taste (TREEBY et al., 2000). However, as far as it is known there are no studies to date that have been done in Brazil in relation to this topic.

As the result of published works may differ from one another and because the terroir can play an important role in the composition and characteristics of wine, an experiment was conducted to determine the effect of 15 rootstocks on the sensory characteristics of Cabernet Sauvignon wine.

Material and Methods

The trial was carried out in the 1999 vintage in the Serra Gaúcha winegrowing region in Brazil (coordinates: 29°09'44" S and 51°31'50" W; altitude: 640 m; the climatological normal for annual mean temperature is 17.3°C and 1,683 mm for rain). The vineyard was established in a Cambissolo soil (FLORES et al., 2012), which is equivalent to an Inceptisol, according to the Soil Taxonomy. Data related to the vineyard, such as soil characteristics, planting, trellising, spaces between rows and plants, pruning and training grapevines, canopy management and control of diseases, pests and weeds were described in previous paper (MIELE; RIZZON, 2017).

The Cabernet Sauvignon grapevines were grafted on fifteen rootstocks, i.e., Rupestris du Lot, 101-14 Millardet et de Grasset, 3309 Couderc, 420A Millardet et de Grasset, 5BB Kober, 161-49 Couderc, SO4, 1103 Paulsen, 99 Richter, 110 Richter, Gravesac, Fercal, Dogridge, Isabel and Solferino (local name of an unknown rootstock). Indeed, Isabel (*V. labrusca* L.) is not a rootstock, but the most cultivated grapevine (mostly own rooted) in Serra Gaúcha, whose production goes primarily to wineries to make wine and grape juice.

The experimental design was completely randomized blocks, with 15 treatments (CS/rootstocks), three replicates, 10 vines per plot. The area of each block was 675 m^2 and the entire experiment 2,025 m^2.

Grape ripening was evaluated by determining the total soluble solids (°Brix) content of grapes from the 45 plots, which was done by a hand refractometer. When the °Brix of the grape juice was stabilized, the grapes of all plots were harvested on the same day. Then, they were placed in plastic boxes, weighted and taken to the winery for processing. Grapes were destemmed, crushed and the liquid and solid phases were transferred to 20-L glass recipients. Sucrose was not added to grape musts for correction. Then, 50 mg L^{-1} of SO_2 were added to each recipient. In addition, 0.20 g L^{-1} of active dry yeast (*Saccharomyces cerevisiae*) was added and the glass recipients were fitted with rubber stoppers and water-filled airlocks. After eight days of alcoholic fermentation, the wines were pressed off the skins and transferred to 9-L glass containers also fitted with rubber stoppers and water-filled airlocks. These containers were kept at 24ºC±1ºC until sugar concentration was less than 4.0 g L^{-1}. Malolactic fermentation was naturally processed, which was regularly evaluated by paper chromatography, and then total SO_2 was adjusted to 50 mg L^{-1}. When this fermentation ended, wines were transferred to 750-mL glass bottles, sealed with cork, and stored at 18ºC in a temperature-controlled room.

Sensory analysis sessions were conducted in April 2000, evaluating wines from each replicate on three different days. The tasting panel was formed by 12 panelists with extensive enology background and experience in wine sensory description. Thus, the result of each variable of each CS/rootstock combination represented the average of 36 sensory analyses. The sessions were performed according to international rules (AFNOR, 1995; SSHA, 1998; MEILGAARD et al., 1999). Tasters were in individual cells separated by an opaque glass and the sessions began at 10h00 where the wine samples were served monadically in ISO glasses and then evaluated blindly. Each glass was identified with three digits and after that, 50 mL of wine sample were poured

into the glasses and tasted at 15°C. The perception of each taster was recorded in a sheet with unstructured scales of 9 cm in length.

The following variables were evaluated in the Cabernet Sauvignon wine, which were related to the visual, olfactory and taste aspects: visual – limpidity, intensity and hue; olfactory – intensity, green bell pepper, fruity, spicy, vegetal and animal; taste/flavor – intensity, body, astringency, acidity, balance, typicality, persistence, green bell pepper, fruity, spicy, vegetal, animal and overall quality.

The data were submitted to Anova and Tukey's multiple range test at 5% probability error using the Statistica program. In addition, correlations were made between the scores of the sensory analysis and data of variables of the grapevine yield components according to the work of Miele and Rizzon (2017).

Results and Discussion

The sensory analysis of the 1999 Cabernet Sauvignon wines shows that tasters found no significant differences ($p > 0.05$) in any descriptor related to the visual (Table 1), olfactory (Table 1) and taste/flavor (Table 2) aspects. This result is generally in accordance with the physicochemical composition of these wines where only two variables ─ pH and alcohol/reduced dry extract ratio ─ were significantly ($p < 0.05$) affected by the rootstock (MIELE; RIZZON, 2018). The organoleptic characteristics of the wines are shown in Figure 1.

Table 1. Visual and olfactory scores of the 1999 Cabernet Sauvignon wines according to the rootstock.

Rootstock	Visual			Olfactory					
	Li	In	Hu	In	Gp	Fr	Sp	Ve	An
Rupestris du Lot	8.6	6.8	3.4	6.9	4.8	3.4	2.5	3.5	1.7
101-14 Mgt	8.6	7.2	2.7	6.8	4.6	3.8	2.6	3.3	1.5
3309 C	8.7	6.5	3.1	6.7	4.9	3.1	2.9	5.6	1.1
420A Mgt	8.5	7.5	2.5	6.7	4.2	3.2	2.6	3.2	2.0
5BB K	8.6	7.6	2.1	6.6	4.2	3.7	2.7	2.9	1.1
161-49 C	8.5	7.1	3.2	6.6	4.4	3.8	3.0	3.0	1.0
SO4	8.6	7.0	2.8	6.6	5.2	3.4	2.6	3.5	1.1
Solferino	8.7	6.6	3.0	6.0	4.3	3.7	2.5	3.0	0.8
1103 P	8.5	7.6	2.8	6.8	4.4	3.0	2.2	3.2	1.7
99 R	8.6	7.3	2.8	6.6	5.2	3.6	2.6	3.5	1.0
110 R	8.7	6.4	3.5	6.7	4.0	3.1	2.6	3.6	1.7
Gravesac	8.6	6.7	3.5	6.1	4.6	2.9	2.7	3.6	1.3
Fercal	8.7	7.8	2.1	6.4	4.4	3.6	2.7	3.0	0.9
Dogridge	8.5	6.7	3.3	7.0	4.2	2.0	1.9	3.9	2.5
Isabel	8.4	7.2	3.3	6.5	4.3	3.2	2.7	3.2	1.0
Mean	8.6	7.1	2.9	6.6	4.5	3.3	2.6	3.3	1.4
P>F (*p* value)	0.0743^{ns}	0.5048^{ns}	0.5523^{ns}	0.9618^{ns}	0.5452^{ns}	0.4668^{ns}	0.9683^{ns}	0.6812^{ns}	0.8091^{ns}

Li= limpidity, In= intensity, Hu= hue, Gp= green bell pepper, Fr= fruity, Sp= spicy, Ve= vegetal, An= animal, ns= not significant.

Table 2 . Taste/flavor scores of the 1999 Cabernet Sauvignon wines according to the rootstock.

Rootstock	Taste/Flavor												
	In	Bo	As	Ac	Ba	Ty	Pe	Gp	Fr	Sp	Ve	An	Qu
Rupestris du Lot	6.2	5.3	3.9	5.6	5.5	5.8	3.4	4.3	2.8	2.4	3.5	1.5	7.3
101-14 Mgt	6.0	4.9	4.0	5.3	5.2	5.4	5.3	4.5	3.0	2.2	3.7	1.6	7.3
3309 C	6.2	5.0	4.2	5.7	5.1	6.3	5.4	5.0	2.8	2.3	3.9	1.5	7.4
420A Mgt	6.4	5.8	4.6	5.5	5.2	5.7	5.6	4.5	3.0	2.5	3.7	1.7	7.4
5BB K	6.4	5.6	4.4	5.5	5.8	6.3	5.9	4.7	3.4	2.6	3.3	1.5	7.5
161-49 C	6.2	5.5	4.5	5.6	5.8	6.0	5.8	4.5	3.5	2.7	3.1	1.0	7.6
SO4	6.2	5.5	4.4	5.3	5.7	6.3	5.6	5.2	3.1	2.6	3.4	0.9	7.5
Solferino	5.6	5.1	4.0	5.4	5.3	5.8	5.4	4.3	3.0	2.6	3.2	0.7	7.4
1103 P	6.6	5.7	4.4	5.4	5.8	6.1	5.9	4.4	3.3	2.7	3.4	1.3	7.5
99 R	6.2	5.6	4.2	5.6	5.9	6.4	5.8	5.8	3.3	2.6	3.5	0.9	7.6
110 R	6.1	4.9	4.3	5.5	4.9	5.4	5.6	4.3	2.8	2.3	3.1	1.7	7.3
Gravesac	5.9	4.8	4.2	5.2	4.8	5.7	5.4	4.3	2.8	2.4	3.4	1.3	7.3
Fercal	6.3	5.8	4.4	5.5	5.6	5.9	6.0	4.2	3.5	2.4	3.2	0.9	7.7
Dogridge	6.1	5.1	4.2	5.5	4.8	5.3	5.6	4.1	2.1	1.9	3.9	2.5	7.2
Isabel	6.1	5.5	4.3	5.4	5.8	6.2	5.9	4.4	3.3	2.6	3.4	1.0	7.6
Mean	6.2	5.3	4.3	5.5	5.4	6.0	5.6	4.6	3.1	2.5	3.5	1.3	7.4
P>F (*p* value)	0.5434^{ns}	0.7317^{ns}	0.4445^{ns}	0.6402^{ns}	0.2080^{ns}	0.7856^{ns}	0.9856^{ns}	0.4878^{ns}	0.7706^{ns}	0.8282^{ns}	0.5246^{ns}	0.4077^{ns}	0.7898^{ns}

In= intensity, Bo= body, As= astringency, Ac=acidity, Ba= balance, Ty= typicality, Pe= persistence, Gp= green bell pepper, Fr= fruity, Sp= spicy, Ve= vegetal, An= animal, Qu= Overall quality, ns= not significant

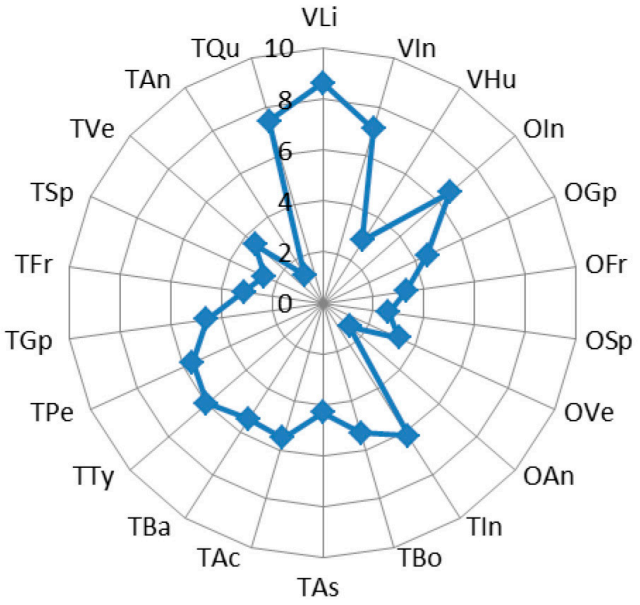

Figure 1. Mean score (over 9) of the sensory analysis of Cabernet Sauvignon wine, whose grapevines were grafted onto 15 rootstocks. Legend: V= visual, O= olfact, T= taste/flavor, Li= limpidity, In= intensity, Hu= hue, Ty= typicality, Gp= green bell pepper, Fr= fruity, Sp= spicy, Ve= vegetal, An= animal, Bo= body, As= astringency, Ac= acidity, Ba= balance, Pe= persistence, Qu= overall quality.

The correlations between the data of the sensory analysis and that of wine composition show that the green bell pepper character of Cabernet Sauvignon wine was positively correlated ($p< 0.05$) with its density, which means that higher the density (and lower the alcohol content) the higher the perception of green bell pepper. In another word, wine from mature grapes has lower concentration of the substance responsible for the green bell pepper character. However, there was no significant correlation ($p> 0.05$) between wine quality (MIELE; RIZZON, 2018) and the variables related to yield components (MIELE; RIZZON, 2017). Indeed, there was no significant ($p> 0.05$) correlation between the wine composition and the grapevine yield, even though productivity differences had been significant — grapevines grafted on the Solferino rootstock had 2.07 times more yield than those on 101-14 Mgt, which were 44.33 t ha^{-1} and 21.45 t ha^{-1}, respectively. It should be emphasized that the 101-14 Mgt rootstock has low vigor, a condition that recommends it for quality wines (OLLAT et al., 2003).

The quality of wine was significantly ($p< 0.05$) correlated with some descriptors, especially green bell pepper ($r= -0.880$), fruity ($r= 0.846$), typicality ($r= 0.834$), persistence ($r= 0.734$) and spicy ($r= 0.570$). Green bell pepper is a vegetal character due to a substance belonging to the group of methoxypyrazines, the 3-isobutyl-2-methoxypyrazine, which is a primary aroma synthesized in the Cabernet Sauvignon grape (RIBÉRAU-GAYON et al., 1998). During the fruit development in the season, the concentration of this substance decreases, especially in hot regions. In this case, their concentration in the wine generally is low. Unlike this, in cool climates where the Cabernet Sauvignon grape does not complete its maturation, the methoxypyrazines are present in wines giving the vegetal character of green bell pepper which may not be considered as good elsewhere. Also, there are two other methoxypirazines with vegetal character, but not of green bell pepper, the 3-isoproyl-2-methoxypyrazine and, to a lesser extent, the 3-sec-isobutyl-2-methoxypyrazine (RIBÉREAU-GAYON et al., 1998).

The rootstocks used in this experiment have a certain genetic diversity and can therefore influence several physiological and biochemical grapevine aspects, which could have a reflection on vine productivity, grape and wine composition and quality. Indeed, results of studies have shown effect on the grapevine physiology (COOKSON et al., 2012), biochemistry (SOMKUWAR et al., 2014), mineral nutrition (KODUR et al., 2011), yield (KELLER et al., 2012), water deficiency or stress (SERRA et al., 2014), fungal diseases (WALLIS et al., 2013), viruses (ROSA et al., 2011) and nematodes (FERRIS et al., 2012).

A previous study (MIELE; RIZZON, 2017) conducted at the same vineyard as this work showed that the rootstock had significant ($p< 0.05$) effect on the Cabernet Sauvignon yield components, the number of grape clusters per vine, yield per vine, cluster weight, yield per pruning weight, leaf area per vine, leaf area index and leaf area per fresh fruit weight. These results could have influenced many variables related to the wine composition, but effectively they were partially affected (MIELE; RIZZON, 2018). This shows that these grapevines may

have regulatory mechanisms between the vegetative and the reproductive systems.

There are few studies conducted worldwide where the rootstock had a significant effect on the wine sensory characteristics. Considering the color, the Shiraz wine from Salt Creek was less dense in color and duller in hue than those from own rooted Shiraz grapevines (HALE; BRIEN, 1978). In another experiment, this same Shiraz wine from the rootstocks Teleki and Schwartzman gave higher color intensity than those from Ramsey (TREEBY et al., 2000) and the aroma of Cabernet Sauvignon wine was enhanced when grapevines were grafted on the Ruggeri rootstock compared to those of Salt Creek (BRAVDO; SHOSEYOV, 2000).

Most studies, however, refer to the general quality of wines instead of evaluating wine descriptors. Working with many rootstocks and cultivars in France, the highest quality of wines was achieved with grapes on the rootstocks 420A Mgt, 3309 C, Gravesac and Riparia Gloire de Montpellier (RENOUF et al., 2010); Chardonnay and Pinot Noir wines had higher quality on 110 R (WOOLDRIGE et al., 2010); Cabernet Sauvignon wine had the highest scores when grafted on 161-49 C and 420A Mgt rootstocks (SILVILOTTI et al., 2007); in another trial, Cabernet Sauvignon wine was scored higher with Riparia Gloire de Montpellier compared with 101-14 Mgt and SO4 (OLLAT et al., 2003); in Austria, a work with 31 rootstocks showed that the best wines were those from the rootstocks 5BB K, SO4 and 5C Teleki (MENHOFER et al., 2011); in the United States, an early work with 10 cultivars showed that wines from the St. George rootstock had higher quality than 99 R, some did not differ greatly and several responded more favorable to the 99 R (OUGH et al., 1968).

The differences found in these studies were due to the experiments being done with different rootstocks and scions and in soils and climate with their own characteristics. In addition, vineyard management and winemaking practices could also have influence on the outcome of the studies.

Conclusion

The rootstocks used in the present research have no significant effect on variables related to the visual, olfactory and taste/flavor aspects of Cabernet Sauvignon wine from a Cambissolo soil of Serra Gaúcha.

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