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Sensory impact of skin contact on white wines characterized by descriptive analysis, time–intensity analysis and temporal dominance of sensations analysis

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ABSTRACT

In white wine fermentation, extended skin contact of crushed grapes is frequently used to increase the varietal aromas of white Riesling and Gewürztraminer wines. At the same time, phenolic compounds are extracted which can yield significant increases in bitterness and/or astringency. Descriptive analysis (DA), time–intensity analysis (TI) and temporal dominance of sensation (TDS) analysis were used to evaluate the changes in flavor of Riesling and Gewürztraminer wines made with varying skin contact times. DA showed that Riesling wines differed only in bitterness and color. In contrast, Gewürztraminer wines varied significantly in bitterness, sweetness, sourness, and astringency as well as for several aroma notes and color. 2009 and 2010 Gewürztraminer wines increased in intensity of honey/caramel, floral, and lemon aromas as well as yellow color, whereas peach/apricot was only significant in 2009 and apple and green grass/green banana only in 2010. Regarding the temporal properties of orally perceived modalities, bitterness TI curves recorded from Gewürztraminer differed significantly in maximum intensity and area under the curve, while Riesling showed no significant differences in any TI parameter. Increasing skin contact altered the dominance of orally perceived attributes. Fermenting the grapes completely on their skins produced a wine, which was significantly more bitter than all other wines according to TI and DA. However TDS analysis showed that the dominating sensation in this wine was not the bitter taste but the astringent mouth feel. TDS revealed further subtle differences caused by botrytized grape material, altering sourness and astringent perception.

Introduction

Improving wine quality

Sensory properties of wines are determined by grape variety and geographic heritage but to a large extent also by oenological treatments applied during grape processing and winemaking. To enhance varietal wine aroma in white wines, extended skin contact of grapes is often applied to facilitate a better extraction of skin constituents such as free and bound aroma compounds, which will enhance floral and fruity characters in subsequent wines and thus improve wine quality (Cabaroglu et al., 1997; Fischer, Trautmann, Binder, Wilke, & Göritz, 2001; Gómez-Míguez et al., 2007; Marais & Rapp, 1986; Palomo, Pérez-Coello, Díaz-Maroto, González Viñas, & Cabezudo 2006).

Benefits and drawbacks of skin maceration

While Gewürztraminer, Riesling, and Muscat varieties most likely benefit from skin contact due to a high amount of extractable aroma precursors in their skins, other varieties such as Chardonnay, Sauvignon Blanc or Airén benefit to a lesser extent. Wines may exhibit lower fruitiness or even negative spicy attributes masking varietal characters (Cejudo-Bastante, Castro-Vázquez, Hermosín-Gutiérrez, & Pérez-Coello, 2011; Marais, 1998; Marais & Rapp, 1986; Test, Noble, & Schmidt, 1986). Furthermore, the impact of skin contact on wine quality also depends on grape processing variables such as contact time, storing temperature, addition of sulfur dioxide (SO_2) or use of pectolytic enzymes (Arnold & Noble, 1979; Cheynier, Rigaud, Souquet, Barillère, & Moutounet, 1989; Hernanz et al., 2007; Marais & Rapp, 1986; Ough, 1969; Ramey, Bertrand, Ough, Singleton, & Sanders, 1986; Reynolds, Wardle, & Dever, 1993). This is mostly rationalized by the concurrent extraction of potassium and polyphenols from

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grape skins and seeds, which both affect sensory properties of wine.

Extended up-take of potassium enhances potassium bi-tartrate precipitation and thus reduces tartaric acid concentration. As a consequence, titratable acidity drops, pH increases, and perceived sourness is diminished (Boulton, 1980; Ough, 1969; Palomo et al., 2006; Ricardo-da-Silva, Cheynier, Samsom, & Bourzeix 1993). Extensive focus was directed towards the extraction of phenols during skin contact of white grapes. While concentrations of the skin and seed derived flavonoids catechin and epi-catechin increased, the flesh derived non-flavonoids, such as caftaric acid, were affected much less (Arnold & Noble, 1979; Cejudo-Bastante et al., 2011; Cheynier et al., 1989; Fuleki & Ricardo-da-Silva, 2002; Gómez-Míguez et al., 2007; Hernanz et al., 2007; Ramey et al., 1986). Some authors welcome the enrichment of total phenols due to their anticipated health benefits (Darias-Martın, Rodrıguez, Dıaz, & Lamuela-Raventós, 2000; Fuhrman, Volkova, Suraski, & Aviram, 2001) while other point out the negative impact caused by enhanced bitterness and astringency (Arnold & Noble, 1978).

Impact of skin contact on taste properties

Chardonnay wines varying in skin contact treatments between 0 and 24 h exhibited no significant differences in bitterness and astringency based on pair-wise comparison tests (Test et al., 1986) or descriptive analysis (Arnold & Noble, 1979). In both cases, authors assumed that an increase of 110 mg/L total phenols (expressed as gallic acid equivalents, GAE) was too marginal to cause linear differences in bitterness or astringency. However, according to Singleton, Zaya, and Trousdale (1980), bitterness was rated significantly higher in a Chardonnay wine made with a skin contact period of 24 h, presumably due to a larger increase in total phenols, while the same treatment exhibited no effect for French Colombard or Chenin Blanc. After skin fermentation of a white wine, total phenols rose more than 200 mg/L GAE, which enhanced astringency and, to a smaller extent, bitterness (Singleton, Sieberhagen, De Wet, & Van Wyk, 1975).

It is surprising that no study has thus far investigated the modulation of temporal perceptions in wine due to skin contact. Noticeable bitterness in white wine has a negative connotation among consumers, partially due to its lingering taste which frequently dominates the aftertaste of the particular wine. The objective of this study is thus to apply sensory techniques to determine the temporal evolution of taste attributes for wines prepared with varying skin contact treatments.

Time related sensory methods

Oral perceptions such as bitterness and astringency are commonly evaluated in a static mode when applying descriptive sensory analysis (DA). To gain further temporal information about the sensory impact of polyphenols, time–intensity analysis (TI) was the method of choice for decades (Brossaud, Cheynier, & Noble, 2001; Fischer, Boulton, & Noble, 1994; Peleg, Gacon, Schlich, & Noble, 1999). However, if more than one attribute has to be studied, TI is a rather time-consuming technique as only one attribute is commonly evaluated at a time (Cliff & Heymann, 1993). Furthermore, TI analysis bears the risk of bias due to halo-dumping effects (Clark & Lawless, 1994). To circumvent this limitation, TDS was developed. TDS records, over time, which attribute is currently viewed as the dominant one by the panel and judges make the choice from a given list of orally perceived traits (Labbe, Schlich, Pineau, Gilbert, & Martin, 2009; Meillon, Urbano, & Schlich, 2009; Pineau et al., 2009). In contrast to TI analysis where one sole attribute is assessed, TDS monitors all oral perceptions parallel. Thus, TDS curves are also accounting for interactions among taste properties (Le Révérend, Hidrio, Fernandes, & Aubry, 2008). Applying DA, TI and TDS to the same set of wines, it could be further demonstrated that each of the methods provided unique information regarding the temporal perception of bitterness and its interaction with major wine constituents such as ethanol and sugar (Sokolowsky & Fischer, 2012).

The objective of this study is to (1) evaluate the sensory impact of commonly used skin contact on two cool climate varieties namely, Riesling and Gewürztraminer, by applying DA, TI and TDS analyses to the same set of wines, (2) to correlate wine composition with orally perceived intensities recorded by DA and parameters extracted from TI and TDS curves and (3) to investigate which complementary knowledge could be gained by each applied sensory technique.

Material and methods

Participants

Panelists for the sensory evaluation of the wines were selected based on interest, availability and prior experience in sensory analysis of wine. The panels for descriptive analysis (DA) of the experimental wines consisted of 16 judges for the 2009 vintage and 17 judges for the 2010 vintage (see Table 1). Nine of the 17 judges on the 2010 panel were also judges on the 2009 panel. After completion of the DA tasks for both vintages, a subset of the panels participated in the TDS analysis. TI analysis of bitterness in wines of vintage 2010 followed the TDS analysis in order to avoid bias for bitterness during the TDS analysis due to the explicit focus on bitterness during TI analysis. The panel for TI analysis was identical to the one used for the TDS analysis, except for one female judge that was excluded. Thus, all judges participating in TI analysis have already had the experience of preceding TDS and DA analysis of the same 2010 wines.

Wines

All experimental wines from both vintages are listed in Table 2 including the applied treatments and their varying skin contact time. Identical sound grape material was used for each variety, which was hand-harvested from vineyards of the Staatsweingut Neustadt located in the Pfalz viticultural region in Germany. In 2009, Gewürztraminer was harvested at a high ripeness level (104 Oechsle/25 Brix) while the grapes from the cooler 2010 vintage had less sugar (87 Oechsle/21 Brix) and more acidity (see Table 7). Riesling was only included in the 2010 vintage (95 Oechsle/23 Brix). All grapes were destemmed, except for the whole cluster treatment. Skin contact was realized in replicates for each maceration time at 15 °C. To prevent microbial spoilage, SO_2 was added (50 mg/L). To enhance the release of aroma precursors from berry skins and to accelerate juice clarification after pressing, two pectolytic enzymes were added at 2 mg/kg (Lallzym HC, Lallemand Inc., Rexdale, Canada and SIHA Panzym Claire rapid, E. Begerow GmbH & Co., Langenlohnsheim, Germany). In 2010, additional treatments included the incorporation of 30% grape material which was infected with the grey rot fungus, *Botrytis cinerea* and a complete fermentation of the crushed grapes on the skins, similar to red wine making. Conditions for pressing, clarification and fermentation (yeast strain Lalvin R-HST Riesling Heiligenstein, Lallemand Inc., Montreal) were kept identical for each treatment and vintage. Two weeks after completion of fermentation, wines were separated from the lees and SO_2 (100 mg/L) and ascorbic acid (150 mg/L) were added. Fermentation replicates were kept separate.