

Thesis title: Evaluation of Carcavelos Fortified Wine Aged in Portuguese (Quercus pyrenaica) and French (Quercus robur) Oak at Medium and High Toast

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Abstract (max 300 words)

Topic position & objectives:

The purpose of this study was to examine the effects of two species of new oak barrels and their toast on Carcavelos fortified wine. Typically fortified wines are aged in old barrels for the purpose of having a neutral effect on the wine. New barrels are sometimes used for white fortified wines for the extraction of some flavors and aromas but are not widespread. In this study, a single experimental plan was carried out. The objective was to examine the evolution of a single vintage fortified wine aged in French and Portuguese Oak, at medium and high toast. The effects of the species of wood as well as toast, on Carcavelos wine could then be examined.

Methods:

This Master Thesis was carried out as part of an experimentation being performed at Quinta do Marquês, made in collaboration with Adega do Casal Manteiga, Municipality of Oeiras and the Instituto Superior de Agronomia (ISA), Universidade de Lisboa. The work was completed under the supervision of Professor Jorge M. Ricardo da Silva. A total of

twenty barrels were used with 5 replicates for each factor. The barrels were fabricated and toasted using the same cooperage, J.M. Gonçalves in Portugal. The wine in this study was analyzed for pH, titratable and volatile acidity, density, alcohol, sugars, SO₂ levels, total phenols, flavonoids, non-flavonoids, tanning power, and color intensity.

Results:

Significant differences were seen between the species *Q. robur* and *Q. pyrenaica* were shown impact on total phenolic content including both flavonoids and non-flavonoids. The total phenols of the wine aged in *Q. pyrenaica* barrels were significantly higher than in the *Q. robur* counterparts with differences of 61.3 mg/L eq. gallic acid and 75.1 mg/L eq. gallic acid for medium and high toast, respectively. *Q. pyrenaica* contained more flavonoids than *Q. robur* with a difference of 35.9 mg/L eq. gallic acid at high toast and 34.2 mg/L eq. gallic acid at medium toast. Regarding non-flavonoid compounds *Q. pyrenaica* showed 39.2 mg/L gallic acid equivalents more than *Q. robur* at high toast and 27.1 mg/L gallic acid equivalents more at medium toast. This difference in non-flavonoids was only statistically significant with the high toast barrels. The degree of toasting had significant effects on the Flavonoid content of the wine, as well as the tanning power. Flavonoid content increased for both *Q. pyrenaica* ($\Delta 37.2$ mg/L eq. gallic acid) and *Q. robur* ($\Delta 35.5$ mg/L eq. gallic acid) in the wines that were aged in barrels that underwent higher toasting compared to medium toasting. The tannin power decreased for both *Q. pyrenaica* ($\Delta 13.66$ NTU/mL) and *Q. robur* ($\Delta 22.78$ NTU/mL) when the toasting increased.

Main conclusions:

Significant differences between *Q. pyrenaica* and *Q. robur* were found in the wine for total phenols, flavonoids, and non-flavonoid compounds. When comparing both species, *Q. pyrenaica* was shown to have more total phenols, flavonoids, and non-flavonoids than *Q. robur* at both medium and high toast. The total phenols of the wine aged in *Q. pyrenaica* barrels were significantly higher than in the *Q. robur* counterparts with differences of 61.3 mg/L eq. gallic acid and 75.1 mg/L eq. gallic acid for medium and high toast, respectively. *Q. pyrenaica* contained more flavonoids than *Q. robur* with a difference of 35.9 mg/L eq. gallic acid at high toast and 34.2 mg/L eq. gallic acid at medium toast. Regarding non-flavonoid compounds *Q. pyrenaica* showed 39.2 mg/L gallic acid equivalents more than *Q. robur* at high toast and 27.1 mg/L gallic acid equivalents more at medium toast. Furthermore, in the barrels that underwent high toasting, the wood has a significant impact. At medium toast the woods effect is not significant. The species of wood appeared to have not affected the tannin power or color intensity of the wines. The degree of toasting showed significant changes in the tanning power and flavonoids content of the wine for both *Q. pyrenaica* and *Q. robur*. The toasting method was shown to have no significant effect on the total phenolic content of the wine. Flavonoid content increased for both *Q. pyrenaica* ($\Delta 37.2$ mg/L eq. gallic acid) and *Q. robur* ($\Delta 35.5$ mg/L eq. gallic acid) in the wines that were aged in barrels that underwent higher toasting compared to medium toasting. The tannin power decreased for both *Q. pyrenaica* ($\Delta 13.66$ NTU/mL) and *Q. robur* ($\Delta 22.78$ NTU/mL) when the toasting increased. Analyses showed no significant effects on the wines density, total acidity, volatile acidity, alcoholic strength, total dry material, and color intensity from the species of wood or the toasting technique. These results are in agreement with other research that shows the total phenolic content as being related to the type of wood species used in cooperaging. This reinforces previous studies that show the total phenolic content extracted into the wine is dependent on the total phenolic content available within the wood after cooperaging. The degree of toasting had significant effects on flavonoid and non-flavonoid content of the wine, as well as the tanning power and reducing sugars content. The changes in phenolic content, seen as a reduction in non-flavonoids with the increase of toasting, and the subsequent increase in flavonoids, which include constituents such as ellagic and gallic acid, may be explained as thermally aided hydrolysis of ellagitannins into ellagic and then gallic acid as it degrades. Moreover, as these tannins are decomposed, the tanning power is reduced. The “Carcavelos” fortified wine made by the Adega do Casal Manteiga is typically aged for 10 years before bottling. Once this wine has finished aging, another analysis can be made using the wine from these barrels. At that time, an HPLC instrument could be used to examine the individual phenolic constituents more closely to show a more definite comparison. Furthermore a sensorial evaluation should take place as the wine will be completed.

Keywords (5):

Aging, Carcavelos D.O.P., Fortified Wine, Oak wood, Toasting