Application Note: 51852

Wine Color Analysis using the Evolution Array UV-Visible Spectrophotometer

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Key Words

- Lab Color
- UV-Visible
- Wine Color
- Wine Color Intensity
- Wine Hue

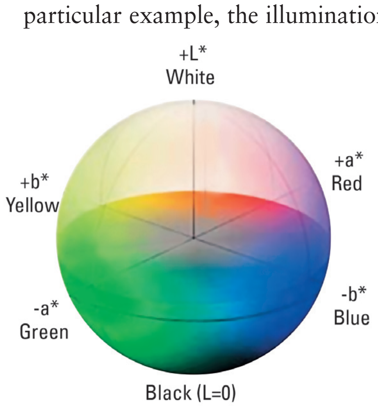
Introduction

UV-Visible spectrophotometry is a fast, simple, non-destructive analytical technique for measuring certain properties of liquids. In particular, the color of a sample can be determined by interpretation of the absorbance of a sample at various wavelengths. The Thermo Scientific Evolution Array UV-Visible spectrophotometer is particularly suited to making color measurements in quality control settings because it measures all wavelengths simultaneously in a fraction of a second. These quality control measurements are frequently used for the analysis of wine and other beverages. Thermo Scientific VISION*collect* software automates the process of calculating color properties according to international protocols and presents the results to the user for record keeping and reporting. In this note, we demonstrate the use of the Evolution™ Array™ spectrophotometer for various measurements of wine.

Background

Several important measures of wine quality can be evaluated by mathematical combination of absorbance values at multiple wavelengths. The values described in this application note are:

- ***Wine Color Intensity*** **–** a simple measure of how *dark* the wine is using a summation of absorbance measurements in the violet, green and red areas of the visible spectrum. Wine color intensity = $A_{420} + A_{520} + A_{620}$ (where A_λ represents the absorbance at wavelength λ).
- ***Wine Hue*** **–** a simplistic measure of the appearance of the color – a ratio of the absorbance in the violet to the absorbance in the green. Wine color hue = A_{420}/A_{520}.
- ***CIE L*a*b**** is one of the most widely used international scales for color. It is calculated from a mathematical combination of absorbance data taken across the entire visible spectrum with standard functions for the illumination source and the observation angle. In this particular example, the illumination source specified for the color calculation is *D65* which is considered to be *Standard Daylight*. The observer function is specified as the CIE standard 10° observer. Of the three values L*, a* and b*, L* is a measure of *luminosity* or lightness. An L* value of 0 represents pure black whereas L*=100 represents pure white. a* is a measure of the redness or greenness of the color. Positive values of a* represent a redder value, negative values represent more green. The b* value is a yellow-blue measurement. Positive values of b* represent a more yellow sample, negative values a more blue sample.



A representation of the L*a*b* colorspace

Experimental

Experiments were carried out using an Evolution Array UV-Vis spectrophotometer running VISION*collect*™ software (Wine color intensity and Wine hue) in Equation Calculation mode, or Color Analysis mode (CIE L*a*b* color). Samples were measured in 1 mm pathlength cuvettes against a deionized water blank.

Experimental parameters for the data acquisition and the color intensity calculation are shown in Figures 1 and 2, respectively. L*a*b* color measurements were carried out in transmittance mode with the Scan No. method parameter set to 10 and the Integration method parameter set to 1.

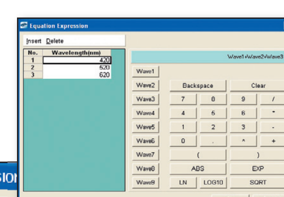


Figure 2: Setting up the calculation

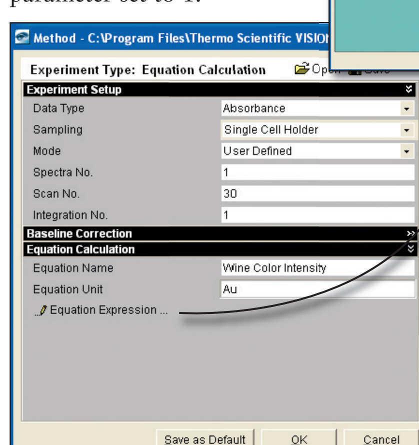


Figure 1: Experimental Parameters

Results

Spectra of seven wine samples are shown in Figure 3. Table 1 shows the color intensity and hue calculation results. The absorption spectra are similar in profile but the intensity of the absorption at the measurement wavelengths varies considerably.

The expected difference between red and white wine is seen clearly in the range between 400 and 650 nm, where red wine samples exhibit an absorbance peak due to absorption by anthocyanin that is absent in the white wines. This peak in the red wine samples may be used in separate methods to determine the anthocyanin content of the wine sample.

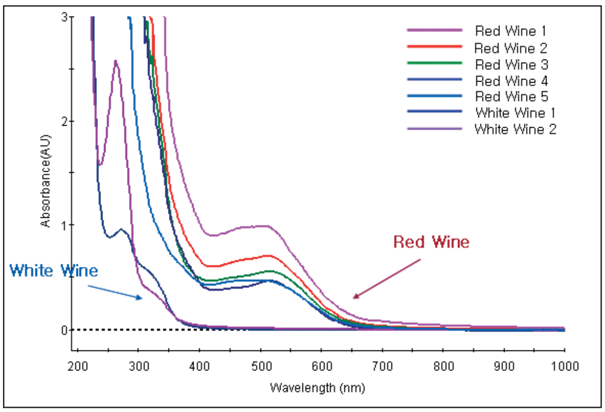


Figure 3: Absorbance spectra of wine samples

	Color Intensity (Au)	Color Hue	420 nm	520 nm	620 nm
Red Wine 1	2.113	0.923	0.894	0.969	0.250
Red Wine 2	1.456	0.859	0.597	0.695	0.164
Red Wine 3	1.146	0.830	0.460	0.554	0.132
Red Wine 4	0.925	0.806	0.373	0.463	0.089
Red Wine 5	0.989	0.939	0.428	0.456	0.105

Table 1: Color Intensity & Hue of wine samples

Figure 4 shows the transmittance spectrum of wine sample 3 and a control sample specified as the target – in this case a deionized water sample. Table 2 displays the measured color parameters for all seven wine samples and the calculated color difference between each and the specified target. ΔE is a common measure of color difference, calculated as:

$$\Delta E = \sqrt{(dL^*)^2 + (da^*)^2 + (db^*)^2}$$

This value is reported in the center column of the table. ΔE is frequently used as a pass/fail measure for whether a sample complies with a standard established for a product.

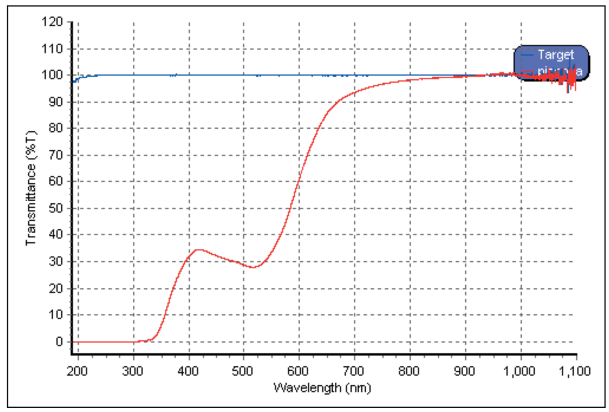


Figure 4: Transmittance spectra of Wine. Target (blue line) is deionized water. Sample (red line) is Red Wine 3.

Conclusion

The Evolution Array spectrophotometer, equipped with VISION*collect* software and the optional Color Analysis mode, offers fast customized calculation of analytical parameters for quality control in the wine industry.

Name	ΔL*	Δa*	Δb*	CIE ΔE*	L*	a*	b*
Target	–	–	–	–	99.9702	-0.0047	-0.074
Red Wine 1	-43.578	36.664	27.849	63.394	56.392	36.660	27.775
Red Wine 2	-34.492	31.901	17.790	50.238	65.478	31.896	17.716
Red Wine 3	-29.508	27.625	12.253	42.237	70.463	27.620	12.179
Red Wine 4	-24.737	25.749	9.769	37.018	75.233	25.744	9.695
Red Wine 5	-25.667	23.068	15.600	37.873	74.303	23.064	15.526
White Wine 1	0.215	-0.479	0.893	1.037	100.185	-0.144	0.819
White Wine 2	-0.713	-0.095	1.695	1.842	99.258	-0.099	1.621

Table 2: CIELAB color and color difference

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