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Apple variety and maturity profiling of base ciders using UV spectroscopy

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ABSTRACT

Varietal base ciders were produced from three varieties of dessert apples ('Pink Lady®', 'Royal Gala' and 'Red Delicious') at pre-commercial, commercial and post-commercial harvest timings. Rapid analytical methods were used to categorise the base ciders, and data analysed using principal component analysis (PCA). The titratable acidity of apple must was significantly higher for the pre-commercial harvest fruit for both the 'Royal Gala' and 'Red Delicious' varieties. The base cider phenolic content was highest in the pre-commercial harvest fruit for all varieties. 'Red Delicious' had the highest total phenolics as determined by spectral analysis and supported by the classification provided by the PCA analysis. The spectral fingerprints of the ciders showed two main peaks at approximately 280 nm and 320 nm indicating phenolic concentrations. Studies analysing characteristics of dessert apple varieties with relevance for cider production will allow for informed decision making for both apple producers and cider makers.

1. Introduction

In the last decade the global cider industry has demonstrated staggered but steady growth and faces a forecast for a steeper positive trajectory. Largely contributing to this is a major increase in boutique cideries in regions that produce large volumes of apples and an increased demand from consumers for a beverage of a lower alcohol content. Apple variety and fruit maturity have a significant effect on the final cider product as it has been demonstrated that the physical and chemical properties of apples vary considerably between varieties (Johnston, Hewett, Banks, Harker, & Hertog, 2001; Watkins, Ferree, & Warrington, 2003; Yahia, 1994). Additionally, there are significant differences in the concentration and composition of secondary plant metabolites between different varieties, rendering certain varieties more suitable for cider production than others (Thielen et al., 2006; Wu et al., 2007). The bittersweet apple varieties are the most important for contributing the bitterness and astringency that characterises traditional ciders (Proulx & Nichols, 2003). Higher acid and polyphenolic content is desirable as it improves the organoleptic quality of the cider (Alonso-Salces et al., 2006; Cline, Neilsen, Hogue, Kuchta, & Neilsen, 2011; Downing, 1989).

Traditionally, cider makers have a preference for specific cider apple varieties but these are often in limited supply. Instead, cider producers make use of dessert apple varieties creating blends to obtain the correct balance of the cider and for ease of fermentation (Joshi & Sharma, 2009). Blends of several varieties are often required to develop a cider with the suitable acidity, aroma, colour and tannins (Bates, Morris, & Crandall, 2001). Blends are also common as there are very few apple cultivars that are considered to be sufficiently complex for single variety ciders (Proulx & Nichols, 2003).

Research into the use of dessert apples alone for cider production has suggested they are less suitable due to their chemical attributes (Kuhn, 1994), yet these varieties fill an important volume gap due to their availability compared to traditional cider apple varieties. When using dessert apple varieties, growers and cider producers must know how to manipulate and manage fruit attributes, to make the highest quality cider from the fruit available on the market. For many dessert apple varieties, data such as pH, titratable acidity, soluble solids of the juice and varying phenolic components have been reported (Drogoudi, Michailidis, & PantelidiSa, 2008; Khanizadeh, Tsao, Rekika, Yang, & DeEll, 2007; Lata, 2007; Lata & Tomala, 2007; Vieira et al., 2009; Wolfe, Wu,

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& Liu, 2003). However the data for phenolic components is based on extractions that are solvent based, directly from the apples. The phenolic components that are present in apples have been shown to alter in content due to the milling and pressing processes of cider making (Boyer & Liu, 2004; Ibrahim et al., 2011; Le Bourvellec et al., 2011; Oszmiański, Wojdyło, & Kolniak, 2011).

Very little research has been completed on the chemical and spectrophotometric attributes of cider produced from dessert varieties, thus a research gap exists, which could include development of rapid analytical methods that could be utilised by industry.

The maturity of the harvested fruit has an important influence on each of the chemical attributes that contribute to cider production. Many physiological and complex biochemical changes occur during the fruit ripening process. Such changes include decreased firmness (Harker & Ferguson, 1988; Harker, Redgwell, Hallett, Murray, & Carter, 2010; Rose & Bennett, 1999), increase in sugars, hydrolysis of starch, decreased organic acid content and change in pH, all of which influence the production of total polyphenols, tannins, colour, alcohol and aromas of the cider (Watkins et al., 2003). To assist with purchase decision making and fruit grading at harvest to obtain a target cider character, growers and cider producers require data on how apple fruit maturity can influence cider production.

The dessert varieties 'Pink Lady®', 'Royal Gala' and 'Red Delicious' are produced in bulk supply in cool climate apple producing regions such as Tasmania (Australia) and growers require a market for second-grade fruit. Cider producers are increasingly using these varieties in blended ciders and require data about the physical, chemical and spectrophotometric attributes of the cider produced from these varieties to manipulate their desired cider style. The primary aim of this study is to investigate the composition data of varietal base ciders from dessert apples at three levels of maturity to assist cider makers in making informed decisions on these varieties. The second aim is to test a rapid analytical method (juice spectral phenolic fingerprinting) developed for sparkling wine production (Kerslake, Jones, Close, & Dambergs, 2013) in dessert apple juice and base ciders.

2. Materials and methods

2.1. Experimental design

Three dessert apple varieties 'Pink Lady®', 'Red Delicious' and 'Royal Gala' were harvested from two commercial orchards in the Huon Valley region in southern Tasmania at three different harvest dates. 'Pink Lady®' fruit was harvested from Orchard A from 22 year old trees grown on M26 rootstock, trained to a central leader. 'Red Delicious' fruit was also harvested from Orchard A, from 35 year old trees on a vigorous rootstock (unknown) trained to a vase shape. 'Royal Gala' fruit was harvested from Orchard B from 12 year old trees grown on M26 rootstock trained to a central leader. Treatments of time of harvest were three weeks prior to commercial harvest (pre-commercial); at commercial harvest (commercial) and three weeks after commercial harvest (post-commercial). Commercial harvest was determined by the grower and based on optimum maturity for the fresh market. Three replicates of approximately 30 kg of fruit were harvested from adjacent trees with each replicate sourced approximately 100 m apart.

2.2. Fruit physical and chemical analysis

Differences in apple maturity between harvest dates were confirmed by measurements of apple length and diameter (200 mm Mitsukota digital measurement calliper), weight (Omega, WSB-8015 bench top scale) and background colour on 20 randomly sampled apples per replicate. Visual appearance (colour) was assessed for each variety following industry standard colour charts. 'Pink lady®' apples have a pink blush over a greenish to yellow background colour and were assessed with the aid of a CTIFL (Centre technique interprofessionnel des fruits et légumes, association 'Pink Lady' Europe). The background colour of 'Pink lady®' apples was assessed along a colour scale (1 to 10 scale with 7 being a yellow and 3 a green), and the percentage of blush was on a 1 to 5 scale based on 20% blush increments. For 'Red Delicious', intensity of red colour (1 to 5 scale) and percentage of red colour (1 to 5 scale) were recorded following industry fruit maturity colour swatches. For 'Royal Gala', percentage of red colour (ENZA New Zealand International 39C02) and background colour (ENZA a Limited Background Colour Swatch 'Gala'/'Royal Gala' January 2003) was measured.

Apples were milled using a high speed hammer mill. The must was then placed into three cheese-cloth (Stockinette, Emor) bags (acting as pressing aids and solids filter) and placed into a horizontal flat-bed water bag press (Solutions in Stainless, Tasmania) with a pressing cycle of five minutes and two pressing runs at 200 kPa. Juice was collected into 20 L buckets. 200 mL of the juice was sampled for analysis (no air gap in 200 mL vials therefore no need for carbon dioxide topping) the remainder was topped with carbon dioxide to inhibit any further oxidation, buckets were fitted with a lid with an airlock.

2.3. Juice composition analysis

Juice samples (prior to additions) were analysed for total soluble solids (TSS) by refractometer (A. Krűss Optronic, Hamburg, Germany), titratable acidity (TA) (0.33 NaOH to end-point of pH 8.2, expressed as grams of malic acid/L) and pH by auto-titrator (Metrohm 702 Sm Titrino, Florida, USA). Each sample was analysed in triplicate with means calculated.

2.4. Cider production

The cider was produced in a temperature controlled facility set to 14 °C ± 1 °C, using field replicates as cidermaking replicates. Pectinase (Novozymes VinoClear Classic) was added at ~20–30 ppm and potassium metabisulphite (Chem-Supply, Gillman, SA, Australia) at 50 ppm. Juice was stored at 14 °C for the duration of the trial, with inoculation (Lalvin "C" – neutral white wine yeast rehydrated at room temperature for 30 min) occurring after 24 h. After 48 h the pH (Metrohm 913 pH meter, Australia) was adjusted with malic acid to approximately 3.70 ± 0.10 and Fermaid A (Lallemand, Montreal, Canada) added to ensure a continuous fermentation. Fermentation progress was monitored by hydrometer (Alla France, France). Once the ferment had reached a specific gravity of 1.000 ± 0.001 or less, primary fermentation was considered complete. pH was confirmed to be less than 3.70, and adjusted with malic acid for microbial safety if required, and settled for two weeks on lees. The cider was racked using a vacuum bottling system under low pressure into polyethylene terephthalate bottles and a 30 mL sample taken for analysis and stored at 2 °C.

2.5. Cider composition analysis

Cider composition was analysed in triplicate with means calculated. TA and pH was analysed by auto-titrator. Cider was diluted 1:10 with 1 M HCl and dark incubated for three hours at ambient temperature (22 °C), then analysed by UV–Vis scanning spectrophotometer (Thermo Scientific Genesys 10S UV–Vis Spectrophotometer, USA) with an absorbance reading taken every 2 nm from 200 to 600 nm inclusive for the spectral phenolic