HPLC Analysis of Organic Acids in Wine

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The quantitative analysis of organic acids is important for the quality control of wine, because the classes and content of organic acids give a characteristic taste to wine. Acetic acid, lactic acid, succinic acid, malic acid, citric acid and tartaric acid are the main organic acids in wine.

The use of a ligand exchange chromatography column from Polymer Laboratories, now a part of Varian, Inc., significantly reduces the need for complicated sample preparation (typically involving elution through an ion exchange resin bed), as retention is brought about by not only ion exchange, but also ion exclusion and partitioning on this type of column.

The value in this approach is demonstrated in the analysis of organic acids in red, white, rosé and dessert wine using a PL Hi-Plex H column.

Experimental

An isocratic HPLC system was set up with a column block heater and RI detector. The mobile phase was 0.004M H_2SO_4, 0.4 mL/min, 75 °C on a PL Hi-Plex H, 8 µm, 300 x 7.7 mm column (PL1170-6830).

Sample Preparation

In order to obtain a complete RI profile, every wine was directly injected onto the column without any sample pre-treatment. The only exception to this being the Eiswein which was diluted by a factor of five with water. Injection volume was 20 µL.

Results

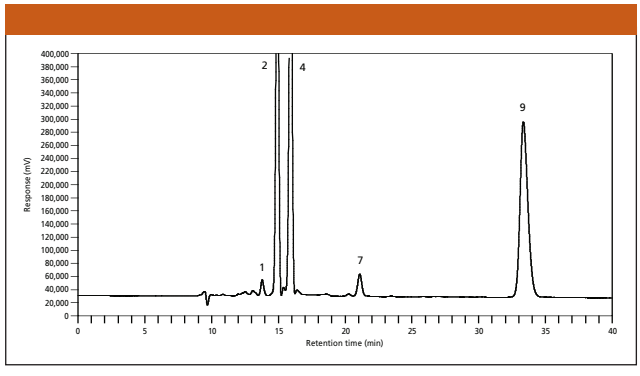

Figure 1: Rosé wine — Grape: Zinfandel

Discussion

The results of this investigation indicate that ligand exchange HPLC can distinguish between different wine types. By using an RI detector, levels of organic acids and sugars are quantified simultaneously.

Figures 1 and 2 show that the rosé and the dessert wine both contain very high levels of malic acid and the fruit sugar fructose. The dessert wine contains up to five times as much sugar as ordinary rosé wine and 70 times as much sugar as the red and white wines. Eiswein (commonly called Ice Wine) is produced from grapes that have been frozen which causes some of the

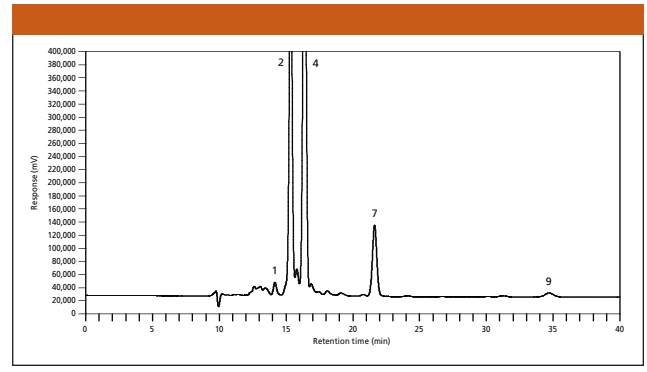

Figure 2: Eiswein dessert wine — Grape: Riesling

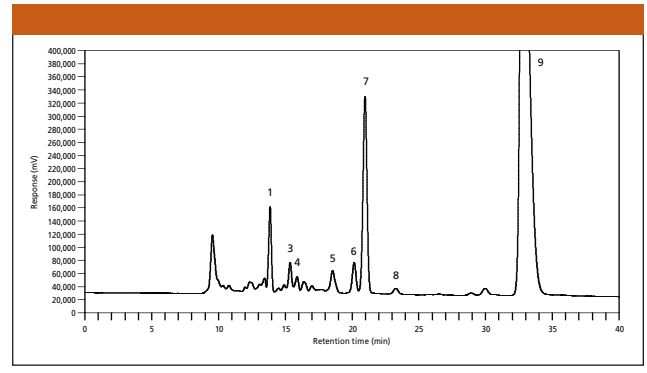

Figure 3: Red wine — Grape: Nebbiolo

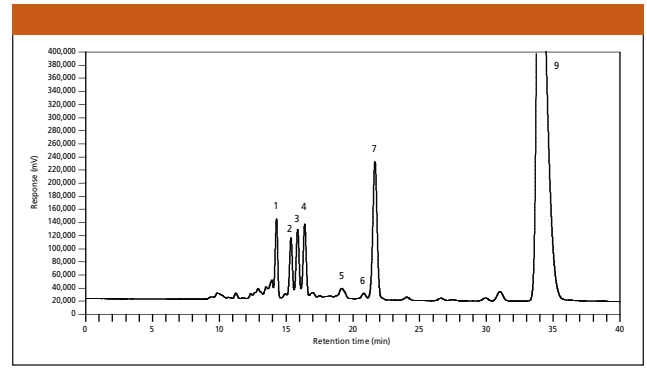

Figure 4: White wine — Grape: Chardonnay
Peak Identification (Figures 1–4): 1. Tartaric Acid, 2. Malic Acid, 3. Glucose, 4. Fructose, 5. Succinic Acid, 6. Lactic Acid, 7. Glycerol, 8. Acetic Acid, 9. Ethanol.

water inside them to freeze out, leaving the sugars and other solids dissolved in the remaining juice. The resulting wine is therefore very sweet but has lots of balancing acidity, which also explains the high level of malic acid in the wine samples.

Figures 3 and 4 show that compositions of the red and white wines look very different to the others, in that they have much lower levels of sugar but much higher levels of lactic acid and glycerol. Red wine is made from the must (pulp) of red or black grapes that undergo fermentation together with the grape skins, while white wine is usually made by fermenting juice pressed from white grapes. During the fermentation process, yeast converts most of the sugars in the grape juice into ethanol and carbon dioxide, which explains the lows levels of glucose and fructose in the wine samples. Some wines also undergo malolactic fermentation, whereby bacteria convert malic acid into the milder lactic acid. All of these factors, and the levels of sugars and organic acids produced by the various fermentation processes, contribute to the differing taste that each wine has, and give each one a unique profile when analyzed by HPLC.

Some of the other peaks that appear in the chromatograms are likely to result from tannins (bitter tasting plant polyphenols) present in the wine that come from the skins and seeds of the grapes used in the fermentation process.

Conclusion

The analysis of wines demonstrates how PL Hi-Plex H columns provide optimum resolution of closely eluting compounds, enabling quantitation of each. These columns are ideal for the analysis of sugar alcohols and sugar molecules using water as the mobile phase. PL Hi-Plex H is also the column of choice for the analysis of organic acids, using dilute mineral acid as eluent. By using the columns at higher operating temperatures, closely eluting compounds can be resolved.

References

(1) Ding, M.Y., Koizumi, H. and Suzuki, Y. (1995) Comparison of three chromatographic systems for determination of organic acids in wine. Analytical Sciences, 11, 239–243.

(2) Schneider, A., Gerbi, V. and Redoglia, M. (1987) A rapid HPLC method for separation and determination of major organic acids in grape musts and wines. American Journal of Enology and Viticulture, 38 (2), 151–155.

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