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Pre-fermentation fining effects on the aroma chemistry of Marlborough Sauvignon blanc press fractions

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ABSTRACT

In the wine industry, fining agents are commonly used with many choices now commercially available. Here the influence of pre-fermentation fining on wine aroma chemistry has been explored. Free run and press fraction Sauvignon blanc juices from two vineyards were fined using gelatin, activated carbon, polyvinylpolypyrrolidone (PVPP) and a combination agent which included bentonite, PVPP and isinglass. Over thirty aroma compounds were quantified in the experimental wines. Results showed that activated carbon fining led to a significant ($p < 0.05$) concentration decrease of hexan-1-ol and linalool in the experimental wines when compared to a control, consistent across all vineyard and fraction combinations. Other aroma compounds were also influenced by fining agent, even if vineyards and press fractions played a crucial role. This study confirmed that fining agents used pre-fermentation can influence wine aroma profiles and therefore needs specific tailoring addressing style and origin of grape.

1. Introduction

Marlborough Sauvignon blanc is the key player in the New Zealand wine industry, exhibiting tropical passionfruit aromas as well as greener tones such as capsicum and fresh cut grass. Generally, free run juice can produce wines with more vibrant and fresh aromas, palates and colour, while heavy press cuts often lead to a lack of varietal aromas, display harsher phenolic profiles and oxidation-dependent brown hues. During winemaking, it is common practice to introduce fining agents that can aid in the removal of suspended solids and hereby improving juice clarity, stability, palate or colour (Ribereau-Gayon, Glories, Maujean, & Dubourdieu, 2001). Currently there are a wide array of fining agents available to the industry including those deriving from plant, animal, synthetic and inorganic sources (Marchal & Jeandet, 2009).

Activated carbon is a commonly used fining agent. Its adsorptive properties have been shown to decrease the amount of pesticides (Sen, Cabaroglu, & Yilmaz, 2012), ochratoxin A (Sierka, 2013), and volatile smoke taint (Fudge, Schiettecatte, Ristic, Hayasaka, & Wilkinson, 2012), in wine. Gelatin is an animal protein which is mainly comprised of glycine, proline, hydroxyproline and glutamic acid which is used to aid the removal of excess tannins (Ribereau-Gayon et al., 2001), decrease proanthocyanidin concentrations in the red wine Tannat (González-Neves, Favre, & Gil, 2014), and anthocyanin concentrations in Vinhão as well as colour density (Castillo-Sánchez, Mejuto, Garrido, & García-Falcón, 2006).

Polyvinylpolypyrrolidone, also known as PVPP, is a synthetic fining agent in the form of a cross linked, resinous polymer that functions like a protein when binding to tannins (Jackson, 2000; Marchal and Jeandet, 2009). Selective hydrogen bonding of flavonols and mono-dimeric phenolics make this agent particularly useful for the removal of bitterness and astringency from wine (Jackson, 2000; Terrier, Poncet-Legrand, & Cheynier, 2009). A study

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using an addition rate of 1.0 g/L PVPP found that pre-fermentation treatment gave no significant sensory differences during triangle tests whereas a post-fermentation addition did (Sims, Eastridge, & Bates, 1995).

Bentonite is another popular fining agent which consists of montmorillonite clay that swells in water to produce a sheet like structure on which cation exchange, hydrogen bonding and adsorption can occur (Jackson, 2000; Marchal and Jeandet, 2009). At an addition rate of 80 g/hL bentonite to Falanghina grape must no significant influences of the must concentrations of linalool, α-terpineol and others were seen (Moio, Ugliano, Gambuti, Genovese, & Piombino, 2004). The addition of bentonite to Albariño must has been shown to deminish the collective presence of terpenes, C_{13}-norisoprenoids and C_6 alcohols with pre-fermentative fining at a rate of 60 g/hL (Armada & Falqué, 2007). Furthermore, a study using a slightly higher dosage of 100 g/hL experienced decreases in the amount of glycosidically bound monoterpenes with bentonite addition to Chambave Muscat grape must (Lambri, Dordoni, Silva, & De Faveri, 2012). Another recent study from the same group highlighted the mechanisms involved in the removal of aroma compounds during bentonite fining; this evidence could shed some light on the impact of this adjuvant on some classes of aroma compounds (Lambri, Dordoni, Silva, & De Faveri, 2013).

Another classic choice of fining agent in the wine industry is isinglass which is made from the dried air bladders of certain fish (Jackson, 2000; Marchal and Jeandet, 2009; Ribereau-Gayon et al., 2001), with a jelly form of the product derived from fish cannery waste (Ribereau-Gayon et al., 2001). Isinglass can be used to improve wine aroma and clarity, in particular with white still and sparkling wines, and at the same time is less prone to overfining (Jackson, 2000; Marchal and Jeandet, 2009). One study found that fining Chardonnay wine with 60 mg/L isinglass resutled in a wine which differed to the control for the sensory attribute floral/honey (Sanborn, Edwards, & Ross, 2010). Different molecular weight isinglasses have been seen to influence wine, with one study showing higher molecular weight isinglass can decrease monomeric flavanols while lower molecular weight isinglass can decrease the amount of oligomeric flavanols in wine, when compared to controls (Cosme, Ricardo-da-Silva, & Laureano, 2008).

Overall there are many fining agents available for use in the wine industry, with each seeming to have their own advantages and limitations. Although various studies regarding the use of fining agents have already been conducted, many of these are on wine and focus on the influence of treatment on polyphenol contents, with only a few papers available related to wine aroma. Some winemakers may choose to keep free run and press fractions separate during juice intake; this provides an opportune time to employ a specifically tailored (*i.e.* lighter or harder) fining regime based on differing phenolic profiles. Anecdotally, winemakers tell us that they aim to carry out most of the prospective fining at the juice stage. This leaves room for some fine tuning after the wine has been blended, and grants minimal interference at the wine stage. For this reason, this research aims to describe the influence of pre-fermentation fining agent addition on various wine aromas. To the best of our knowledge this is the first time that indepth aroma studies have been conducted on the influence of fining press fraction juices with particular reference to Marlborough Sauvignon blanc.

2. Materials and methods

2.1. Chemicals and fining agents

Fining agents used were gelatin from Laffort (Bordeaux, France), activated carbon from Erbslöh (Geisenheim, Germany), PVPP from International Speciality Products (Wayne, NJ) and a mixed agent consisting of bentonite, PVPP and isinglass from Laffort (Bordeaux, France). For the winemaking process, the EC-1118 yeast strain came from Lalvin (Ontario, Canada), Dynastart® and Nutristart® (both food grade) came from Laffort (Bordeaux, France), potassium metabisulfite from Enartis E® (Trecate, Italy) and Clinitest™ tablets from Bayer Healthcare LLC (Tarrytown, NY). Sodium hydroxide, anhydrous sodium sulfate and sodium chloride were all reagent grade with purity of 98.5% or higher from Scharlau (Barcelona, Spain), as was the methanol (HPLC grade). AnalaR, Normapure (Lutterworth, United Kingdom) supplied hydrochloric acid (HPLC grade). Ethyl propiolate (99%) and butylated hydroxyanisole (reagent grade) were supplied by Sigma Aldrich (Castle Hill, NSW, Australia). Absolute ethanol, ACS grade, was supplied by ECP Ltd (Auckland, New Zealand while the dichloromethane for gas chromatography was supplied by Suprasolv®, Merck (Darmstadt, Germany). Solvents used to rinse the syringe between injections during the analysis of volatile thiols were hexane (95%) from Merck (Darmstadt, Germany) and isopropanol (HPLC grade) from Unichrom, Ajax Finechem, (Newmarket, New Zealand). The SPE cartridge used was a Supelclean™ ENVI-18 supplied by Supelco (Castle Hill, NSW, Australia).

Synthesised at the University of Auckland (Hebditch, Nicolau, & Brimble, 2007) were the internal standards d_2-3MH and d_2-3MHA. Unlabelled standards, 3-mercaptohexyl acetate (98%) and 3-mercapto-1-hexanol (98%) were supplied by Oxford Chemicals (Hartlepool, United Kingdom) and Acros Organics (Morris Plains, NJ), respectively. D_3-3-isobutly-2-methoxypyrazine supplied by CDN Isotopes (Quebec, Canada) and 2-isobutyl-3-methoxypyrazine (99%) from Aldrich (Sheboygan Falls, WI). Standard compounds used in the methoxypyrazine analysis included d_3-3-isobutly-2-methoxypyrazine supplied by CDN Isotopes (Quebec, Canada) and 2-isobutyl-3-methoxypyrazine (99%) from Aldrich (Sheboygan Falls, WI).

For the quantification of other volatiles listed non-deuterated internal standards used included DL-3-octanol (99%) supplied by Acros Organics (Morris Plains, NJ), 4-decanol (98%) supplied by Lancaster (Pelham, NH) and 3,4-dimethlyphenol (99%) supplied by Aldrich (Sheboygan Falls, WI). The remaining deuterated internal standards: d_3-2-phenylethyl acetate, d_5-2-phenyl alcohol, d_{12}-hexanal, d_3-3-methylbutyl acetate, d_3-n-hexyl acetate, d_{11}-ethyl hexanoate, d_3-ethyl butyrate, d_{15}-ethyl octanoate, d_{11}-n-hexyl alcohol, d_2-3-methyl-1-butyl alcohol and d_3-linalool were supplied by CDN Isotopes with purity $\geqslant$98% (Quebec, Canada). A Barnstead Nanopure Diamond™ (ThermoFisher Scientific, Waltham, MA) with resistivity at 17.1 MΩ nm was used to supply all ultra-pure water. BOC Gases NZ Ltd (Blenheim/Auckland, New Zealand) supplied the dry ice (food grade) and carbon dioxide (food grade) used during the winemaking process as well as the nitrogen, argon (both industrial grade) and helium (instrument grade) used during the instrumental analyses.

2.2. Grape harvest and winery processing

Two vineyards from Marlborough New Zealand were used for this study. One vineyard in the Awatere valley (A) and the other in the Wairau valley (B) were machine harvested on the 11/04/13 and the 12/04/13, respectively. During harvest, the grapes received approximately 60 g/t of potassium metabisulfite (PMS) in solution to help protect against oxidation during transportation. At the winery the grapes were destemmed/crushed (Vaslin Bucher Delta E8; Chalonnes-sur-Loire, France), and then pressed using Bucher 350 Xpert pneumatic presses (Chalonnes-sur-Loire, France). The press programme used a range of pressures, rotations and holding times with a maximum pressure of 1.8 bar.