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Phenolic composition and antioxidant activity in sparkling wines: Modulation by the ageing on lees

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ABSTRACT

Sparkling wines (SW) have a special biological ageing on lees that is performed using two distinct methods: in the bottle (*Champenoise*) or in isobaric tanks (*Charmat* method). The objective of this study was to compare the levels of phenolic compounds, β-Glucosidase and antioxidant activity during the ageing on lees, in samples of SW produced at industrial scale by both methods. The β-Glucosidase activity has been constant over time, showing a close relationship with all the polyphenols studied (resveratrol, piceid, tyrosol, gallic, caffeic and ferulic acids), which were affected by the *sur lie* time. With these cross-reactions, the biological properties of the SW were also modulated. The results showed that the long period of ageing decreased the antioxidant potential in all samples. This work demonstrates that the *sur lie* is more important than the production method itself, due to its ability to modulate the necessary changes to achieve the specific objective.

1. Introduction

The elaboration of SW consists of two phases. In the first one, the base wine (BW) is obtained after applying white vinification. The second phase is conducted through the *Champenoise* or *Charmat* methods. The principal differences between these methods are the conversion of glucose in ethanol by yeasts (second fermentation) and ageing on lees (*sur lie*) that can take place in the same bottle or in isobaric tanks. During this time of contact, the exchanges between the components present in the medium (wine) and in the yeast cells will serve as the substratum for the chemical and enzymatic reaction forming different biochemical profiles888 (Buxaderas & López-Tamames, 2012; Gallardo-Chacón, Vichi, Urpí, López-Tamames, & Buxaderas, 2010; Pozo-Bayón, Martínez-Rodríguez, Pueyo, Moreno-Arribas, 2009; Torrens, Riu-Aumatell, Vichi, López- Tamames, & Buxaderas, 2010; Bosch-Fusté et al., 2009). Thus, as those reactions are modulated by the technology used, the sensorial and biological characteristics of each one of the products are directly related to the microorganism employed, and the chemical composition of the BW, resulting in unique profiles with many points of interest for the scientific, as well as for the economic and technical communities.

The *Saccharomyces cerevisiae* yeast in dried and active form is widely used in wineries, because it can ensure a homogeneous fermentation, resulting in high quality wines (Buxaderas & López-Tamames, 2012; Valero, Moyano, Millan, Medina, & Ortega, 2002). Reactions of hydrolysis during the winemaking are caused by enzymes of the grapes themselves or from the microorganisms taking part in the process, as the β-Glucosidases. The influence in the wine composition has been studied, mainly because these enzymes are also capable of hydrolysing non-volatile wine compounds (Hernández, Espinosa, Fernández-González, & Briones, 2003). Polyphenols are a wide range of biological molecules which play a protective role in plants and are daily found in many types of foods and beverages (Leopoldini, Russo, & Toscano, 2011; Prokop, Abrman, Seligson, & Sovak, 2006). The chemical structure of the polyphenols determines their physiological actions, including the antioxidant activity, protection against heart diseases, cancer and neuronal disorders (Stefenon et al., 2012a; Fukui, Choi, & Zhu, 2010; Leopoldini et al., 2011). Resveratrol and its derivatives glucosylated, tyrosol and phenolic acids are cited, between others activities, as neuroprotective and anticancer agents (Fukui et al., 2010; Rodrigo, Miranda, & Vergara, 2011; Vauzour, Corona, & Spencer, 2010). To the best of our knowledge, there are few reports

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about β-Glucosidase performance and about the role of phenolic compounds, especially during ageing on lees in SW, both regarding their capacity to help in human health maintenance as well as in improving the quality of products (Gallardo-Chacón et al., 2010; Stefenon et al., 2010b).

In this context, the goal of this study was to show, for the first time, a comparison between the levels of these phenolic compounds, the enzymatic (especially β-Glucosidase) and antioxidant activities during ageing on lees, in samples of SW produced at industrial scale using the *Champenoise* and *Charmat* methods in the South of Brazil. Furthermore, due to the worldwide increase in sales of these products at, the bonds between the aspects cited above, the general quality of the SW and the differences between both methods were also discussed.

2. Material and methods

2.1. Samples

The samples were elaborated in industrial scale in the companies Möet Henessy do Brazil – Vinhos e Destilados Ltda and Cave Geisse Ltda, using the *Charmat* and *Champenoise* methods (Fig. 1) and divided into three groups: (A) 7000 bottles of *Champenoise* 100% Chardonnay (CHC; base wine – BW1); (B) 7000 bottles of *Champenoise Assemblage* with 48% Chardonnay + 42% Italic Riesling + 10% Pinot Noir (CHA – BW2) and (C) 21,000 bottles of *Charmat Assemblage* (BW2 too). Groups A and B were split in pupitres with a capacity of 120 bottles each one. As for Group C, from three tanks with a capacity of 53,000 litres each one, three other blocks of 7000 bottles were separated. The yeast used in both methods was the *S. cerevisiae* EC1118 and the procedures of filtration, tartaric and protein stabilization were performed before the SW elaboration.

2.2. Chemical reagents

Reagents for the enological assays and DPPH• (2,2-diphenyl-1-picrylhydrazyl) were acquired from E. Merck, Darmstadt, Germany, while the reagents for the high-performance phenolic liquid chromatography (HPLC) and enzyme analyzes were acquired from Sigma–Aldrich (except for piceid HPLC grade, which was acquired from Polyphenols Laboratories AS, Sandnes, Norway). All other reagents were acquired from Extrasynthese, Gennay, France.

2.3. Enological analysis

The alcohol content, total acidity, pressure, volatile acidity, pH, free and total SO_2, dry extract and reduced dry extract, concentration of glucose and ascorbic acid were determined using the methods described by Zoecklein, Fugelsang, Gump, and Nury (2000, chap. 7). For each group of samples, those analyzes were performed in six bottles randomly chosen (twice in each one).

2.4. Determination of polyphenols by UV spectrophotometry

Total polyphenols (TP) and total hydroxycinnamates (THC) were quantified by measuring the absorbance at 280 and 320 nm (Shimadzu UV-1700 spectrophotometer), respectively. TP were expressed as mg/L of catechin and THC as mg/L of caffeic acid. The total flavonoids (TF) were calculated using the following formula, as described by Iland, Ewar, Sitters, Markides, and Bruer (2000), and expressed in mg/L of catechin. $TF = [(A_{280} - 4) - 0.66] \times (A_{320} - 1.4)$.

To determine the total amount of oligomeric procyanidins (OPC), first an acid hydrolysis was performed and then the absorbance at 520 nm was measured in a spectrophotometer (Fukui & Nakahara, 2006). The results were expressed in mg/L of OPC. For each group of samples, those analyzes were performed in six bottles randomly chosen (twice in each one).

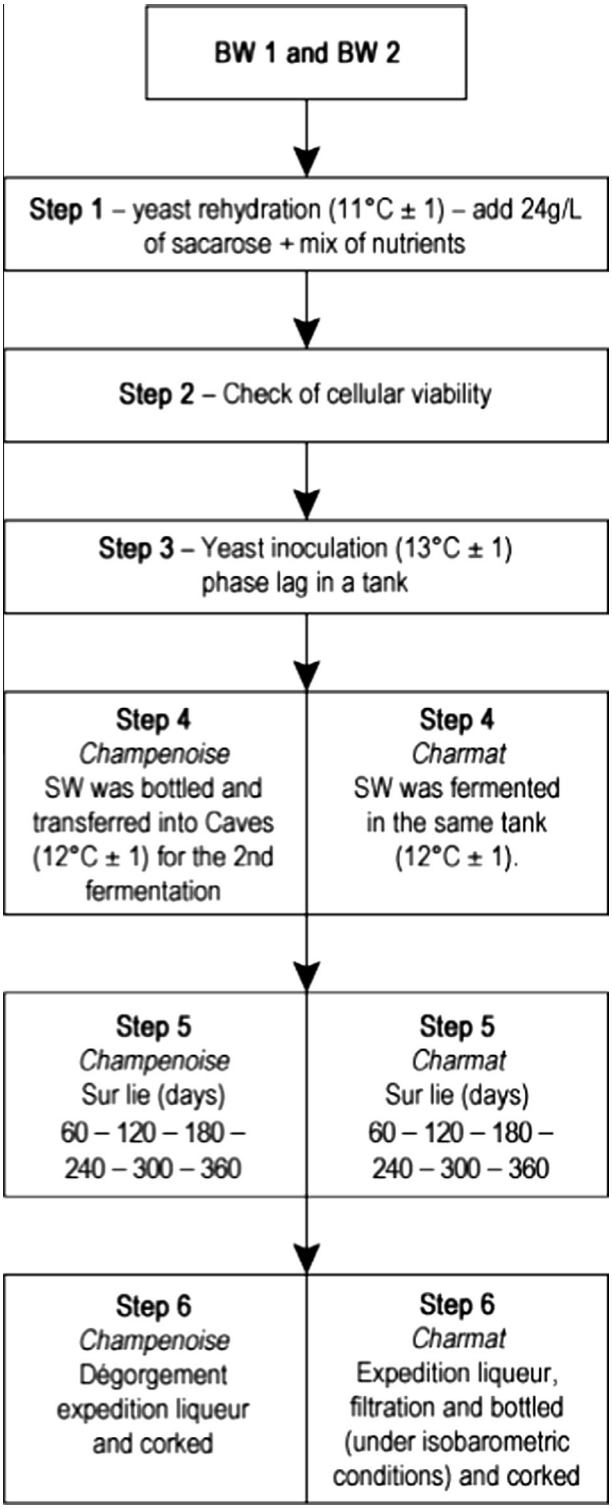

Fig. 1. Schema simplified of sparkling wine production at industrial scale.

2.5. Evaluation of antioxidant activity in vitro

The scavenging capacity of the free radical DPPH• was measured adding a Tris–HCl buffer solution (100 mM, pH 7.0) containing