



Perceived minerality in sauvignon blanc wine: Chemical reality or cultural construct?



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ABSTRACT

The study aimed to determine the relationship between perceived mineral character in wine and wine chemical composition. We investigated the sensory properties and chemical composition of sauvignon blanc wines from two major sauvignon-producing countries, New Zealand and France. Sensory experiments employing 16 wines (8 French, 8 New Zealand) were conducted in Marlborough, New Zealand and in three regions of France, namely Bordeaux, Burgundy, and the Sancerre/Loire region. Wine professionals (31 New Zealanders and 32 French professionals) sensorially characterised the 16 wines under three conditions, bouquet only (ortho-nasal olfaction), palate only (nose clip condition), and full tasting (global condition: ortho-nasal olfaction, retronasal olfaction, taste, trigeminal stimulation). Sensory data from the global condition only are reported in this article. Physical and chemical analyses conducted on all wines included wine standard parameters, elemental composition, volatile aroma composition, and measures of organic acids. Major results demonstrate that (i) on average French and New Zealand wines were perceived similarly in intensity of mineral character, although judgments to individual wines differed as a function of participant culture; (ii) French and NZ participants drew on different information to make their sensory judgments; and (iii) several aspects of wine composition associated positively with perception of mineral character while others associated negatively, the significant associations differing as a function of participant culture.

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1. Introduction

Mineral characteristics are frequently reported when white wines are described sensorially (Ballester, Mihnea, Peyron, & Valentin, 2013; Heymann, Hopfer, & Bershaw, 2014; Parr, Ballester, Peyron, Grose, & Valentin, 2015). Despite this, our knowledge and understanding of the role played by a wine's composition in producing characteristics perceived as *mineral* remains limited. Combining both sensory and chemical data has become an established method for examining a range of wine phenomena including regional characterisation of wines (Green, Parr, Breitmeyer, Valentin, & Sherlock, 2011), perceived quality (Sáenz-Navajas et al., 2015), and influence of yeast (King et al., 2010). We aimed to combine sensory data from wine professionals of two diverse cultures (France, NZ) with chemical data to investigate the relation between wine composition and perception of mineral character in sauvignon blanc wines.

In previous articles, we reported sensory data concerning qualitative and quantitative aspects of perceived minerality in chardonnay wines (Ballester et al., 2013) and sauvignon blanc wines (Parr et al., 2015). The present study extends this work by investigating the sensorial reality of perceived minerality in wine from a wine-composition perspective. More specifically, we associate key aspects of the sensory data concerning the sauvignon wines described in Parr et al. (2015) with physical and chemical characteristics of the same sixteen wines to investigate which, if any, aspects of wine composition are potentially relevant to perception of mineral character in sauvignon wines. Analysing both sensory and chemical data together is essential to elucidating the nature of minerality in wine, as chemical data alone cannot predict how an experienced taster will evaluate a wine's character (Noble & Ebeler, 2002).

1.1. Potential sources of perceived mineral character in wine

1.1.1. Wine origin and elemental composition

Historically, wine origin has been an important factor when considering perceived minerality in wine, not least because of an assumed link

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between perception of mineral character in wine and aspects of vineyard *terroir* or grape provenance (see Maltman, 2013 for a review). A number of wine writers defend the literal definition of minerality, namely the sensory impact of elements such as salts (Vignon, Pillet, Kessler, Lhotellier, & Le Bras, 2012). However, Maltman (2013) propounded that there is no evidence for a direct link between minerals in a soil and elements in a wine. The current study does not purport to address this issue directly. On the other hand, we considered the issue indirectly in two ways. First, we investigated the relation between concentration of wine elements and perceived minerality to determine the relationship between elemental composition and wine flavour, including perception of mineral character (Yang, Duan, Du, Tian, & Pan, 2010). In doing this, we note that concentrations of Ca, Mg, K and other elements measured in the wines are as likely to have their source in oenological processing (e.g., deacidification; use of bentonite for fining) as in vineyard soil composition (Maltman, 2013). Our interest in the current study was in their influence on wine perception rather than their source. Second, we investigated the influence of wine origin, with sauvignon wines from French regions where the wines have a long history of being described in terms of stony or soil notes (e.g., “flinty”, “silex”, “chalky”, “wet stones”) by their producers compared with New Zealand sauvignons. The latter wines have historically been described as fruit-driven, with the interest in their perceived minerality a more recent fashion (Parr, Green, White, & Sherlock, 2007; Parr et al., 2015). Hence, we measured a suite of biologically relevant elements that may affect wine perceived attributes, either as a result of plant uptake (Tyler & Olsson, 2001) or oenological processing.

1.1.2. Acidity

Mineral character in wine, in particular in wines from cooler climates, is often associated with wine acidity (Coutier & Marchand, 2011; Ross, 2012) by wine writers and wine producers. To date, this remains a hypothesis in that data from the few studies that have investigated perception of minerality in wine in relation to wine acidity have produced equivocal results. Heymann et al. (2014) reported minerality to be positively correlated with acid taste, and with measures of malic acid, tartaric acid, and titratable acidity. On the other hand, Ballester et al. (2013) found one sub-group only of their participants to associate minerality with perceived acidity, and Parr et al. (2015) reported no association or an inverse association of perceived minerality with perceived sourness. One conceivable reason for the lack of consistency in previously reported data is that the relation between individual aspects of acidity such as pH and titratable acidity may be more relevant to perceived wine qualities than the individual components themselves. In the present study we explored how the quantitative relation between wine pH and titratable acidity (e.g., low pH and high TA, low pH and low TA) related to qualitative and quantitative aspects of perceived minerality in wines by employing an acidity index (Plane, Mattick, & Weirs, 1980) as a derived variable.

1.1.3. Association of minerality with sulphur compounds

Concurrent increased usage of the descriptor *mineral* and increased usage of anoxic bottle closures, in particular screw-cap closures, has not gone unnoticed by wine writers (e.g., Goode & Harrop, 2011). Various hypotheses have been put forward in wine industry media, often indirectly, to suggest that increased perception of minerality in wines bottled under closures other than cork could have its basis in factors related to sulphide reduction and/or the implication of odoriferous thiol compounds. We investigated wine compositional differences in the volatile sulphur compounds typically associated with the pungent aromas of perceived reduced character (e.g., hydrogen sulphide) with perception of mineral character in the wines. As with acidity, recent empirical results concerning this hypothesis are not definitive. Although Parr et al. (2015) found no association, Ballester et al. (2013) and Heymann et al. (2014) both reported sensory data demonstrating a positive relationship between reductive notes and perceived minerality. However, this

perceptual relationship was not confirmed conceptually with Ballester et al. (2013) and Le Fur and Gautier (2013) both reporting few citations of reductive or sulphur notes when wine experts provided linguistic data in the form of definitions of minerality.

Other sulphur compounds found in sauvignon wine, notably the varietal thiols, are generally considered to contribute positively to a wine's aroma (Darriet, Tominaga, Lavigne, Boidron, & Dubourdieu, 1995; Green et al., 2011; Tominaga, Furrer, Henry, & Dubourdieu, 1998). Further, several thiol compounds reported in sauvignon wine and in chardonnay wine have been linked with mineral notes in prior research. For example, Tominaga, Guimbertau and Dubourdieu (2003a, b) identified and assayed a thiol compound benzenemethanethiol (BMT), the descriptors of which are gun flint, in various wines including chardonnay, sauvignon blanc and sémillon, with wine tasters reporting empyreumatic, spicy and mineral characters in sauvignon blanc wines as BMT concentration increased (Tominaga, Baltenweck-Guyot, Peyrot des Gachons, & Dubourdieu, 2003). In their sensory study, Parr et al. (2015) reported that citrus and passion fruit, two characters often associated with 3-sulfanylhexan-1-ol (3MH) and 3-sulfanylhexyl acetate (3MHA), respectively, significantly contributed but in opposite ways to the perception of minerality in New Zealand sauvignon wines (Parr et al., 2015), with citrus a positive predictor and passion fruit a negative predictor of minerality. Hence, in the current study, we determined concentrations of varietal thiols in the wines including BMT and a fermentative thiol with reductive notes, ethyl-2 sulfanylacetate (E2MA) (Nikolantonaki & Darriet, 2011).

1.1.4. Absence of flavour in wine

The final hypothesis we considered concerns an association between perceived minerality in white wine and the sensory context created by relative absence of flavour in a wine, in particular, the absence of fruity characteristics (Goode, 2012). It has been hypothesised by some wine writers that a low intensity of varietal flavours (e.g., low concentrations of varietal thiols, esters, and/or methoxypyrazine compounds in sauvignon wine) may give rise to a sensory context where a wine is judged as *mineral* by a process of elimination, that is, merely because no other descriptor comes to mind. To investigate this notion, the current study related measures of perceived minerality with determination of concentrations of chemical compounds typically associated with the fruity and vegetal aspects of sauvignon blanc wines (Green et al., 2011).

1.2. Sauvignon blanc

Sauvignon blanc, *Vitis vinifera* L. var. sauvignon blanc, has been described as a variety presenting characteristic nuances from herbaceous characters associated with various alkyl 2-methoxypyrazines to more fruity nuances related to passion fruit, grapefruit and boxwood nuances associated largely to the presence of powerful varietal thiols. These latter compounds can evolve during wine aging to produce empyreumatic, smoked, flinty/stone nuances depending on vine provenance (Dubourdieu, Tominaga, Masneuf-Pomarede, Peyrot des Gachons, & Murat, 2006). The implicated chemical compounds, along with the sensory qualities of sauvignon wine, have been the subject of much research (e.g., Allen, Lacey, Harris, & Brown, 1991; Darriet et al., 1995; Tominaga et al., 1998; Parr et al., 2007; Parr, Valentin, Green, & Dacremont, 2010; King et al., 2010; Capone & Jeffery, 2011; Green et al., 2011; Pena-Gallego, Hernandez-Orte, Cacho, & Ferreira, 2012). For current purposes, sauvignon blanc is an ideal varietal upon which to investigate perceived minerality as a function of grape provenance. The major reason for this is that the classic variants from central France are frequently described in terms of mineral characteristics (Easton, 2009; Parr et al., 2010) whereas New Zealand sauvignon is judged typically as exhibiting intense fruity and vegetal characters rather than obvious minerality (e.g., Parr et al., 2007, 2010). Hence, in terms of our directional hypothesis linking wine flavour and perceived minerality,

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