

A Research Note

Adulteration of Wine with Sorbitol and Apple Juice

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ABSTRACT

One hundred and thirty-nine Australian wines, including white and red wines, port, sherry and muscat, were analyzed for sorbitol and chlorogenic acid in connection with the adulteration of wine with sorbitol and apple juice, respectively. Sorbitol was found in 10 wines in the range 3.4-6.7 g/L, well above the likely natural level of 0.1-1.0 g/L. The detection limit for sorbitol was 0.1 mg/L. In a further five wines, chlorogenic acid was found in the range 10-31 mg/L. The natural occurrence of chlorogenic acid in wine is <2 mg/L. The detection limit for chlorogenic acid in white and red wines was 0.5 mg/L and 1.0 mg/L, respectively.

Sorbitol, a harmless polyol, is used in many processed foods and found in a wide range of fruits (9,10). However, its use in wines to favorably alter organoleptic properties is prohibited in many countries including Australia. In late 1988, investigations by the Australian Wine and Brandy Corporation revealed that an Australian wine producer had been using sorbitol in some of its products.

At the same time, the produce of a second Australian wine company was investigated by the Corporation for adulterating wine with apple juice. In the past, sorbitol levels in wine have been used as an indication of adulteration by apple juice as the latter contains appreciable levels of sorbitol (2 g/L-9 g/L) (9,10). However, today it is known that the levels of sorbitol that can occur naturally in wine are much higher than was once thought, i.e., up to 1 g/L (7). Furthermore, the level of sorbitol in apple juice is variable, as is the amount of apple juice that may be used in adulterating the wine. Therefore, the presence of sorbitol alone is inconclusive in establishing whether wine has been adulterated with apple juice (7).

Apple juice is known to contain relatively high levels of chlorogenic acid (>30 mg/L) (2,3,6), while wine is believed to contain either no chlorogenic acid or only very low levels (<2 mg/L) (4,11,13,14,17). Therefore, the possibility exists that the presence of chlorogenic acid in wine might be indicative of adulteration with apple juice.

The objectives of the current investigation were to analyze wine samples for their sorbitol and chlorogenic acid content. A total of 139 wines was examined, including

wines from two companies suspected of adulterating wine with sorbitol and apple juice, respectively.

METHODS AND MATERIALS

Sampling

One hundred and thirty-nine bottles and plastic-lined cardboard casks of wine were obtained at various retail outlets throughout New South Wales by Inspectors of the N.S.W. Department of Health. The samples were stored below 4°C prior to analysis.

Sorbitol analysis

Sorbitol was determined as its trimethylsilyl derivative by gas-liquid chromatography (12). The chromatograph used was a Hewlett-Packard 5890 and the working conditions used were as follows: (a) column, 25 m x 0.2 mm i.d. SE-54; (b) oven temperature: 150°C (2 min) to 210°C at 4°C/min, then to 230°C at 2°C/min, and finally to 310°C (5 min) at 40°C/min; (c) carrier gas, N₂ at 0.5 ml/min; (d) split ratio, 100:1; (e) injector temperature, 270°C; (f) detector temperature, 330°C; and (g) injection volume, 1 µl. Quantitation was done by an internal standard method using diethyl phthalate.

Chlorogenic acid analysis

Chlorogenic acid was determined by high pressure liquid chromatography (6). The analyses were performed using a Waters Model 590 pump equipped with a Waters Wisp 710B autosampler and a Hewlett-Packard Model 1040A detector and the working conditions used were as follows: (a) wavelength, 320 nm; (b) injection volume, 50 µl; (c) mobile phase, 0.005M aqueous potassium hydrogen phosphate and methanol; and (d) flow rate, 1.0 ml/min.

Linear gradient elution was from 15 to 40% methanol in 15 min followed by isocratic elution for 5 min. and linear gradient elution from 40 to 15% methanol in 10 min. Quantitation was done by an external standard method.

RESULTS AND DISCUSSION

A total of 139 Australian wines was analyzed for their sorbitol and chlorogenic acid content. Results of sorbitol analyses of the ten wines, obtained from the producer suspected of using sorbitol, are presented in Table 1 and show sorbitol levels well in excess of likely maximum "natural" levels in wine, i.e., 1 g/L (1,7). Of the remaining

TABLE 1. Sorbitol analyses of ten wines obtained from the company suspected of using sorbitol during production.

Wine	Sorbitol (g/L)
A	6.6
B	6.1
C	5.0
D	6.6
E	6.7
F	6.5
G	5.2
H	5.2
I	4.3
J	3.4

Detection limit: 0.1 g/L.

TABLE 2. Sorbitol and chlorogenic acid levels in five wines obtained from the company suspected of adulterating wine with apple juice.

Wine	Chlorogenic acid (mg/L)	Sorbitol (g/L)
White wine	10	0.6
White Lambrusco	16	1.3
White wine	25	1.6
Reisling	29	2.1
Moselle	31	2.2

Detection limits: 0.5 mg/kg and 1.0 mg/kg of chlorogenic acid in white and red wines, respectively, and 0.1 g/L of sorbitol.

129 wines investigated, 125 wines representing 27 wine producers, contained sorbitol at levels below 1.0 g/L, i.e., the currently accepted maximum for naturally occurring sorbitol in wine.

Four wines, produced by the company suspected of using apple juice in its wines, were found to contain sorbitol at levels above 1 g/L but below those levels listed in Table 1. These results are presented in Table 2.

Chlorogenic acid was found in five of the 139 wines that were investigated and only in the wines obtained from the company under suspicion of using apple juice in its product. Chlorogenic acid was not detected in the remaining 134 wines (Table 2).

Studies by Brause and Raterman (2) led them to propose 50 mg/kg of chlorogenic acid as a minimum for authentic apple juice, although they later reduced this to 30 mg/kg (3). In eight apple juices studied, they found chlorogenic acid levels in the range 93-232 mg/kg. In a similar study by Lee and Wrolstad (6), chlorogenic acid was found in the range 1-214 mg/L with 4 of the 8 samples studied containing chlorogenic acid below 30 mg/L. However, Lee and Wrolstad depectinized their apple juice samples and it is known that depectinization will result in a loss of chlorogenic acid (16).

In contrast to apple juice, wine contains little or no chlorogenic acid. Early workers have reported finding chlorogenic acid in wine (5,8,15). Weurmann and DeRooij (17) and Ribereau-Gayon (11) however failed to detect

chlorogenic acid and Ribereau-Gayon reported that he believed some early workers had confused caffeic acid for chlorogenic acid. A more recent reference (4) quotes a level of 0.5-2.0 mg/L for chlorogenic acid in wines, and work by Singleton, Timberlake, and Lea (13) on phenolic cinnamates in Muller-Thurgau white wines failed to find quinates after hydrolysis of the cinnamates, thereby implying the absence of chlorogenic acid. More recent work performed at the Australian Wine Research Institute failed to find chlorogenic acid in a survey of 50 Australian wines (14).

When considered with earlier work on the levels of chlorogenic acid in apple juice (2,3,6) and in wine (4,11,13,14,17), the results of this study endorse the view that the presence of chlorogenic acid at unusually high levels is a reliable indicator of the adulteration of wine with apple juice.

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