AWRI Australian Wine Research Institute

Fact Sheet
WINEMAKING

Treating smoke-affected wine with activated carbon

Background

When grapes are exposed to smoke, they can absorb volatile phenols, which bind to sugars in the grapes forming non-volatile phenolic glycosides. In juice and wine, both volatile phenols and their glycosides can cause unpleasant 'ashy' and 'smoky' sensory sensations and a lingering aftertaste, commonly described as 'smoke taint'.

What is activated carbon and how can it be used to mitigate smoke taint?

Activated carbon products are highly porous carbon-rich materials used in applications such as filtration and water treatment. They are known to adsorb organic compounds, including undesirable contaminants such as the volatile phenols and phenolic glycosides associated with smoke taint. Activated carbon products can be used to treat smoke-affected juices (white or rosé) or wines; however, they also remove positive colour, aroma and flavour compounds.

Generally, phenolic glycosides are more prevalent than volatile phenols in juices or musts, whereas smoke-tainted wines often contain a combination of both volatile phenols and phenolic glycosides. It is important to select the right carbon product for the desired application (e.g. one product might be better at removing phenolic glycosides and another at removing volatile phenols).

Performance differences among different carbon products

The efficiency of activated carbon products in removing smoke taint compounds is highly dependent on:

(i) the type of carbon product used

(ii) the matrix (e.g. juice versus wine; red versus rosé or white)

(iii) the dose added.

Some activated carbon products are better at removing phenolic glycosides, and the removal occurs better in juice than wine. Other carbons preferentially remove volatile phenols in wine (Figure 1).

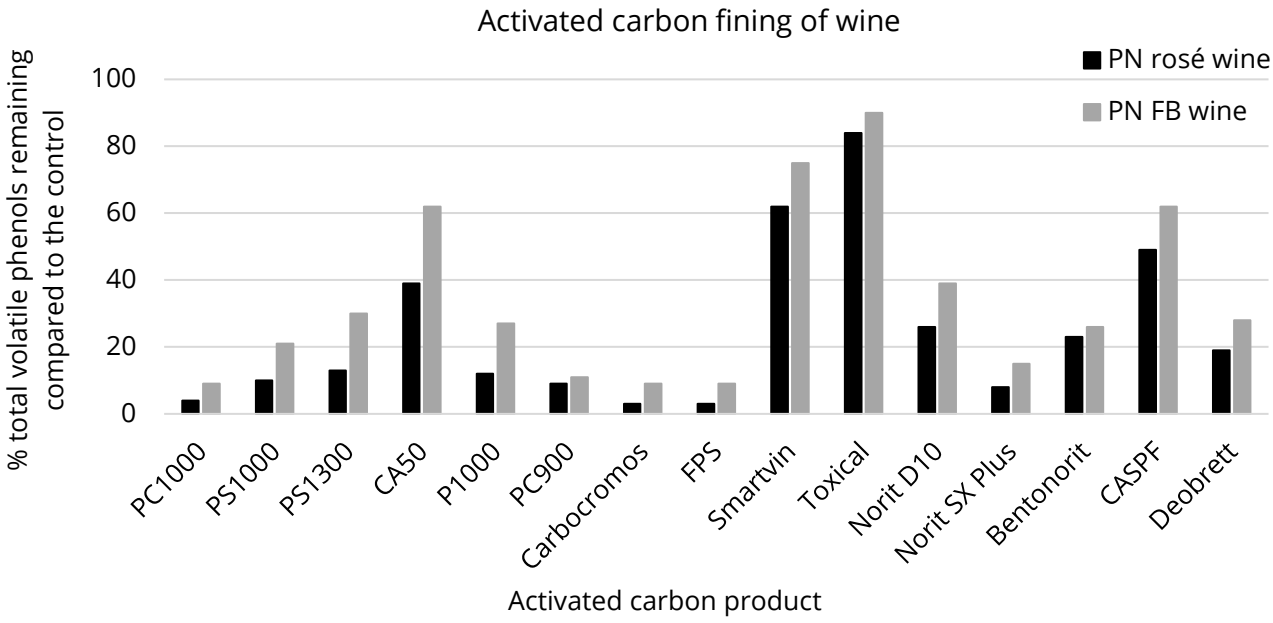

Figure 1. Comparison of the ability of 15 activated carbon products (dose 2 g/L, contact time 24 hours) to remove total volatile phenols (VPs) from 2019 smoke-affected Pinot Noir (PN) rosé and full-bodied (FB) wines. Results are presented as percentage of volatile phenols remaining compared to the control (i.e. wine without carbon treatment). Starting total volatile phenols (sum of guaiacol, 4-methylguaiacol, m-, o- and p-cresols, syringol and methylsyringol) for the rosé and full-bodied PN wines were 77 and 149 µg/L, respectively.

Assessing performance

The evaluation of the different activated carbon products was based on measurement of their ability to remove volatile phenols and phenolic glycosides from wine. For removal of volatile phenols from wine, Carbocromos super (Vason) and FPS (Vason) were among the best performers (Figure 1). Activated carbon products were not very effective at removing phenolic glycosides from wine. For example, for two full-bodied Pinot Noir red wines, the reduction in phenolic glycosides, at best, was less than 20%, even at a dose of 2 g/L (data not shown). The activated carbon products fared slightly better in white and rosé wines, with some removing between 50 and 60% of the phenolic glycosides. Removal of phenolic glycosides is better

performed in juice than in wine. Greater success was observed when using activated carbons to remove volatile phenols from wine.

Carbon treatment of wine

A 2019 smoke-affected full-bodied Pinot Noir wine was treated with PS1300 or FPS at doses of 1 and 2 g/L. Carbon contact time was 48 hours and wines were clarified with the assistance of bentonite. Wine treated with activated carbon showed a reduction in smoke taint sensory ratings (rated on a scale of 0 to 9, Table 1), with a more pronounced effect seen at higher carbon doses.

Table 1. Smoke taint ratings for 2019 smoke-affected Pinot Noir wine with no treatment (control) and treated with activated carbon products (FPS or PS1300) at two doses (1 and 2 g/L)

Control (no carbon)	FPS 1 g/L	FPS 2 g/L	PS1300 1 g/L	PS1300 2 g/L
6.2	2.8	1.5	2.7	1.6

Similar to smoke-affected juices, treating wine with activated carbon requires a balancing act between reducing smoky attributes while retaining desirable sensory attributes. Additions of activated carbons at less than 1 g/L might be appropriate in some wines to achieve this balance.

Studies performed at commercial wineries

Remediation trials were undertaken at four commercial wineries on 2020 smoke-affected Pinot Noir, Shiraz, Durif and Muscat wines. Activated carbons (Table 2) were initially screened in benchtop trials to shortlist the best carbons and dose rates (from 0.25 to 1 g/L) to achieve the most favourable sensory outcome (i.e. a reduction in smoke characters while still maintaining fruit aroma and flavour). The best performing carbons from the benchtop trials included Fenol Free, FPS, Black PF, Granucol GE and Granucol FA and these were further evaluated in 30 L trials. A pre-treatment with glycosidases for two to three weeks prior to carbon treatment was also evaluated for the Shiraz 2, Durif and Muscat wines.

Table 2. List of activated carbons evaluated in bench trials and their manufacturer/supplier

Manufacturer/supplier	Carbon name
Carbochem	CA-50
Cabot	CASPF
Enartis	Black PF
Enartis	Fenol Free
Enartis	Enoblack
Grapeworks	Carbine T Poudre
Grapeworks	Noir Activa Max
Victus International	Granucol FA
Victus International	Granucol GE
Vason	FPS

Smoke affected wines (30 L) were typically treated with the activated carbons for 24 hours; bentonite (200-400 mg/L) was then added to aid in settling of the carbon and the wines were racked after three to seven days. Wines were sent to the AWRI for bottling and chemical and sensory evaluation. The sum of the volatile phenols (n=7) and sum of the phenolic glycosides (n=6), along with the mean ratings for 'smoke' aroma and 'smoke' flavour for control and carbon-treated wines are provided in Table 3.

Table 3. Sum of the volatile phenols, phenolic glycosides and mean ratings for smoke aroma and smoke flavour for each of the wines

Treatment	Dose rate (g/L)	Sum of volatile phenols[a]	Sum of phenolic glycosides[b]	Smoke aroma	Smoke flavour	Significant sensory difference from control?
Pinot Noir						
Control	-	40	54	2.10	3.64	-
Black PF	0.25	32	57	1.59	2.72	No
Fenol Free	0.25	30	59	0.81	2.16	Yes, aroma and flavour
FPS	0.25	33	56	1.65	2.44	Yes, flavour only
Shiraz 1						
Control	-	56	110	1.66	2.67	-
Black PF	0.6	47	98	0.96	1.15	Yes, flavour only
Fenol Free	0.6	35	97	0.44	1.07	Yes, flavour only
FPS	0.6	41	100	0.38	0.44	Yes, flavour only
Shiraz 2						
Control	-	56	161	0.42	1.19	-
Enz1[c] + ProVGreen[d]	0.4	56	92	1.12	1.56	No
ProVGreen[d]	0.4	50	170	0.27	0.73	No
Granucol FA	0.4	51	169	0.28	1.10	No
Fenol Free	0.4	40	166	0.16	1.24	No
Durif						
Control	-	24	395	0.15	0.75	-
Fenol Free	0.5	16	376	0.40	0.69	No
Enz2[e] + Fenol Free	0.5	31	189	1.39	2.51	Yes, aroma and flavour [f]
Granucol GE	0.5	23	394	0.80	1.43	No
Muscat						
Control	-	36	230	1.27	1.25	-
Granucol GE	0.5	32	242	0.66	0.98	No
Enz2[e] + Granucol GE	0.5	36	162	1.68	2.18	Yes, flavour only [f]
FPS	0.5	25	228	1.38	1.14	No
Black PF	0.75	32	234	1.05	0.93	No

[a] Sum of volatile phenols = additive concentrations (in µg/L) of 4-methylguaiacol, guaiacol, *o*-cresol, *p*-cresol, *m*-cresol, syringol and 4-methylsyringol; [b] Sum of phenolic glycosides = additive concentrations (in µg/L SyGG equivalents) of Syringol gentiobioside (SyGG), methylsyringol gentiobioside (MSyGG), phenol rutinoside (PhRG), cresol rutinoside (CrRG), guaiacol rutinoside (GuRG) and 4-methylguaiacol rutinoside (MGuRG); [c] Enz1 = Zimarom from Vason dosed at 5 g/hL; [d] ProVGreen is a combination of activated carbon and a pea protein; [e] Enz2 = Trenolin® Bouquet PLUS from Erbslöh dosed at 15 mL/hL; [f] significantly higher than the control

"The best performing carbons were the ones most respectful of the fruit, as well as reducing some of those smoke characters"

Victorian winemaker

Most Pinot Noir and Shiraz 1 wines treated with activated carbons were rated as being significantly lower in smoke sensory characteristics compared to the control wines. The impacts were less pronounced for Shiraz 2, Durif and Muscat wines and this was most likely due to the low levels of smoke perceived in the control wines prior to carbon treatment. Despite these wines containing concentrations of volatile phenols and phenolic glycosides indicative of smoke exposure, other factors such as fruit intensity and/or sugar content (i.e. for the Muscat wine) may be masking the intensity of the smoke characters. These results further highlight that different varieties and styles will have more (or less) pronounced 'smoky' flavour even with the same concentrations of smoke volatile phenols and phenolic glycosides. Even within the same varieties the perception of smoke taint may vary even if they contain comparable concentrations of the smoke taint compounds (e.g. Shiraz 1 and Shiraz 2).

The reduction in wine smoke sensory characters after activated carbon treatment is most likely a direct result of reductions in the concentrations of volatile phenols. In this study, the impact of low doses of activated carbon on wine glycosides was minimal, supporting previous observations that activated carbons are not very effective at removing phenolic glycosides from wine. The Durif and Muscat wines pre-treated with glycosidases prior to carbon treatment were perceived as being higher in smoke character than the control wines. As glycosidases are known to degrade phenolic glycosides and increase concentrations of volatile phenols, a higher dose rate of carbon will be required after glycosidase treatments compared to using carbon fining as the sole treatment.

Recommendations/conclusions

The selectivity and tendency to protect desirable aromas and flavours might differ between carbon products and needs to be considered prior to carbon fining of wine. Furthermore, the appropriate carbon addition will be dependent on the level of smoke compounds in the wine. Chemical analysis for volatile phenols and phenolic glycosides is therefore recommended prior to fining.

It is recommended that evaluations of carbon treatments be performed on small volumes of wine to determine sensory impacts before treating larger quantities of wine. Further blending of carbon-treated wine with non-smoke-affected wine is another option to obtain a final wine with suitable sensory characteristics.

While all activated carbon products evaluated in this work were commercially available, it is also recommended that wineries contact product manufacturers to ensure that their product adheres to the relevant food standards code for use in wine production. Carbon products suitable for treatment of water or other foods may not be appropriate for wine production. Note that the OIV recommends carbon additions should be less than 1 g/L for wine. Carbon fining rates are more typically around 500 mg/L. The addition of larger quantities of carbon (>1 g/L) to wine may remove excessive colour and flavours, making it appear un-wine-like. In addition, for some carbon

types, the addition of larger quantities could result in the release of metal compounds into the wine.

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