

COLOUR ASSESSMENT OF PORT WINES USING COLORIMETRIC AND SPECTROPHOTOMETRIC METHODS



CATÓLICA
FACULTY
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PORTO

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Introduction

Colour is an important quality parameter in wines and is the result of a complex mixture of pigments (including anthocyanins and their derivatives, quinones, xanthylum compounds, etc.). Red wine colour changes over time, as pigments react between themselves and with other wine macromolecules (particularly polyphenols) [1]. During wine tasting, colour is normally assessed on the outer rim of the wine profile in a tilted glass, since most wines are too opaque to be analysed in the middle of the glass. Therefore, depending on the depth of observation considered, the perception of wine colour can be different [2;3;4].

The precise measurement of wine colour is usually done using molecular (UV-VIS) spectrophotometric methods. In the current official (OIV) method, the transmittance spectrum of a particular sample is measured and used to calculate CIELab parameters (L^* , a^* and b^*), which define a single (predominant) colour for a particular wine. Reflectance colorimetry is an alternative well-established method for measuring colour in foodstuffs, which can also be used in transparent samples (such as wines) as long as a reflective background is used. In this study, a reflectance colorimeter was used to measure CIELab colour parameters of Port wine samples of different categories at different depths, in Petri dishes. The obtained results were compared with the parameters obtained using the OIV method.

Methods

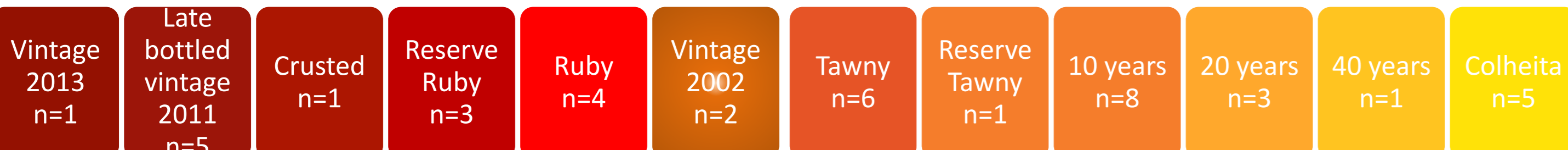
Samples

Port wine samples (n=40) from different categories/styles were kindly supplied by IVDP. Samples from were selected

Port wine samples

Aged in bottle (Ruby-style)
(n=16)

Aged in wood cask (Tawny-style)
(n=24)



Colorimetric method:

The colorimetric measurements were made with a Konica Minolta Chroma meter 400 (CR-400) which measured the reflected radiation and calculated the corresponding CIELab parameters. A prior calibration of the colorimeter was performed using the white calibration plate provided with the equipment, which was also used as a background for the sample measurements. Different volumes of Port wine sample (2.5 ml, 4.0 ml, 5.0 ml, 6.0 ml and 7.5 ml) were transferred to a glass Petri dish (with a diameter of 4.0 cm) in order to measure colour at different depths (2.0 mm, 3.2mm, 4.0 mm, 4.8 mm and 6.0 mm). The measurements with Konica Minolta Chroma meter 400 were made with D65 illuminant and 2° angle observation, corresponding to the CIE 1931 colour space [5].

UV-VIS method

A double-beam spectrophotometer (Helios Alpha UV-Vis from Thermo-Scientific) was used to obtain the transmittance spectra of samples between 300 and 800 nm using a 1 mm path length quartz spectrophotometric cell. The obtained results were used to calculate the values of the CIELab parameters using the transmittance values and the mathematical formulae described in the OIV method [6]. The theoretical CIELab parameters at different different path-lengths (2.0 mm; 3.2 mm; 4.0 mm; 4.8 mm; 6.0 mm) were calculated using the correspondent transmittances calculated from the Beer-Lambert-Bouguer law ($T=10^{-\epsilon bc}$).

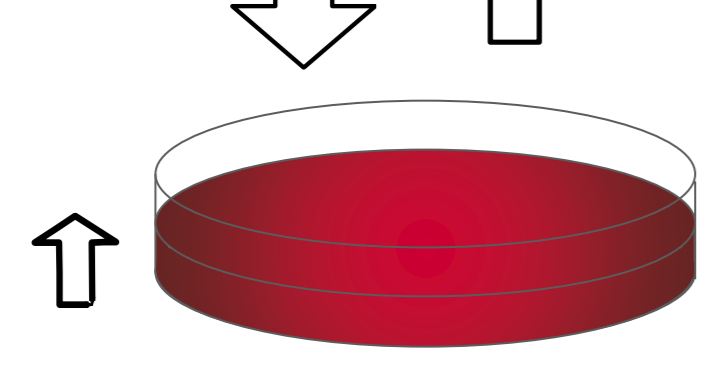
Konica Minolta Chroma meter CR-400



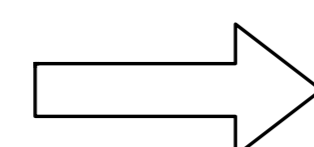
$L^*a^*b^*$ values \Rightarrow $L^*C^*H^*$

Incident radiation

Reflected radiation



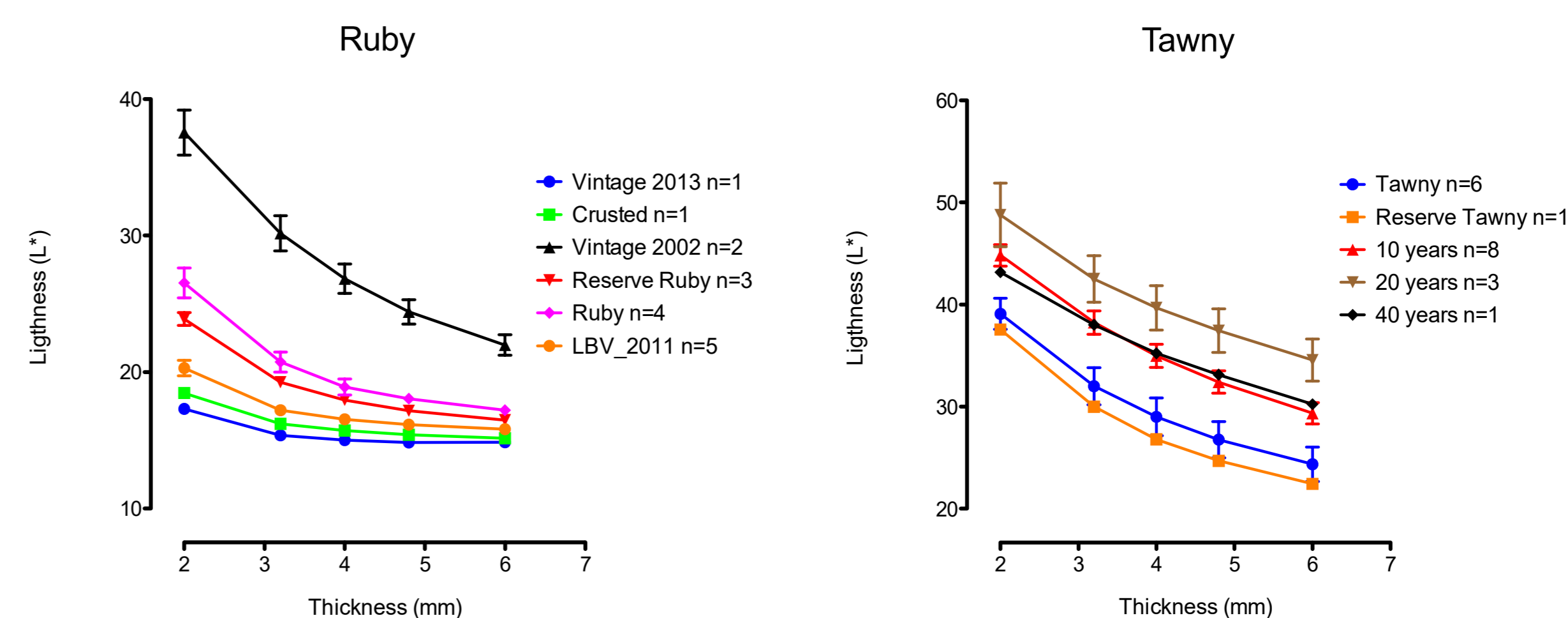
Petri dish size:
d= 4 cm
h=0.8 cm
Depth tested:
2 mm; 3.2 mm; 4 mm; 4.8 mm; 6 mm



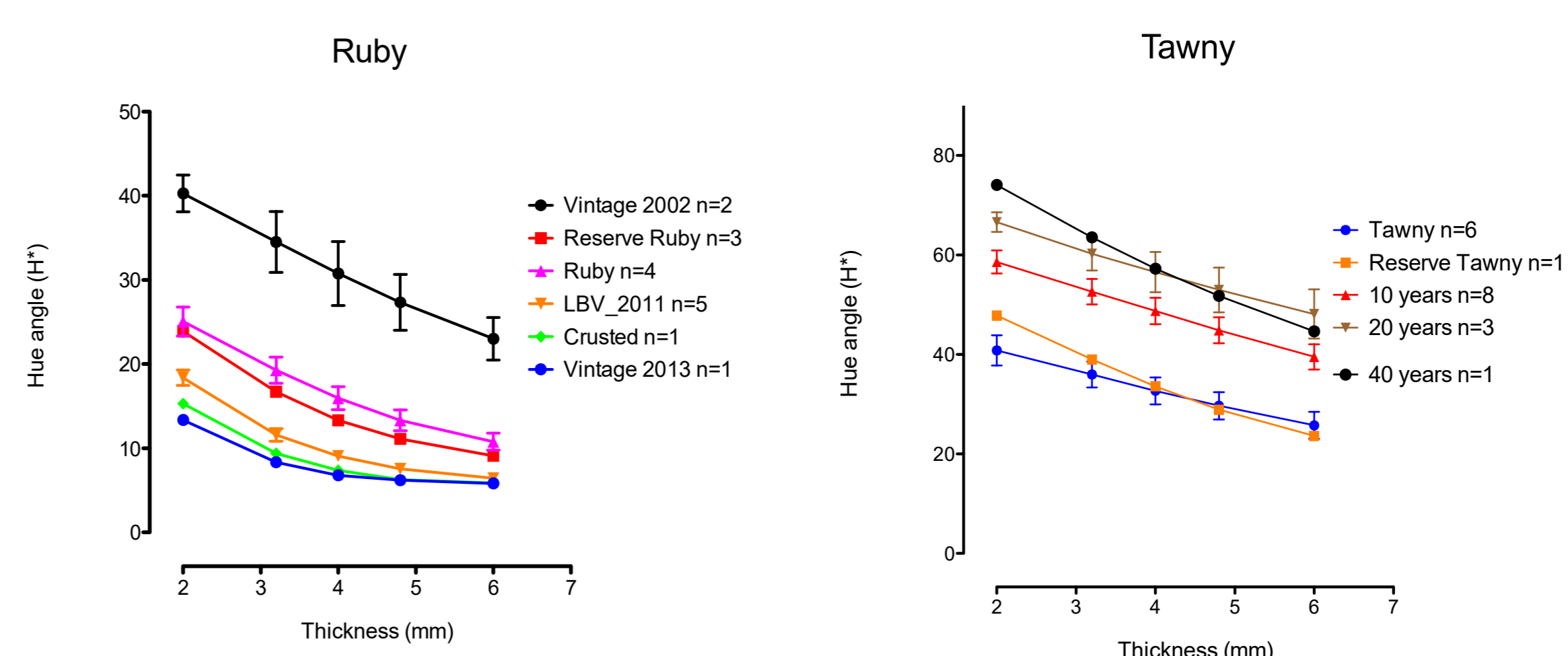
Results

1) Colour profile of Ruby and Tawny Port wines

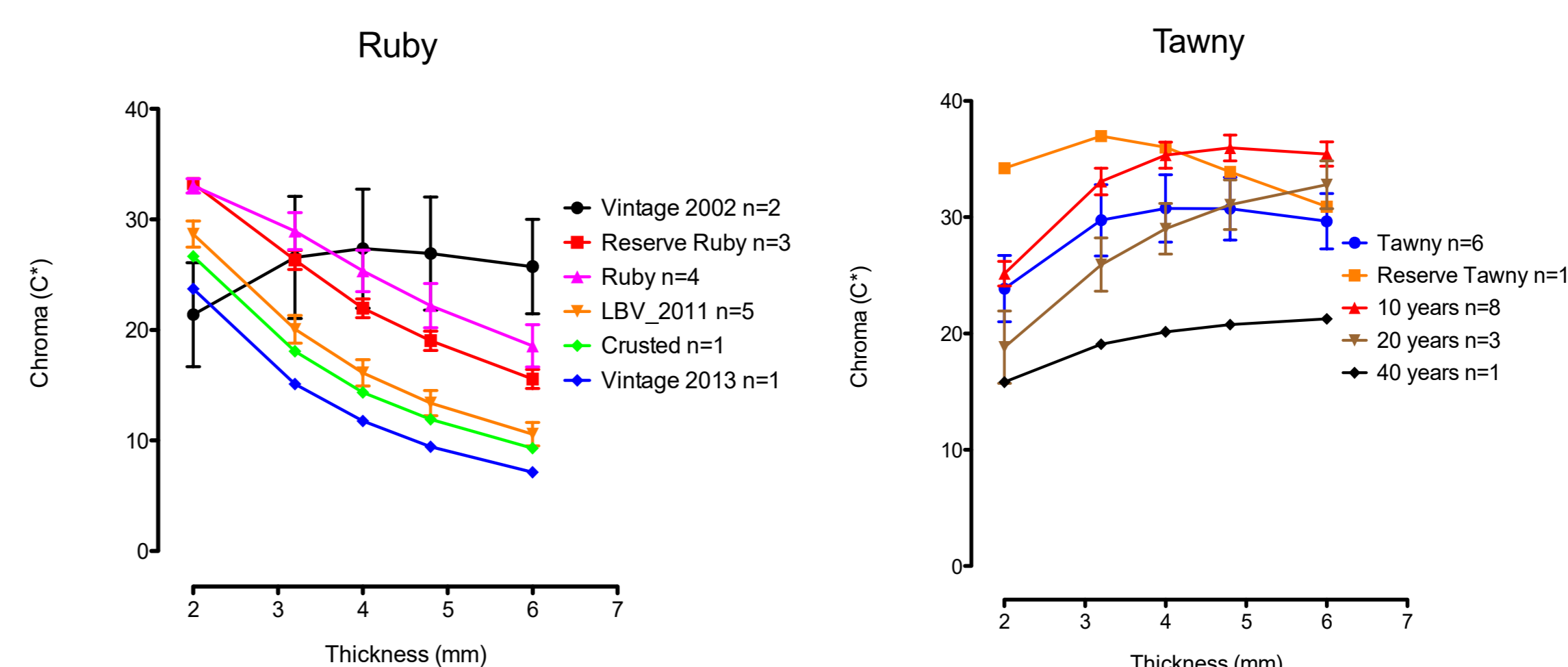
□ Lighness (L^*) profile of Ruby and Tawny styled Port wines at different depth



□ Hue angle (H^*) profile of Ruby and Tawny styled Port wines at different depth



□ Chroma (C^*) profile of Ruby and Tawny styled Port wines at different depth



2) Comparison of the colorimetric and spectrophotometric methods

Table 1 – Linear correlations of the CIELab parameters obtained by the colorimetric vs spectrophotometric measurements

Depth	Tawny			Ruby		
	Lighness (L^*)	Hue (H^*)	Chroma (C^*)	Lighness (L^*)	Hue (H^*)	Chroma (C^*)
2.0 mm	$y=0.772x + 48.6$ R=0.559	$y=1.16x - 12.1$ R=0.970	$y=0.555x + 45.6$ R=0.583	$y=2.48x - 15.4$ R=0.984	$y=0.911x - 1.48$ R=0.914	$y=0.748x + 23.8$ R=0.389
3.2 mm	$y=1.34x + 23.3$ R=0.836	$y=1.11x - 7.07$ R=0.938	$y=0.16x + 63$ R=0.227	$y=3.41x - 35.1$ R=0.979	$y=0.731x + 7.16$ R=0.904	$y=1.73x - 7.71$ R=0.666
4.0 mm	$y=1.51x + 16.8$ R=0.860	$y=1.06x - 3.17$ R=0.919	$y=0.0879x + 67$ R=0.104	$y=4.15x - 49.4$ R=0.978	$y=0.732x + 8.71$ R=0.922	$y=1.96x - 12.7$ R=0.750
4.8 mm	$y=1.67x + 11.1$ R=0.871	$y=1.03x - 0.184$ R=0.904	$y=0.0837x + 66.9$ R=0.0816	$y=4.95x - 64.3$ R=0.976	$y=0.767x + 9.17$ R=0.934	$y=2.03x - 13.4$ R=0.783
6.0 mm	$y=1.87x + 4.33$ R=0.878	$y=0.994x + 3.11$ R=0.889	$y=0.209x + 60.5$ R=0.155	$y=6.12x - 85.0$ R=0.967	$y=0.838x + 9.05$ R=0.953	$y=2.08x - 13.2$ R=0.817

Conclusions

1. Wines from the same category exhibited similar colour (depth) profiles with Tawny-styled wines showing a more linear profile with depth than Ruby-styled wines regarding the L^* and H^* parameters. For young ruby-styled wines, the colour profile seem to stabilize at 4.0 mm depth, particularly for younger wines.
2. Chroma (C^*) showed a different behaviour in ruby and tawny wines, with a maximum obtained at 2.0 mm depth for ruby wines (except for aged vintage Port) and at 3.2-4.0 mm depth for tawnies
3. Good correlations between the colorimetric and OIV methods were obtained for the L^* (Ruby:R>0.97; Tawny:R>0.87) and H^* parameters (Ruby:R>=0.95; Tawny>=0.97) with the C^* parameter giving inferior results particularly in Tawny-style wines (Ruby:R>=0.81; Tawny>=0.58).
4. The colorimetric method proved to be a useful for estimating the colour profile of Port wines, being quicker and more informative than spectrophotometric methods

References

1. [1] Boulton, R. (2001) Am J Enol Vitic 52(2): 67-87.; [2]Huertas, R. et al. (2003) Color Res Appl 28(6): 473-479; [3] Martin, MLG-M et al. (2007) Food Qual Pref 18: 862-871; [4] Sáenz Gamasa, C. et al. (2009) Eur Food Res Technol 229:263-276; [5]Konica-Minolta, <http://www.konicaminolta.eu>; [6] OIV (2006) Compendium of International Analysis of Methods. Method OIV-MA-AS2-11

Acknowledgements

The authors wish to thank Erica Fiume and Bianca Nielsen for their technical help. This work received financial support from FCT via project UID/Multi/50016/2013