Why does this wine smell like apricots?

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Abstract

The compounds in white wine that give rise to varietal 'stone fruit' aroma characters are not well understood. Relating the compositional differences among wines to their sensory attributes can help uncover the cause of specific sensory differences. Viognier and Chardonnay wines with differing levels of 'stone fruit' character, ranging from low to high intensity, were characterised by sensory descriptive analysis and comprehensive quantitative chemical analysis. Several aroma compounds were positively associated with the 'apricot' aroma attribute notable in some of the Viognier wines, including γ-lactones, monoterpenes and aldehydes. Sensory reconstitution experiments verified that a mixture of three monoterpenes, linalool, geraniol and nerol, was the most important group for the model to be perceived as having an 'apricot' attribute.

Introduction

'Stone fruit' aroma attributes are important to many varieties of white wine, such as Chardonnay and Viognier. Some γ-lactones, monoterpenes and aldehydes have been reported as important aroma compounds in fresh stone fruits [1]. However, very little is known about the chemical basis of 'stone fruit' aromas in wine. Previous Chardonnay wine sensory studies have included a 'stone fruit' descriptor but these studies did not focus on wines with clear 'stone fruit' aroma attributes. Little has been reported about aroma compounds in Viognier wine. Multivariate statistical techniques can be used to find relationships between compositional differences among wines to their sensory attributes [2]. Using an appropriate set of wines, highlighting the sensory attribute of interest, is more likely to provide well modelled predictions of the aroma compounds responsible for that attribute and to help determine if sensory difference is due to variation in concentrations of aroma compounds, an absence/presence of certain aroma compounds or an additive effect of several aroma compounds. To confirm or dismiss these predictions, reconstitution, addition and omission experiments in a realistic model are required [3].

Experimental

Materials

A set of 18 commercially available wines (six wines each: Australian Chardonnay; Australian Viognier; and French Viognier) were selected by a small group of experienced wine tasters from 75 potential wines to encompass a wide range of 'stone fruit' intensities.

Sensory evaluation

Descriptive sensory analysis was carried out on the wines using similar methodology to Mayr et al. 2014 [4]. A sensory panel, consisting of 10 trained panellists, rated the intensity of sensory attributes of the wines in triplicate under controlled conditions.

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Analysis of the volatile compounds

Wines were characterised by comprehensive quantitative chemical analysis, targeting over 100 volatile aroma compounds using previously published methods [5-13] with stable isotope dilution analysis (SIDA-MS) and basic wine chemical composition.

Statistical analysis

Sensory panel performance was evaluated using Fizz, Senstools and PanelCheck software. Analysis of variance (ANOVA) was carried out using Minitab 17.1.0. Following ANOVA, Fisher's least significant difference (LSD) value was calculated ($P = 0.05$). The sensory attribute ratings were related to chemical composition by partial least squares regression (PLSR) using The Unscrambler X software.

Aroma reconstitution

Preliminary model reconstitutions were promising for 'apricot' but not for 'peach'. Therefore, only apricot was further investigated.

Addition and omission descriptive sensory studies were conducted in a wine-like base model wine: ethanol (13.3 %v/v), tartrate (2 g/L), glucose/fructose (2 g/L), glycerol (4.6 g/L), citric acid (0.4 g/L), malic acid (2.6 g/L), succinic acid (0.6 g/L), SO_2 (20 mg/L), pH 3.33 and food colouring. All models contained a mixture of 55 aroma compounds (mean concentrations of the 18 wines from the wine sensory study, Table 1). The aroma compounds predicted from the PLSR to be important to apricot were added as groups at the mean concentrations measured in the three wines with the highest intensity rating of apricot (Table 1). Sensory assessments were performed by a panel of eight in the same manner as for the wines, but only aroma attributes were assessed not palate.

Table 1: Volatile compounds included in Control model reconstitution and concentrations of compounds that were included in the reconstitution study for 'apricot' aroma

Compounds in Control model	*Addition to Control model*		*µg/L*
14 ethyl and acetate esters	Lactones	γ-nonalactone	5.9
5 alcohols		γ-decalactone	1.2
8 fatty acids		(Z)-6-dodeceno-γ-lactone	0.05
3 sulphur compounds	Monoterpenes	linalool	83
3-mercaptohexanol		geraniol	27
8 oak-derived volatiles		nerol	5.3
10 oxidation-related volatiles	Aldehydes	benzaldehyde	206
2,3-butanediol		(*E*)-2-hexenal	0.37
α-terpineol, β-damascenone		(*E*)-2-nonenal	1.8
γ-octa and γ-decalactone		(*E*)-2-hexenol	3.2
6-amyl-α-pyrone			

Results and discussion

Relationships between the sensory and chemical data

The sensory descriptive analysis data established that the selected 18 wines had distinct descriptors of stone fruit aroma attributes, 'apricot' (tinned apricots) and 'peach' (fresh white peach), with widely differing intensity ratings. Notably, the two stone fruit attributes were not closely correlated.

Of the 104 targeted wine aroma compounds, 79 were detectable and quantified in the 18 wines. The odour activity values (OAVs) of many of the aroma compounds were below 0.5. However, OAVs do not account for additive, synergic, antagonistic or perceptual interactions that might be occurring. Hence, all compositional measurements were used in the multivariate analysis.

From the PLSR analysis, several aroma compounds were positively associated with the 'apricot' aroma attribute notable in some of the Viognier wines (Figure 1). γ-Nonalactone, γ-decalactone and the previously little studied and potent aroma compound (Z)-6-dodeceno-γ-lactone were associated with the apricot sensory attribute, together with the monoterpenes linalool, geraniol and nerol, several aldehydes and (E)-2-hexenol. 3-Mercaptohexyl acetate and *trans*-ethyl cinnamate were negatively correlated. In contrast, other wine aroma studies have generally reported monoterpenes to imbue 'floral', 'citrus' and 'pine-like' characters [14]. The 'peach' aroma attribute was associated with a range of fermentation-derived ethyl and acetate esters, fatty acids and monoterpenes (Figure 1). However, the association with monoterpenes was strongly influenced by a few Viognier wines rated highly in both 'apricot' and 'peach', thus confounding the 'peach' reconstitution model.

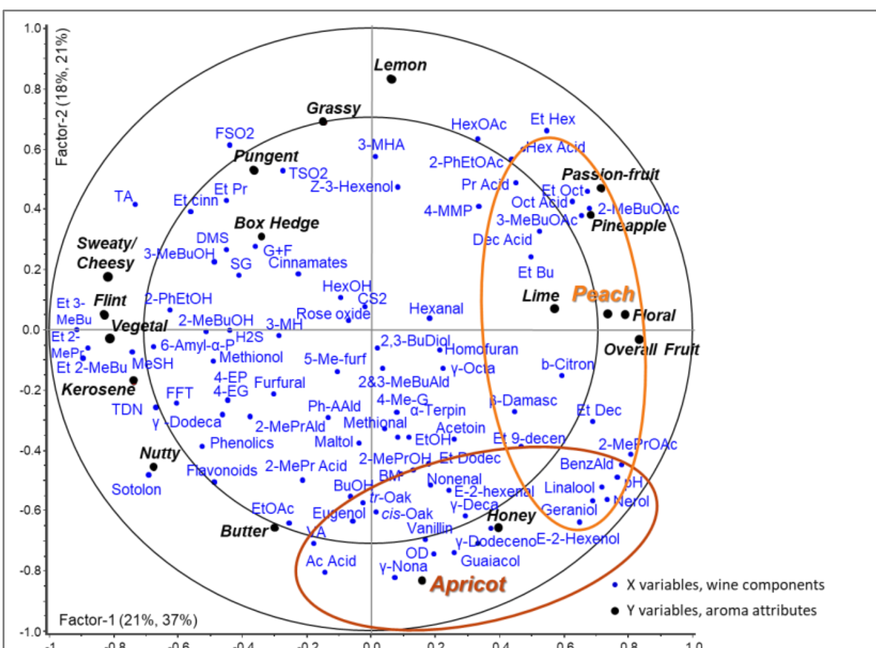

Figure 1: PLSR of chemical composition and sensory data loadings plot: volatile aroma compounds that explain apricot and peach aroma attributes.

Aroma reconstitution

All models containing the monoterpenes were rated higher in 'apricot' than the Control model (Figure 2). However, the lactones did not increase the intensity of 'apricot'. Aldehyde additions did not enhance 'apricot' scores (data not shown). 'Peach' aroma attribute intensities were not significantly different across the models.

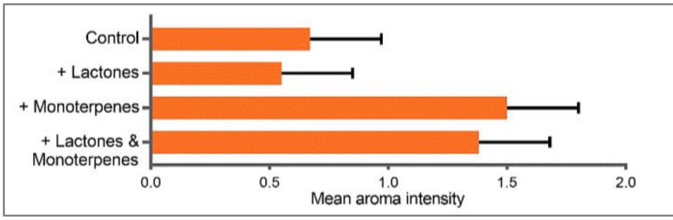

Figure 2: Mean ratings of 'apricot' aroma attribute in white wine reconstitution models. Compounds in the reconstitution models are listed in Table 1. Error bars are plus half LSD (P = 0.05).

'Tropical', 'confection/floral', and 'cardboard' aroma attribute intensities were significantly different across the models ($p < 0.05$) and the effects of the additions and omissions for these attributes were varied (data not shown). To our knowledge, this is the first time that this comprehensive approach has been used to identify the aroma compound(s) responsible for a particular wine aroma attribute from a set of wines specifically selected with that attribute. Subsequently, reconstitution studies confirmed that the mixture of the three monoterpenes linalool, geraniol and nerol, in the presence of ubiquitous wine compounds, was the most important group for the model to be perceived as having an 'apricot' attribute.

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