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Corvina and Corvinone grape berries grown in different areas and their aptitude to postharvest dehydration

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ABSTRACT
The Valpolicella area (Veneto Region, Italy) is famous for its high quality wines: Amarone and Recioto, both obtained from partial post-harvest dehydrated red grapes. The main cultivars used for these wines are Corvina and Corvinone. In this region hundreds of years ago a particular wine making process was developed to dehydrate the grape after the harvest.
The aim of this innovative work was to study how the environmental factors affected the post-harvest dehydration process.
Different vocation units were defined from a pedological survey using landscape genesis. Afterwards Corvina and Corvinone vineyards, trained with simple Guyot, were selected and observed for a three year period (2009-2011).
New parameters correlated to grape dehydration rate were evaluated: quantity of epicutiuolar wax (Ew), skin thickness (ThS), bunch density (BD) and berry surface to volume ratio (S/V).
The results showed a variation of these parameters depending on the environmental variability, mainly due to pedological soil characteristics (texture, depth, soil water availability), site-altitude and exposure. The Ew, BD and S/V showed a good correlation with the kinetic of post-harvest weight loss, so the evaluation of these parameters can be used as a prediction model. This new information is useful for winemakers so they can separate the grapes depending on the growing area to reach an optimum post-harvest weight loss (from 35% to 45%).

Keywords: grapevine, epicuticular wax, skin thickness, postharvest weight loss.

1 INTRODUCTION

The Valpolicella area (Veneto Region, Italy) is famous for its high quality wines: Amarone and Recioto, both obtained from partial post-harvest dehydrated red grapes. The main cultivars used for these wines are Corvina and Corvinone and, in smaller quantities, some other local varieties such as Rondinella and Molinara.
The notion of Vitivinicultural "terroir", defined by the OIV with the resolution 333/2010, includes climatic, topographical, geological and pedological criteria, traditional grape vine varieties and the skill of the vine growers. In this region hundreds of years ago a particular wine making process was developed to dehydrate the grape after the harvest.
The property of the grapes to be dehydrated is influenced by their morphological characteristics which can be affected by vineyard microclimate [1]. Light intensity, available soil water content and temperature can modify grape morphological and anatomical characteristics that influence the postharvest dehydration of the berry [2, 3]. Since the main goal of a zoning study is to improve the knowledge of vine growers and viticultural operators, the aim of this innovative work was to study how the environmental factors affected the post-harvest dehydration process.

2 MATERIALS AND METHODS

2.1 Investigated vineyards site

The study was carried out in the AOC "Valpolicella-Valpantena" vineyards located just to the north of Verona (Italy) (45°29'22.21"N, 11°0'49.24"E). In a previous study of this area a soil map based on the landscape genesis was made. Using this information, confirmed also by a further pedological survey, 8 different *terroir* vocation units (TU) were defined. Afterwards 51 Corvina and Corvinone vineyards, trained with simple Guyot, were selected and observed (tab.1). Air temperature and rainfall were recorded in 8 different vineyards one per each TU with an automatic weather station. In the same vineyards the volumetric soil water content was measured by time domain reflectometry (TDR) at three different depth intervals: 0.1-0.35 m, 0.35-0.6 m and 0.6-0.85 m. The soil water content was then expressed as total transpirable soil water (TTSW) according to the method described in previous studies [4, 5].

2.2 Grape composition and yield

The phenology (véraison and commercial maturity) and the chemical composition of the grape during the ripening stages were assayed for a three year period (2009-2011). Furthermore at harvest the yield of 20 plants per vineyard and the qualitative grape characteristics were determined: total soluble solids (TSS), total acidity (TA), pH anthocyanins content and their extractability, and total flavonoids. On the same plants the pruning wood was weighed as an indicator of the vine vigour.

2.3 Grape aptitude to postharvest dehydration

In addition to the normal qualitative parameters, additional parameters which could be more correlated to grape dehydration rate were evaluated: quantity of epicuticular wax (Ew), skin thickness (ThS), bunch density (BD) and berry surface to volume ratio (S/V). The BD was calculated as the ratio between the volume and the length of the bunch. The berry surface and volume were calculated, with the formula of a prolate spheroid, measuring the height and equatorial diameter of the berry. The Ew was extracted by dripping 30 berries in chloroform and the quantity was expressed per unit of berry surface area [6]. The ThS was measured with a Texture Analyzer as reported in literature [7].

The dehydration rate was assessed by weighing weekly, the boxes prepared at harvest containing 6 kg of grapes. The boxes were placed in the same conditions with controlled temperature and humidity (T=18°C ± 10%; UR= 70% ± 10%). For each TU and for both the studied varieties 460 kg of grape were harvested; 180 kg were used immediately to make the wine and the remaining 280 kg were dehydrated in 6 kg boxes and then vinified.

Table 1. Experimental design of the study

Terroir Vocation Unit (TU)					Vineyards studied	
Soil	*Soil depth*	*Granulometry*	*Name*	*Altitude*	*Corvina*	*Corvinone*
Limestone	Shallow	Coarse	LC	380	3	3
	Medium	Medium	LM	200	3	3
	High	Fine	LF	140	3	3
Marly limestone	Shallow	Coarse	MC	380	3	3
	Medium	Medium	MM	200	3	3
	High	Fine	MF	140	3	-
Clay loam	High	Medium	CM	80	5	4
	High	Fine	CF	80	5	4

3 RESULTS AND DISCUSSION

The climatic conditions varied during the three seasons studied (Fig. 1). The year 2010 was colder (expect July) and rainier than the other two years. The average harvest date of the different TU was similar in 2009 and 2011 while in 2010 it was delayed by 14 days. Considering the rainfall no differences were found between the 8 TU whereas four different temperature areas were individuated mainly due to the altitude. During the vegetative season there was a difference in the average temperature of 1.3°C between the 380 m and the 80 m vineyards and of 2.5°C in the maximum temperatures. As the climatic conditions of 2010 (rain and flood event) were very different from the other two years the data collected in 2010 were analysed separately.

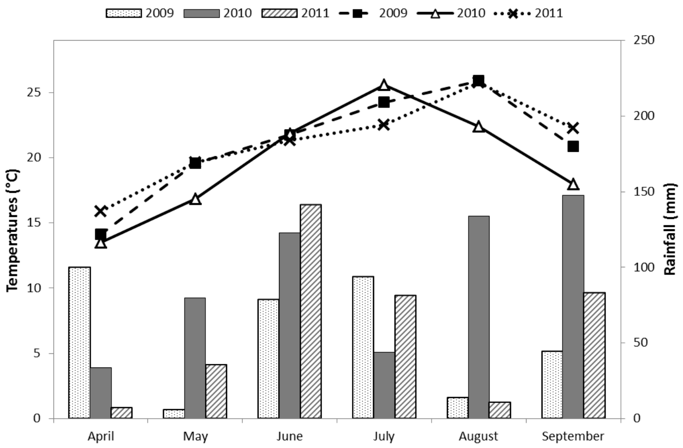


Figure 1. Monthly temperatures and rainfall in the AOC Valpolicella-Valpantena in 2009, 2010 and 2011.

The available soil water content was different between TU: in the limestone soils the content was lower than in the marly limestone soils at the same altitude, while in the flood plain the fine granulometry soils had less TTSW than the medium ones (tab. 2). The grape quality parameters showed a significant difference between TU for both the varieties (data not shown), except for the TA and the pH. The Corvina showed the highest content of TSS (21.3 °Brix) and total anthocyanins (0.81 mg/berry) in the CF unit, where it had the lowest plant yield (2.7 kg) due to the smaller bunch: 238 g with an average of 290 g (data not shown). In the LM unit the sugar content and the total anthocyanins were the lowest (18 °Brix and 0.46 mg/berry) and the grape production was the highest (3.7 kg). In the 380 m altitude units (MC and LC) characterized by cooler temperatures, the anthocyanins's extractable fraction and the total flavonoids were the highest (tab.2). Most of the parameters correlated to grape dehydration rate showed a significant difference between TU (Ew, ThS, BD). The S/V did not show any difference between TU as it is mainly dependent on the genetic characteristics of the grape varieties [8], indeed the Corvina showed an average value of 3.8 and the Corvinone of 3.15. Different agronomic practices (training systems) could affect this ratio (data not reported). The epicuticular wax (Ew) showed a good variability between TU. The highest value of Ew was found in the CF units (1.35 µg/mm^2) in a plain situation where the TTSW was low; vice versa the LF unit showed the lowest content of Ew where the TTSW was medium and the vineyards were collocated in the hill slopes. The skin thickness (ThS) was higher where the TTSW was lower, CF and LM unit (tab.2). Previous works found a similar correlation of ThS but with the vine water status, in stressed situations to prevent water loss the plant showed a significant increase of berry skin thickness [3].

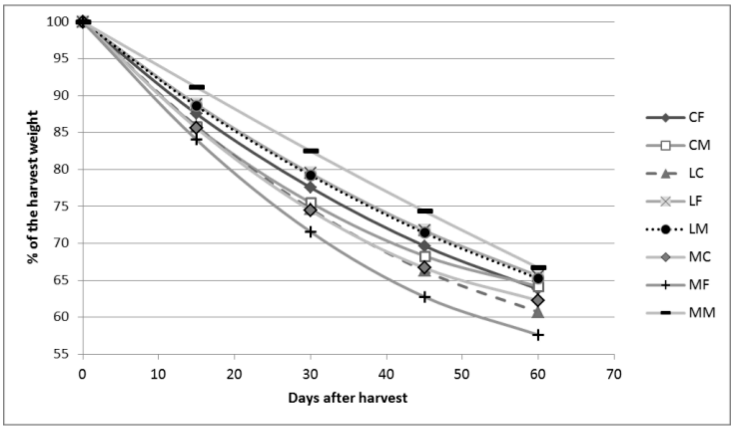
Table 2. Corvina yield and qualitative parameters in the different Terroir Unit
(the values are the averages of 2009 and 2011).

Parameters	***Terroir Units***								
	CM	**CF**	**MF**	**LF**	**MM**	**LM**	**MC**	**LC**	***Sig.***
TSS [°Brix]	20.8^{b}	21.3^{a}	19.9^{c}	21.5^{a}	19.9^{c}	18.0^{d}	19.8^{c}	19.2^{cd}	*
TA [mg/L]	6.2	6.1	5.6	5.7	6.1	5.4	7.0	6.8	*ns*
pH	3.3	3.3	3.5	3.4	3.5	3.6	3.4	3.4	*ns*
Tot.anthocyanins [mg/berry]	0.56^{b}	0.81^{a}	0.50^{c}	0.52^{cb}	0.63^{b}	0.46^{c}	0.69^{ab}	0.86^{a}	**
Extractable anthocyanins [mg/berry]	0.29^{b}	0.36^{ab}	0.31^{ab}	0.26^{b}	0.29^{b}	0.17^{c}	0.37^{a}	0.41^{a}	**
Total flavonoid [mg/berry]	2.57^{ab}	2.78^{ab}	1.92^{cb}	1.66^{c}	2.34^{ab}	1.51^{c}	2.72^{a}	3.09^{a}	***
Plant yield [kg]	3.7^{a}	2.7^{b}	3.3^{ab}	3.2^{ab}	3.5^{a}	3.7^{a}	2.6^{b}	3.2^{ab}	**
Plant pruning wood [kg]	0.84^{b}	1.08^{a}	0.95^{a}	0.65^{c}	0.73^{b}	0.75^{b}	0.98^{a}	0.63^{c}	**
BD	12.5^{c}	14.0^{b}	15.4^{ab}	15.2^{ab}	16.2^{a}	12.5^{c}	14.1^{b}	14.7^{b}	**
Ew [µg/mm^2]	1.12^{b}	1.35^{a}	0.93^{c}	0.85^{d}	0.95^{c}	0.97^{c}	1.03^{bc}	1.06^{b}	***
S/V	3.8	3.7	3.7	3.7	3.8	3.8	3.9	3.9	*ns*
ThS [µm]	172^{c}	185^{ab}	181^{b}	179^{bc}	170^{c}	197^{a}	183^{b}	178^{bc}	***
Total transpirable soil water (TTSW %)									
June-July	60.37	35.67	62.63	53.23	60.17	43.76	49.97	41.19	
August-Sepember	56.61	28.40	44.35	43.00	49.26	30.52	39.35	34.07	

Note: Mean followed with the same letter do not differ significantly at p=0.05. Asterisk indicate: ***** p< 0.001, ** p< 0.01, * p<0.05**

In figure 2 the Corvina weight loss kinetic during the postharvest dehydration is reported. At the end of the process (60 days after harvest) the range of weight loss, expressed in percentage of the initial weight, was between 62 and 57 %. The MM unit with the more dense bunch showed a slower kinetic. A similar weight loss pattern was observed in the LM where the bunch density was loose but the ThS was the highest. The MC, LC and CF units showed the same value of bunch density and skin thickness but a different quantity of epicuticular wax on the berry surface. The CF unit with more Ew had a slower dehydration rate than MC and LC unit, which showed a lower quantity of Ew.

The multiple stepwise regression analysis showed a model (p=0.003; r=0.51) where the first variable included was the bunch density and the second one was the quantity of epicuticular wax.



TU	% of the harvest weight after 45 days
CM	68.3^{b}
CF	69.6^{b}
MF	62.7^{d}
LF	71.7^{ab}
MM	74.3^{a}
LM	71.4^{ab}
MC	66.6^{c}
LC	66.3^{c}

Figure 2. ***On the left:*** **Corvina kinetic of postharvest dehydration process (values are the averages of 2009 and 2011).** ***On the right:*** **Weight loss expressed in % of the initial weight after 45 days from the harvest.**

4 CONCLUSIONS

The results showed a correlation of the qualitative parameters with the plant yield. The plant yield resulted affected by the environmental variability mainly in the pedological soil characteristics (texture, depth, soil water availability) and site-altitude; this seems to have a certain effect on bunch weight. The skin thickness (ThS) seemed linked to the soil water availability, with a low value the plant showed a thick ThS. The Ew, BD and S/V showed a good correlation with the kinetic of post-harvest weight loss. The S/V showed an important effect, different varieties had a different weight loss pattern. Considering the same variety the BD played the main role in the post-harvest kinetic followed by the Ew. This new information is useful for winemakers so they can separate the grapes depending on the growing area and modifying the post-harvest conditions (temperature, humidity and ventilation) to reach an optimum weight loss (from 30% to 40%).

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