Effect of high hydrostatic pressure on antioxidant activity, color, and anthocyanin content of red wine

Mickael da C. Santos[a], Ana Rodrigues[b], Carlos Rodrigues[b], Natércia Teixeira[c], Victor de Freitas[c], Jorge A. Saraiva[a], Cláudia Nunes[a] and Manuel A. Coimbra[a]

[a]*QOPNA, Department of Chemistry, University of Aveiro, 3810-193 Aveiro, Portugal*

[b]*Dão Sul –Sociedade Vitivinícola, S.A., 3430-909 Carregal do Sal, Portugal*

[c]*Chemistry Research Center, Department of Chemistry, Faculty of Science, University of Porto, 4169-007 Porto, Portugal*

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1. INTRODUCTION

During the last decade, the use of high hydrostatic pressure (HHP) for food preservation and processing and also for creating new types of food products has increased substantially. Foods commercially processed by HPP are submitted to pressures in the order of 400-600 MPa, to destroy microorganisms and inactivate enzymes, with minimal effects on sensorial and nutritional food quality [1]. The application of HHP in winemaking is still at an early stage of development [2] and the effect on physical-chemical characteristics of wine is still unknown, namely on colour, antioxidant activity, and phenolic compounds composition.
The objective of this work was to contribute for the evaluation of the feasibility of using HHP for an efficient conservation of wine with maintenance or improvement of its sensorial and nutritional characteristics. The results will contribute to evaluate the use of HHP to produce wines of superior and distinct quality. In this work, the effect of HPP on color, antioxidant activity, and anthocyanin content of red wine was studied.

2. MATERIALS AND METHODS

2.1 High pressure treatments

Red wine (*Vitis vinifera* L., Touriga Nacional variety), 2009 vintage, was treated with a high pressure processing system (Unipress Equipment, Model U33, Poland) at the end of alcoholic fermentation. Wine samples of 15 mL were packed and vacuum sealed in bags that were pressurized in a vessel of 35 mm diameter and 100 mm height. The wine was treated at different combinations of pressure/time: 320 MPa/20 min, 425 MPa/10 min, 425 MPa/5 min, and 500 MPa/5 min. All the treatments were carried at room temperature.

2.2 Color and antioxidant activity determination

To measure the color of wine, a spectrophotometric method was used that allows the calculation of tristimulus values and the coefficients required for trichromatic color specification. In this method, the color characteristics are expressed by color intensity, which is given by the sum of the absorbances at 420, 520 and 620 nm, and color tonality, by the ratio of absorbance at 420 and 520 nm [3].
The antioxidant activity was determined by the ABTS method [4].
The color and antioxidant activity of red wine were determined after the treatments and after 3 months of storage.

2.3 Anthocyanin content

The wine samples were analyzed by HPLC using the methodology described by Roggero *et al.* [5]. Anthocyanins and their monoglucosides 3-acetyl esters were identified based on the UV/VIS spectra and retention times of the respective standards. The concentration of each anthocyanin was calculated using the calibration curves of the anthocyanins standards. The anthocyanin content of the samples was determined after 3 months of storage.

3. RESULTS AND DISCUSSION

3.1. Color and antioxidant activity

Globally, it was observed that after 3 months of storage the majority of the pressurized wine samples showed a decrease in color intensity and an increase in color tonality, when compared with color at the beginning of storage (results not shown). It was noted that the wine pressurized during 5 min (425 and 500 MPa) was the most affected by the treatment, where it was noticed a decline in the intensity of color around 50% when compared to the untreated wine sample.

After pressurization there was a slight decrease in antioxidant activity of wine treated at 350 MPa for 20 min and 500 MPa for 5 min and no significant differences were observed in wine treated at 425 MPa (Figure 1). However, after 3 months of storage, there was a more pronounced decrease of antioxidant activity with storage time. Samples pressurized for 5 min revealed to be the most affected by pressure, with a decrease of 70% relatively to the beginning of storage and the untreated sample. The sample pressurized at 425 MPa for 10 min showed the minor decrease of the antioxidant activity (18%).

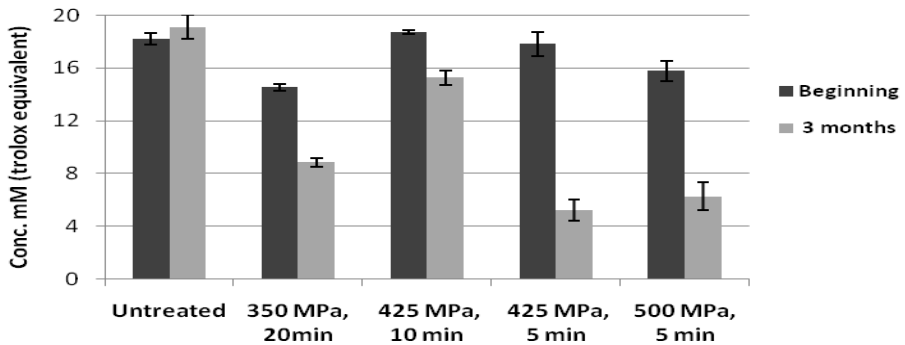

Figure 1. Antioxidant activity of wine samples at the beginning of storage and after 3 months.

Comparing the antioxidant activity values with the color of the samples, it was observed that the decrease in antioxidant activity seems to be associated with the decrease in color intensity and the increase in color tone. The samples that showed greater decrease of antioxidant capacity during storage are the ones with less color intensity and more color tonality, namely the samples treated at 425 and 500 MPa during 5 min.

3.2. Anthocyanin content

After 3 months of storage the pressurized wine showed an anthocyanin content lower (82 to 97%) when compared with the untreated wine (Figure 2). This result shows that HPP treatments originated a decrease in anthocyanins. The samples with lower content of anthocyanins (samples pressurized during 5 minutes) are those with lower antioxidant capacity and lower color intensity. This result points to a direct relation between the anthocyanin content, antioxidant capacity, and wine colour.

During maturation and aging of wine, the wine color changes from a red tonality to an orange one, possibly due to reactions, such as oxidation, reduction and/or polymerization in which anthocyanins can participate, being precursors of new pigments [6]. As it was observed a large amount of precipitate in the pressurized samples, it is possible that it corresponded to the precipitation of anthocyanins, contributing to the decrease in color intensity and the antioxidant activity of these samples.

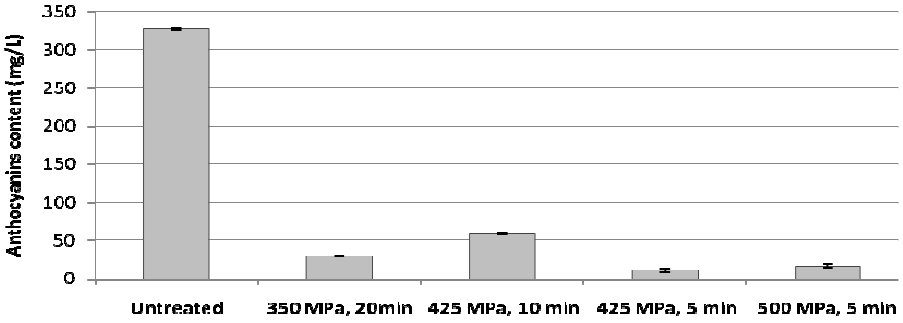

Figure 2. Anthocyanin content in wine samples after 3 months of storage.

Differences between the different pressure/time combinations studied have also been observed, showing that the treatments with higher pressures (425 and 500 MPa) during a low period of time (5 min) had higher influence on the parameters analyzed. These results indicate that high pressure treatments can influence red wine sensorial characteristics, being the effect dependent on the time/pressure binomial used. This shows that, the use of HPP to pasteurize wine, as was proposed by previous works [2], needs to be applied with care to minimize the impact on sensory quality. More studies concerning the chemical reactions caused by HHP in wine are needed to identify the optimal conditions to preserve wine by HPP.

References

1. Ramirez.R, Saraiva.J, Pérez Lamela.C, Torres.J. A. Food Eng. Rev. 1(2009) 16–30.
2. Mok.C, Song.K.T, Park.Y.S, Lim.S, Ruan.R, Chen.P. J. Food Sci. 71(2006) 265-269.
3. Regulamento (CE) da Comissão (1990) Determinações analíticas, Jornal Oficial das Comunidades Europeias. L 272
4. R. Re, N. Pellegrini, A. Proteggente, A. Pannala, M. Yang and C. Rice-Evans, Free Radic. Biol. Med. 26(1999) 1231-1237.
5. J. P. Roggero, S. Coen and B. Ragonnet, Am. J. Enol. Vitic., 37(1986) 77-83.
6. M. Corrales, P. Butz and B. Tauscher. Food Chem. 110(2008) 627-635.

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