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Influence of harvesting technique and maceration process on aroma and phenolic attributes of Sauvignon blanc wine

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ABSTRACT

Sauvignon blanc wines are characterised by their varietal aromas and low phenolic content. Mechanical harvesting has been shown to increase several varietal aromas. Likewise, maceration techniques have produced increases in phenolic content and antioxidant activity, but these can also alter tactile attributes and sensory profiles. Mechanical harvesting and cryogenic maceration were used in combination to produce a Sauvignon blanc wine with increased phenolic content and antioxidant activity, while showing a similar sensory profile to control wines.

Phenolic profiles of the wines showed differences between the harvesting and maceration techniques. Mechanical harvesting contributed to decreases in phenolics through reaction with oxidative radicals. Cryogenic maceration increased phenolics and antioxidant activity. Cryogenic maceration also increased the levels of several varietal aromas, for Sauvignon blanc wines made from both hand-picked and from machine-harvested fruit. Furthermore, cryogenic treatment of hand-picked fruit increased varietal thiols to levels similar to machine-harvested control wines.

1. Introduction

Wines are complex mixtures of chemical compounds that provide characteristic physical and sensory attributes. These compounds interact with receptors and chemicals in the body to produce the observed attributes (Thorngate, 1997). Compounds of particular interest are those associated with antioxidant and potential health benefits and those eliciting characteristic aromas and mouthfeel. Increasing these compounds will allow for wines that maintain quality while producing desired antioxidant benefits.

The phenolic compounds found in wine have been shown to provide antioxidant, antibacterial and antimicrobial activity, thereby being of interest to consumers for potential health benefits (Xia et al., 2014). These beneficial compounds are found in greater quantities in red wines, but are also present in white wines. It would therefore be useful to increase these compounds in white wines. The most common way to increase phenolics is to alter the maceration technique used in wine production. However, not all maceration techniques are applicable to the production of white wines or are only applicable to certain varietals. In a previous study comparing Sauvignon blanc prepared under various maceration techniques it was shown that wines prepared by cryogenic maceration showed significant increases in phenolics and antioxidant activity over control wines (Olejar, Fedrizzi, & Kilmartin, 2015). In addition to the increased phenolics, a sensory panel reported aromas similar to those of controls. Baiano et al. (2012) found similar results of increased antioxidant activity between cryogenic macerated and control Sauvignon blanc wines.

Increasing phenolics can alter the tactile sensory attributes of a wine (Harbertson, Parpinello, Heymann, & Downey, 2012). Some of these attribute changes are not desirable in white wines and have led to more limited application of certain maceration techniques to white wines. The altered tactile sensory attributes caused by increased phenolics can be buffered by the increases of other compounds found in conjunction (Gawel, Schulkin, Smith, & Waters, 2014), but care must be taken to achieve a balance between all of the attributes. Allen et al. (2011) and Herbst-Johnstone et al. (2013) showed that the harvesting of Sauvignon blanc by machine harvester can increase certain varietal aroma compounds. The ability to increase the aroma compounds during the harvesting process provides an opportunity to alter maceration techniques to enhance the antioxidant activity of the wine.

Based on the earlier maceration trials of Olejar et al. (2015), the current study investigates differences between Sauvignon blanc wines made from hand-picked (HP) and machine-harvested (MH)

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wines prepared by cryogenic maceration (CR) for increased antioxidant activity and the maintenance of aroma compounds.

2. Materials and methods

2.1. Chemicals

Carbon dioxide, nitrogen, helium and argon gas and dry ice were provided by BOC (Auckland, NZ). Phenolic standards, Folin–Ciocalteu reagent, 6-hydroxy-2.5.7.8-tetramethylchromane-2-caboxylic acid (Trolox), 2,2′-diphenyl-1-picryhydrazyl (DPPH), butylated hydroxyanisole (BHA), sodium chloride, sodium hydroxide, *n*-alkane linear retention standards, and ethyl propiolate (ETP) were obtained from Sigma-Aldrich (St. Louis, MO). Methanol, ethanol, acetonitrile, monosodium and disodium phosphate were obtained from Scharlau (Sentmenat, Spain). Ortho-phosphoric acid was purchased from Ajax Finechem Pty, Ltd (Sydney, Australia). 18-Ohm water was produced with a Barnsted Nanopure water system (Thermo Scientific, Waltham, MA). 3-Mercapto-1-hexanol (3MH) and 2-methoxy-3-isobutylpyrzine (MIBP) came from Acros Organics (Geel, Belgium), and 3-mercaptohexyl acetate (3MHA) from Oxford Chemicals (Seaton Carew, UK). Thiol internal standards d_2-3-mercapto-1-hexanol (d_2-3MH) and d_2-3-mercaptohexyl acetate (d_2-3MHA) were synthesised at The University of Auckland (Hebditch, Nicolau, & Brimble, 2007). Seven deuterated compounds for use as internal standards were supplied by CDN Isotopes (Quebec Canada), namely d_5-ethyl butanoate, d_2-3-methyl-1-butyl alcohol, d_3-3-methylbutyl acetate, d_{11}-n-hexyl alcohol, d_3-n-hexyl acetate, d_3-β-phenylethyl acetate, d_5-β-phenylethanol. Hexanol, (*Z*)-3-hexen-1-ol and (*Z*)-3-hexenyl acetate were sourced from Fluka, Aldrich and SAFC (Castle Hill, NSW, Australia), respectively, while hexyl acetate came from Acros Organics (Geel, Belgium). Potassium metabisulfite was purchased from Enartis (Trecate, Italy).

2.2. Juice preparation

Vitis vinifera var. Sauvignon blanc grapes, clone UCD 01 were sourced from the Marlborough region of New Zealand during the morning hours, 0900–1000. 125 kg of grapes were handpicked and divided into two groups; hand-picked control, HPC and hand-picked cryogenic, HPCR. Grapes were destemmed and crushed by hand with 62.5 kg being pressed for HPC and 62.5 kg being divided into three 20 L, food grade, polypropylene buckets of dimensions 27.0 cm radius × 38.0 cm in height. Dry ice was added prior to addition of must and again when 10 L of must were added to bring the temperature at approximately 10 cm of depth to −20 °C. Utilising a stainless steel punch-down tool, the must was manually mixed as dry ice was added to facilitate equal distribution. Upon reaching −20 °C, the must was then allowed to thaw over a 24-h period to 15 °C in ambient winery temperatures ranging from 15 to 20 °C. Upon thawing the musts were pressed in an 80-L hydraulic press (Zambelli Enotech, Camisano, Italy). Grapes not undergoing cryogenic maceration were immediately pressed.

An additional 125 kg of must were obtained from a mechanical harvester, operating on the same rows shortly afterwards. Must was obtained from the gondola prior to transport to the winery. The must was divided in two, with half being pressed (MHC) and half being frozen with dry ice as previously described (MHCR).

Following collection of the free-run juice, pressing of the must occurred with 2 cycles of 15 min at a pressure of 3 bar. The pomace was decompacted between cycles. The musts yielded an average of 56% juice and had 50 ppm SO_2 added prior to overnight shipment at 4 °C to The University of Auckland Wine Hall. The juices were cold settled overnight and divided into triplicate 10-L glass demijohns for fermentation.

2.3. Wine preparation

Juices were cold settled at −4 °C overnight prior to racking, prefermative analysis and fermentation with *Saccharomyces bayanus*, EC-1118 yeast (Lalvin, Montreal, Canada) at 15 °C. The 10 L experimental ferments were monitored by daily weighing until a constant weight was obtained for three consecutive days, at which time °Brix was obtained and sugar was monitored by Clinitest tablets (Bayer, Pymble, Australia) to ensure complete fermentation. Following alcoholic fermentation the wines were placed at −4 °C to cold settle and cold stabilise. After 48 h, the wines were transferred off the heavy lees and allowed to continue settling for an additional 21 days. Once clear the wines had 30 ppm SO_2 added, and were bottled in 750-mL green glass screw-cap bottles and stored at 4 °C until sensory analysis.

2.4. Conventional analysis

Sugar content (°Brix) was determined by using hydrometer. Total acidity (TA), volatile acidity (VA), and ethanol content (%v/v) were performed on a WineScan (FOSS, Hillerød, Denmark). pH was measured utilising a Thermo Orion 420 A+ pH metre (ThermoFisher Scientific, Waltham, MA). Wine tristimulus colour was obtained by full spectrum scanning from 280 to 780 nm at 5-nm increments using a Shimadzu, UV-1700 spectrophotometer (Kyoto, Japan), followed by integration utilising the method set forth in the *Compendium of International Methods of Wine and Must Analysis* (OIV, 2014). Wine samples were placed into 10-mm glass cuvettes and spectra obtained in the transmittance mode. Values for L^*, a^*, and b^* were obtained through integration and the tables provided within the reference literature.

2.5. Antioxidant and phenolic profiles

Antioxidant activity was determined using the DPPH radical-scavenging assay described by Villano, Fernandez-Pachon, Moya, Troncoso, and Garcia-Parrilla (2007). A 63 μM DPPH solution was prepared with 80% methanol. To 3.9 mL of the DPPH solution, 0.1 mL of wine or Trolox standard were added. The mixture was placed at room temperature, shielded from light, for 60 min. Analysis of the samples was performed at 515 nm.

Total phenolic content was established by the Folin–Ciocalteu assay, as described by Bajčan, Harangozo, Hrabovská, and Bončíková (2013). In a 50 mL volumetric flask, 1.0 mL of wine or gallic acid standard and 5.0 mL of 18 Ohm water were added. To this 0.25 mL of Folin–Ciocalteu reagent and 3.0 mL of 20% sodium carbonate were added. The flasks were brought to volume with distilled water and placed at room temperature, shielded from light for 90 min. The sample absorbance was then measured at 765 nm.

Phenolic compounds were determined by HPLC using the method described by Olejar et al. (2015). Wine and standard solutions were filtered through 0.2-μm syringe filter and 20 μL of the filtrate were injected into an Agilent 1100 HPLC with UV/Vis detector (Santa Clara, CA) and an ESA Coulochem III electrochemical detector (Waltham, MA). Chromatography occurred at 1.0 mL/min over 30 min at 40 °C on a 3.0 × 100 mm, 3 μm, Supelco Ascentis RP-amide column (Bellefonte, PA). Analyte separation was performed using a gradient elution of mobile phase **A**: 30 mmol phosphate buffer at pH 2.6, and mobile phase **B**: a mix (30:10:60) of 100 mmol phosphate buffer, methanol, and acetonitrile at pH 2.6. The gradient was 0–10 min 12% **B**, 10–15 min 30% **B**, 15–17.5 min 55% **B**, 17.5-21 min 55% **B**, 21–23 min 100% **B**, and 23–25 min 0% **B**. Detection of analytes was done at 280, 305, 320 and 365 nm, as well as at 450 and 750 mV.