Is It The Age Or The Autolysis? Pulling Apart Where Sparkling Wine Character Comes From

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Introduction

- Méthode Champenoise consists of two successive fermentations. The first transforms grape juice into still base wine and the second is initiated by addition of the liquor de tirage (mixture of sugar and yeast). Ageing of the secondary ferment on yeast lees, during which gradual breakdown of yeast cells (autolysis) and subsequent release of volatile and non-volatile compounds, is thought to be responsible for the aromatic complexity in these wines.

Aims

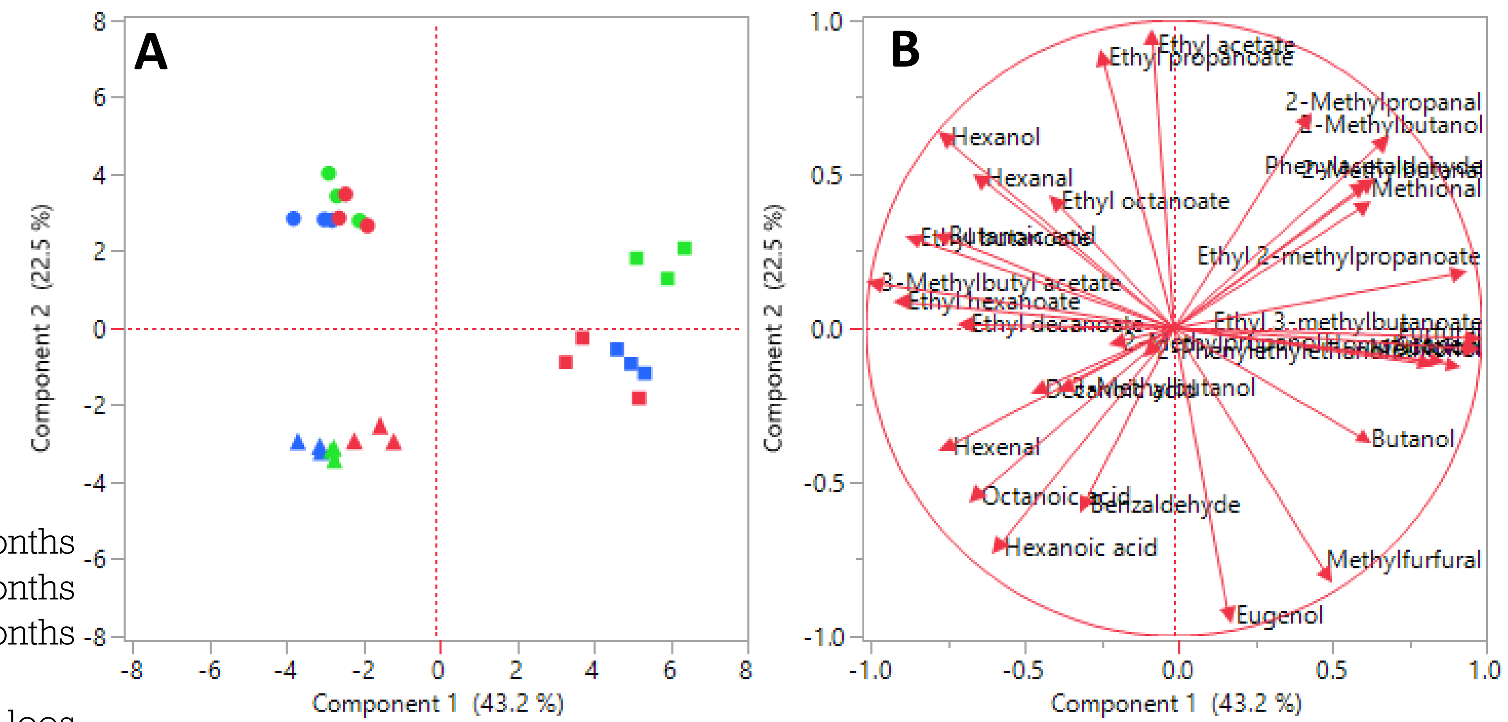
- To determine whether volatile fermentation products (FP) and oxidised compounds originate from ageing of the base wine itself (base no lees), ageing on the lees (base + lees) or upon secondary fermentation and further ageing on lees (tirage) of Chardonnay (CHA) and Pinot Noir (PIN) sparkling wines at 6, 12, and 24 months of ageing.

Results

- 29 FP and 17 oxidative character analytes were quantified.
- Clear separation of CHA & PIN based on ageing time (Figures 1a & 2a).
- Further investigation into compounds above odour threshold at 24 months (Table 1) indicates:
  - FP profiles of PIN very similar in tirage and base wines whereas variability is present in profile of oxidised compounds.
  - More variability in FP profiles of CHA but pattern of variability in oxidised compounds similar to PIN.

Conclusions

- Time is main driver for differences in aroma.
- Yeast cellular components and CO_2 likely preventing degradation of amino acids to Strecker aldehydes in tirage and base + lees wines → likely due to a reduced oxygen environment.



● = 6 months
▲ = 12 months
■ = 24 months
◆ = Base no lees
◆ = Base + lees
◆ = Tirage

Figure 1. PCA of Chardonnay wine volatile compounds.

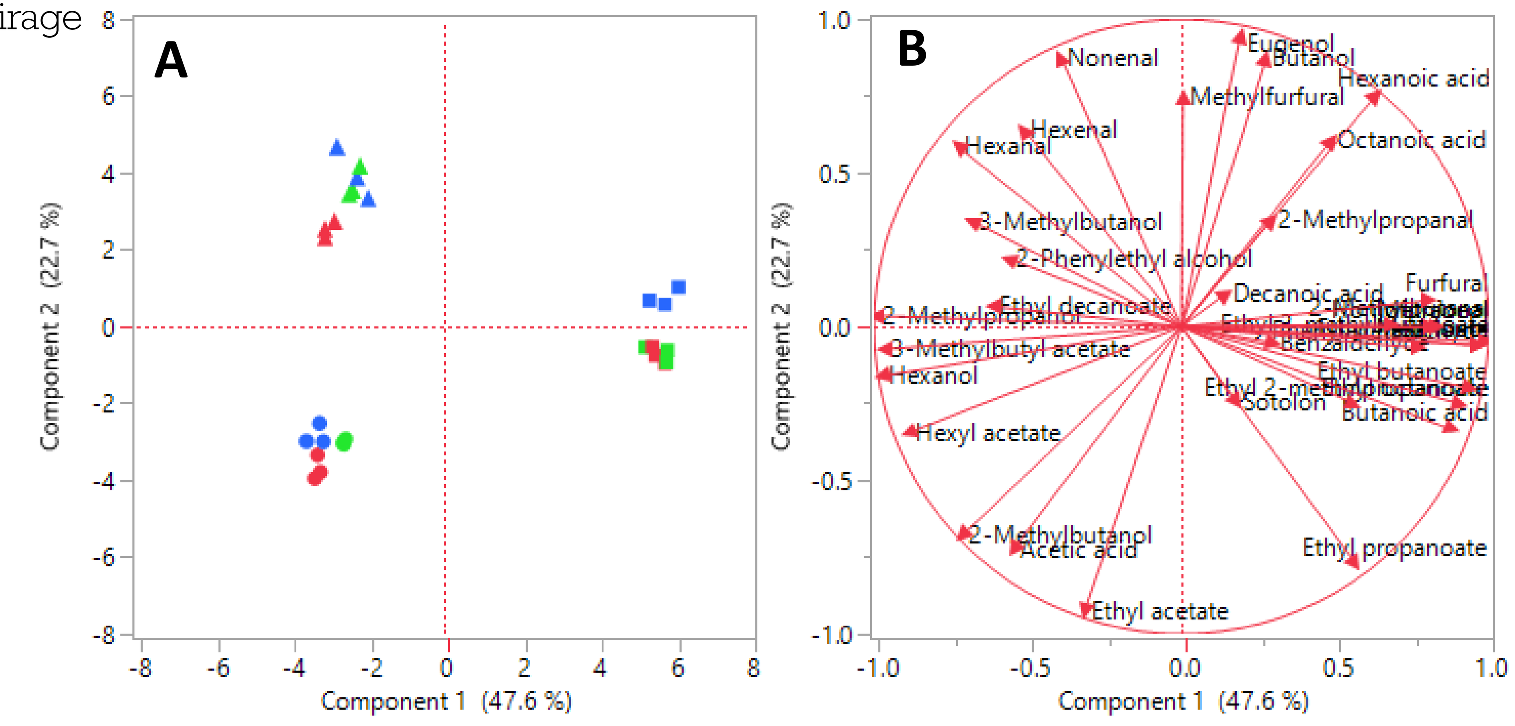


Figure 2. PCA of Pinot Noir wine volatile compounds.

Table 1. Statistically significant compounds (µg L^{-1}) in Chardonnay and Pinot Noir at 24 months ageing[1].

		Chardonnay			Pinot Noir					
	Compounds	Base no lees	Base + lees	Tirage	Base no lees	Base + lees	Tirage	Odour threshold[2]	Odour descriptor[2]	
Volatile fermentation products	3-Methylbutyl acetate	111^{A}	110^{A}	126^{B}	116^{AB}	120^{A}	108^{B}	30	Fruity (banana)	Acetate ester
	Hexanoic acid	NS	NS	NS	7500^{A}	8200^{AB}	7800^{B}	420	Sweaty	Fatty acids
	Octanoic acid	8600^{A}	7900^{A}	11100^{B}	8300^{A}	11300^{B}	8800^{A}	500	Sweaty, cheese	
	Decanoic acid	980^{A}	1080^{A}	2900^{B}	1000^{A}	2200^{B}	1100^{A}	1000	Rancid, fat	
	2-Methylpropanol	NS	NS	NS	18100^{A}	16800^{B}	17500^{AB}	40000	Solvent, wine, bitter	Higher alcohols
	3-Methylbutanol	127000^{A}	120000^{AB}	116000^{B}	126000^{A}	118000^{B}	125000^{AB}	30000	Whiskey, malt, burnt	
	2-Methylbutanol	30000^{A}	27000^{AB}	25000^{B}	26800^{AB}	25100^{A}	27300^{B}	1200	Malty, solvent-like	
	2-Phenylethyl alcohol	11100^{A}	10600^{AB}	9600^{B}	11000^{A}	9500^{B}	10900^{A}	14000	Honey, spice, rose, lilac	
	Ethyl acetate	16800^{A}	17300^{A}	13900^{B}	17700^{A}	14200^{B}	17300^{A}	12264	Ethereal, fruity	Ethyl esters
	Ethyl propanoate	66^{A}	64^{A}	57^{B}	67^{A}	59^{B}	66^{A}	45000	Ethereal, fruity, rum	
	Ethyl 2-methylpropanoate	68^{A}	66^{A}	53^{B}	69^{A}	56^{B}	58^{B}	15	Sweet, rubber	
	Ethyl butanoate	NS	NS	NS	346^{AB}	331^{A}	358^{B}	20	Fruity (apple)	
	Ethyl octanoate	1080^{AB}	1060^{A}	1200^{B}	NS	NS	NS	5	Fruity, fat, candlewax	
	Ethyl decanoate	122^{A}	123^{A}	316^{B}	NS	NS	NS	200	Fruity (grape)	
Oxidised compounds	Methionol	920^{A}	1170^{B}	1420^{C}	1130^{A}	1180^{A}	1420^{B}	1000	Cooked potato-like	Alcohols
	Eugenol	2.95^{A}	3.26^{B}	3.19^{B}	NS	NS	NS	6	Clove-like	
	Homofuraneol	1760^{A}	2940^{B}	4390^{C}	670^{A}	790^{A}	1860^{B}	10	Caramel	Furans
	Sotolon	NS	NS	NS	6.6^{A}	7.3^{A}	11.6^{B}	15	Curry, seasoning	
	Benzyaldehyde	13^{A}	40^{B}	16^{A}	NS	NS	NS	2000	Bitter almond-like	Aldehyde
	2-Methylpropanal	28.3^{A}	14.5^{B}	14.2^{B}	NS	NS	NS	6	Malty	Strecker aldehydes
	2-Methylbutanal	80^{A}	10^{B}	30^{AB}	72^{A}	33^{B}	27^{B}	1.5	Malty	
	Methional	17^{A}	3^{B}	4^{B}	8.9^{A}	5.6^{B}	2.9^{C}	0.5	Cooked potato-like	
	Phenylacetaldehyde	31^{A}	10^{B}	11^{B}	19.3^{A}	12.7^{B}	9.1^{C}	1	Honey, floral	

1 Colours are based on functional grouping and gradients denote relative concentration for a given compound at a particular timepoint. Means with different letters within a particular timepoint are significantly different (Tukey's HSD, $p < 0.05$). ☐ Above odour threshold but not significant between treatments (one-way ANOVA, $p > 0.05$) ☐ Below odour threshold

2 References: Bakker & Clarke 2012 Wine Flavour Chemistry. Wiley-Blackwell 2nd Ed. 183-218; Cameleyre et al. 2017 Food Chem 237:364-371; Czerny et al. 2008 Eur Food Res Technol 228:265-273; Francis & Newton 2005 Aust J Grape Wine Res 11:114-126; Guth 1997 J Agric Food Chem 45:3027-3032; Mayr et al. 2015 J Agric Food Chem 63:3394-3401

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