VITIS v. CORVINA GRAPES COMPOSITION AND WINE SENSORY PROFILE AS AFFECTED BY DIFFERENT POST HARVEST WITHERING CONDITIONS

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Abstract:

Context and purpose of the study In Valpolicella area (Verona – Italy) Vitis vinifera cv. Corvina is the main wine variety to obtain, after grape withering, Amarone wine: this study was carried out in order to compare two different grape dehydration conditions with the aim of verifying the final composition of Corvina dried grapes and the organoleptic profile of corresponding Amarone wine.

Material and methods To obtain Amarone wine, Corvina grapes before vinification has to be stored in dehydrating room in order to achieve at least the 30% weight loss. In our experiment (2016/17) we harvested Corvina grapes from the same vineyards but before vinification we used two different withering conditions: i) room with natural air movement forced by opening the windows mainly during the day and ii) room equipped with mechanical air movement system (fans) and air humidity artificial control (around or below 70/75%). In both conditions grape has been left since their 30% weigh loss. Berry macro-composition (sugar, acids, pH) and micro-composition (total polyphenols, anthocyanins, stilbenes, aroma compounds) has been detected for the two grapes postharvest management and the two vinification has been done too.

Results The healthy berries status did not signed any differences. In artificial conditions grape lost 30% weigh 15/25 days before the natural ones, sugar enrichment was not strictly linked with the water loss, but it was more related with the withering conditions and ripeness stage at harvest. Anthocyanins skin content resulted higher or slightly higher in natural conditions but anthocyanin extractability are equal. Stilbenes compound (trans resveratrol, trans piceide, δ viniferina, etc) are higher in grapes dried in artificial conditions. This latter result could be linked to less stress responses that natural condition impose to berry cells. The total aromatic compounds resulted more pronounced in grapes dried in natural conditions; the single chemical compounds that resulted in higher quantity were: nerolo, geraniolo, 3-OH-β-damascenone, vomifoliolo, guaiacolo, metilsalicilato, alcolbenzilico, eugenolo, acetovanillone. The differences were clearly in favour of natural withering system especially in 2015 and 2017. In terms of wine sensory profile the wine obtained with grape dehydrated in natural room has been preferred for its higher pronounced body and structure, for its spices, fresh and ripe red fruit flavour.
The results underline that postharvest dehydration conditions have a significant impact on general bunch metabolism and even if the water loss increases the solute concentration, physiological and biochemical processes may affect berry composition and wine character under different dehydrating choices.

Keywords: Grapevine, Corvina, Dehydration, Amarone

1. Introduction

Corvina non botrytized withered grapes is the main variety used to obtain the famous worldwide marketed Valpolicella Amarone wine. Corvina is an autochthonous variety belonging to Verona area; its wine is marked by cherry, bitter almond and flower flavours and fresh acidity. However, it lacks in anthocyanins and its skin tannins content is moderate: this is why the withering process has been selected over the decades to concentrate and enrich the berry composition. Amarone is a sort of icon in the oenological sector due to the high quality level obtained thanks to the second grape ripening carried out in warehouse. In the past, dehydration process was developed by laying the grape in dehydrating rooms without any climatic control; nowadays, air humidity and ventilation can bemodified (but no temperature control is allowed). Artificial environment conditions give more chances to have a faster dehydration and to obtain healthy dried grapes. Together with water loss and consequent sugar concentration and acidity conservation, metabolic changes occur in terms of aroma compounds (Bellincontro *et al*. 2004) and polyphenolic composition affecting the wine sensory profile. Among polyphenols, stilbenes synthesis (i.e. trans-resveratrol, viniferins, piceid) is crucial for their nutraceutical properties. The aim of this work is to compare natural and artificial Corvina dehydration processes in order to assess their effect on dried grape chemical composition and peculiar wine organoleptic evaluations.

2. Materials and methods

The experimental data have been collected during 2016 and 2017. The vineyard was selected in Valpolicella classic area (loc. Novare in Negrar municipality), owned by Bertani Domains winery. The trellising system was Guyot, the plant density was equal to 4.444 vines per ha, the variety was Corvina, clones ISV-CV48 grafted on kober 5 bb. The harvest period, as local tradition, was set 10 days before the commercial harvest for Valpolicella fresh wine, occurring on 17thSeptember2016 and 6thSeptember2017. The fresh grapes were stored in plastic boxes - the ones used for modern warehouses - and in traditional "arelle" (wooden trays) for natural conditions. In modern warehouses, air humidity is kept between 60 and 70% (optimal range for grape dehydration); wind speed inside the warehouse was provided by fans used to drive the air flow through the windows. On the other side, the natural and traditional dehydration management was obtained with no air humidity control or mechanic air movement: the warehouse manager had either to open or close the window to help the air rich in humidity fly outside through the windows. The two withering rooms were close to each other and inside of the winery property. The berry chemical composition was analysed at four different drying stages: i) T0 fresh berry, ii) T10% berry weight loss, iii) T20% berry weight loss, iv) T30% berry weight loss. Sample preparation and chemical analysis were detected as described in Mirko de Rosso et al. 2016. The grapes were crashed at 30 %weight loss and wines have been obtained using 100 kg of dried grape; panel test consisted of 8 local wine tasters with deep experience in Amarone wine.

Statistical analysis- A one-way analysis of variance has been performed in order to compare the results. In the case of significant difference between the thesis, the LSD (Least Significant Difference) test was applied to explore the differences among means. The analysis was considered at a confidence level of 95%. Stat-graphics 17.2® (Stat-point Technologies Inc., Warrenton, Virginia) was used to perform the analysis.

3. Results and discussion

3.1 Drying room climate and berry macro-composition

Referred to 2017 fig. 1 shows the average temperature and air humidity inside of artificial and natural drying rooms (temperature is also compared with the external one). The average temperature was lower in natural conditions and closest to the external one than the artificial drying conditions, where the highest temp. is related to the lowest air humidity. Due to automatic air humidity control, this value was lower in artificial conditions. The 2016 weather conditions, respect 2017 imposed inside of dehydration rooms lower temperature but comparable air humidity, the relative differences in temperature and air humidity between the two withering conditions utilized were very similar as shown for 2017.

Because of the lower air humidity, the time taken to reach 30% berry water loss was faster in controlled system (20 days earlier in 2016 and 15 days earlier in 2017). At the same time, berries sugar content was 30.1 and 31.0 Brix degree in 2016 and 27.5 and 28.8 in 2017, respectively for artificial and natural drying conditions. Malic acid remained almost the same in both conditions, while tartaric acid showed a slight increase in natural condition (+10-15%).

In both years, total flavonoids were higher in natural conditions (2380 mg/kg dried berries vs 3640 in 2016 and 1560 vs 2.200 in 2017). In 2017, anthocyanins were much higher in natural system (340 mg/kg vs 435), while in 2016 the quantity was around 600 mg/Kg of dried berries for both drying systems.

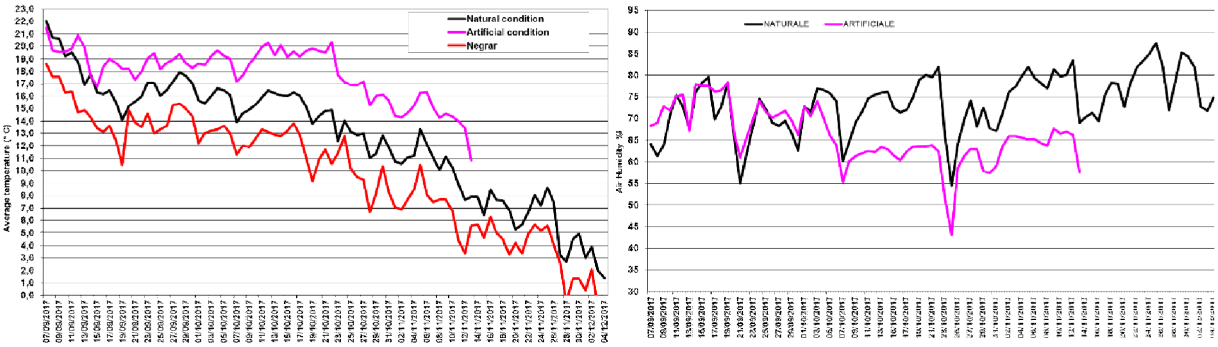


Figure 1: Natural and artificial climate withering conditions (left temperature, right air humidity, year 2017)

3.2 Stilbenes compound

Dehydration induces specific chemical changes in berries and most of them involve secondary metabolites, such as polyphenols (just stated to be higher in natural condition) and stilbenes, which determine nutraceutical properties of wine (Mencarelli *et al*, 2010).Considering the total quantity of stilbene at 30% weight loss(WL), data reported in tab. 1 state that the grape under natural dehydration have less stilbenes in both years. In both conditions, total content highlights that these compounds are mainly synthetized after 10% (WL) in 2016 and at the end of withering in 2017, probably when the most critical physiological condition occurred. Considering the single compounds, trans-resveratrol and trans-piceid are the two main stilbenes in dried grapes.

Table 1: Stilbene derivatives identified in Corvina withered grapes under two different withering processes

	T0		-10%				-20%				-30%			
			Art		Nat		Art		Nat		Art		Nat	
	mg/kg	semidisp.	mg/kg	semidisp.	mg/kg	semidisp.	mg/kg	semidisp.	mg/kg	semidisp.	mg/kg	semidisp.	mg/kg	semidisp.
trans-piceide	3,40	1,29	7,51	2,87	6,59	0,14	14,94	0,74	8,75	1,33	8,55	0,99	6,11	0,18
trans-piceatannolo	0,27	0,38	3,29	0,62	2,78	0,08	3,29	0,25	6,49	3,41	6,17	0,04	2,21	0,11
trans-resveratrolo	0,27	0,52	5,16	0,72	3,17	0,00	11,27	1,16	11,60	1,76	10,90	0,56	3,63	0,50
cis-piceide	0,56	0,43	1,09	0,65	1,99	0,44	3,67	0,42	4,09	0,44	1,79	0,77	1,85	0,22
trans-e-viniferina	0,16	0,04	0,10	0,02	0,09	0,01	0,15	0,01	0,10	0,03	0,32	0,14	0,29	0,23
d-viniferina	0,03	0,02	0,07	0,03	0,07	0,01	0,27	0,05	0,11	0,02	0,25	0,01	0,09	0,01
Total 2016	**4,69**		**17,23**		**14,69**		**33,60**		**31,15**		**27,98**		**14,17**	
trans-piceide	1,72	0,16	1,97	0,62	3,46	0,89	0,39	0,10	2,42	0,06	12,62	1,06	1,93	0,21
trans-piceatannolo	0,11	0,03	0,21	0,04	0,38	0,04	0,08	0,02	0,24	0,05	2,38	0,61	0,36	0,15
trans-resveratrolo	0,16	0,02	0,70	0,01	1,92	0,43	2,00	0,74	2,18	0,76	17,28	0,41	7,63	2,10
cis-piceide	1,14	0,04	1,29	0,34	1,54	0,45	0,26	0,03	0,80	0,14	3,16	0,64	0,90	0,01
trans-ε-viniferina	0,25	0,01	1,51	0,48	1,26	0,27	0,60	0,15	1,91	0,11	1,25	0,24	3,64	0,28
δ-viniferina	0,03	0,01	0,09	0,03	0,04	0,01	0,24	0,01	0,11	0,03	0,31	0,02	0,26	0,01
Total 2017	**3,42**		**5,77**		**8,59**		**3,56**		**7,66**		**36,99**		**14,73**	

3.3 Aromatic compounds

Aliphatic alcohols: Concerning the aliphatic alcohols production in 2016, a significant difference ($p<0,05$) between artificial and natural thesis can be found at T0 and at -20% WL. The highest concentration of aliphatic alcohols is achieved at -20% WL with artificial drying process.In 2017, a significant difference ($p<0,05$) can be found at -10% and -30% WL. The highest aliphatic alcohols concentration is reached at -30% WL with natural withering.

C-6-aldehydes:Concerning the C-6-aldehydes production, a significant difference ($p<0,05$) between artificial and natural thesis can be found at -20% and -30% WL, both in 2016 and 2017.At -20% WL, the highest concentration of C-6-aldehydes is achieved in 2017 with the natural conditions, while in 2016 it is achieved with the artificial ones.

Monoterpenes: Concerning the Monoterpenes production in 2016, a significant difference ($p<0,05$) between artificial and natural thesis can be found at -10% WL. The highest concentration of Monoterpenes is achieved at -20% WL, both with natural and artificial fading.In 2017, a significant difference ($p<0,05$) can be found at -

10%, -20% and -30% WL. The highest Monoterpenes concentration is reached at -30% WL with the natural drying process.

Norisoprenoids: Concerning the Norisoprenoids production in 2016, a significant difference (p<0,05) between artificial and natural thesis can be found at -10% WL. The highest concentration of Norisoprenoids is achieved at -20% WL, both with natural and artificial conditions. In 2017, a significant difference (p<0,05) can be found at -10%, -20% and -30% WL. The highest Norisoprenoids concentration is reached at -30% WL with natural fading.

*Benzenoids:*Concerning the Benzenoids production in 2016, a significant difference (p<0,05) between artificial and natural thesis can be found at -30% WL. The highest concentration of Benzenoids is achieved at -30% WL with natural fading. In 2017, a significant difference (p<0,05) can be found at -20% and -30% WL. The highest Benzenoids concentration is reached at -30% WL with natural drying conditions.

Furans: Concerning the Furans production in 2016, a significant difference (p<0,05) between artificial and natural thesis can be found at T0, -10% and -20% WL. The highest concentration of Furans is achieved at -20% WL with artificial fading.

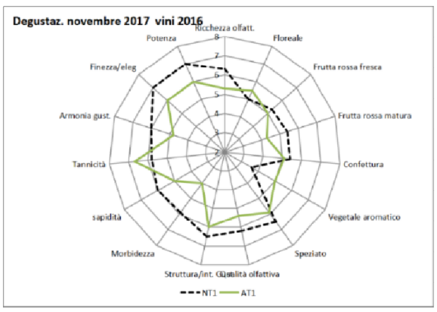
In 2017, no significant difference (p<0,05) is found in the different thesis. The highest Furans concentration is reached at T0, although no statistical difference can be found with the -30% WL (both artificial and natural withering processes).

Table 2: Variation in the concentration (referred to berry weight) of classes of aroma compounds induced by two different drying conditions at different weight loss steps

	2016						
	T0	**-10%**		**-20%**		**-30%**	
		Art	**Nat**	**Art**	**Nat**	**Art**	**Nat**
aliphatic alcohols (µg/kg)	206 ± 29	389 ± 27	334 ± 48	797 ± 14	553 ± 32	467 ± 118	492 ± 2
C-6-aldehydes (µg/kg)	24 ± 3	44 ± 3	43 ± 3	50 ± 2	35 ± 1	19 ± 8	35 ± 3
monoterpenes (µg/kg)	408 ± 15	720 ± 18	527 ± 37	767 ± 68	761 ± 26	670 ± 112	721 ± 15
norisoprenoids (µg/kg)	672 ± 74	959± 3	778 ± 86	1052 ± 20	1114 ± 12	1016 ± 97	984 ± 56
benzenoids (µg/kg)	2887 ± 90	4038 ± 597	4627 ± 371	5181 ± 540	5763 ± 483	4102 ± 483	6340 ± 493
furans (µg/kg)	57 ± 4	91 ± 1	94 ± 5	125 ± 9	135 ± 1	89 ± 17	138 ± 4
	2017						
	T0	**-10%**		**-20%**		**-30%**	
		Art	**Nat**	**Art**	**Nat**	**Art**	**Nat**
aliphatic alcohols (µg/kg)	491 ± 105	437 ± 8	367 ± 6	427 ± 39	565 ± 162	524 ± 39	850 ± 102
C-6-aldehydes (µg/kg)	46 ± 7	52 ± 14	66 ± 4	93 ± 11	172 ± 10	61 ± 9	120 ± 16
monoterpenes (µg/kg)	740 ± 107	493 ± 47	773 ± 76	510 ± 25	771 ± 93	546 ± 64	854 ± 21
norisoprenoids (µg/kg)	1076 ± 147	861 ± 125	1395 ± 75	1300 ± 165	1718 ± 357	1044 ± 63	3324 ± 123
benzenoids (µg/kg)	3321 ± 476	2739 ± 202	3377 ± 352	4129 ± 497	5614 ± 1426	5462 ± 580	9980 ± 45
furans (µg/kg)	97 ± 16	68 ± 2	59 ± 2	53 ± 7	52 ± 5	93 ± 9	75 ± 15

3.4 wine sensory evaluation

According to the wine sensory evaluation (fig. 2) that took place one year after microvinification, wine scores confirm that the natural drying process accounts for a better judgment in terms of olfactory (spicy, red ripe fruit) body and taste score.



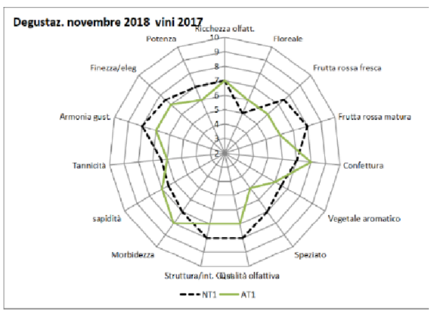


Figure 2: Wine sensory profile of the two wines (Nat and Art) obtained with the two grape drying methods

4. Conclusion

The berry macro-composition resulted similar in the two Corvina dried grapes. Polyphenols and anthocyanins (in 2016) were higher in natural process.The different stilbene biosynthesis of the two processes applied can probably be explained by the lower cell stress induced by natural dehydration conditions; in those conditions(higher air humidity, lower temperature),it took more time to reach 30%weight loss and this could be the first signal of lower stress. The aroma concentration in dried grapes increases during postharvest dehydration, both in artificial and natural processes, but the higher quantity was found in grapes dried under natural conditions. The C-6 aldehydes showed a reduction in the last step (-30%WL): this can be considered a positive effect compared to their undesirable green and herbaceous odour. The wine sensory evaluation gave preference to the wine obtained with natural withered grape process. This research has confirmed that a great strategy to obtain more traditional and artisan Amarone wine consists in slowing down the drying process and causing less cells stress.

5. Acknowledgements

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6. Literature cited

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