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Effect of grape juice press fractioning on polysaccharide and oligosaccharide compositions of Pinot meunier and Chardonnay Champagne base wines

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ABSTRACT

Press fractioning is an important step in the production of sparkling base wines to segregate the grape juices with different qualities. Grape juice fractions were collected during the pressing cycle at industrial and laboratory scales. The Pinot meunier and Chardonnay Champagne base wines obtained from the free-run juice and the squeezed juices exhibited strong differences from the beginning to the last step of pressing cycle for numerous enological parameters. Significant changes in polysaccharide (PS) and oligosaccharide (OS) base wine composition and concentration were found as the pressing cycle progressed. During the pressing cycle, the total PS concentration decreased by 31% (from 244 to 167 mg/L) and 32% (from 201 to 136 mg/L) in the Pinot meunier and Chardonnay wines respectively. The wine OS amounts varied between 97 and 139 mg/L. The polysaccharide rich in arabinose and galactose (39–54%) and mannoproteins (38–55%) were the major PS in the base wines.

1. Introduction

The separation of different grape juice fractions during the pressing cycle is considered as the most important step to control sparkling base wine quality. The aim of the grape juice press fractioning for sparkling wine production such as Champagne is to segregate the grape juice with different qualities and characteristics such as total acidity, pH, phenolic content, coarseness, herb aroma, color and oxidation level. A complete pressing cycle for this style of wine is a series of pressure increases/decreases and pomace breakup resulting in a considerable variation in juice composition occurring throughout the pressing cycle (Blanck & Valade, 1989; Hardy, 1990; Marchal et al., 2012).

Considering the current rules for pressing in Champagne production, grape juice extraction is strictly limited to 25.5 hectoliters, after settling, per 4000 kg marc (traditional unit of measurement for a press-load with whole bunches). In the Champagne region, the law dictates that the grape juice obtained has to be separated in two tanks, according to quality: the first quality juice (the "Cuvée", representing 20.5 hL) and the second quality juice (the "Tailles", representing generally the last 5 hL extracted and corresponding to the first "Taille" and the second "Taille").

Beyond the legal rules of volumetric press fractioning ("Cuvée" 80.4% vol and "Tailles" 19.6% vol), many winemakers adapt juice fractioning that takes into account 1) the grape quality (maturity, juice extraction capacity, millerandage, oxidasic "casse" sensitivity, grape variety) and 2) the type of press (4000 kg traditional press with horizontal plate, 4000, 8000 or 12000 kg pneumatic presses), according to the wine they want to produce (fruity wines, wines to be aged on lees or in barrels before "*tirage*", wines produced from blending different years (non-vintage traditional Champagne wines) or vintage wines.

Today, most champagne presses are equipped with two tanks per press to separate the "Cuvée" and the "Tailles". However, many winemakers install three and exceptionally four tanks to achieve a better juice fractioning. For about 15–20 years, some winemakers separate the auto-pressed juice (free-run juice released during the loading of the press) from the "Cuvée". This auto-press juice is of a low quality and is generally blended with the "Tailles". Some winemakers allocate the "Cuvée" to two stainless steel tanks. This

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results in four factions of different qualities (auto-pressed juice, first "Cuvée", second "Cuvée", and "Tailles"). Others continue to separate the "Tailles" into "Tailles" 1 and "Tailles" 2 because of the strong changes observed at the end of the pressing cycle (Hardy, 1990). More rarely, winemakers separate the auto-pressed juice and then each of the 4–5 squeezed juices into 4–5 different tanks. To date, this juice separation is done exclusively on the basis of sensory observations whatever the fractioning type chosen (from 2 to 5–6 tanks).

A book published in 1718 in Reims (France) and attributed to the priest Jean Godinot lays the foundation for press fractioning of Pinot noir juices with numerous practical observations (Godinot, 1718). These writings describe the assessment of the color and the quality of grape juices throughout the crushing cycle of the grape bunches. The author explained that the wines produced from the juices released during the first and second squeezes are more delicate and more expensive than wines produced from the third and fourth squeezes. It is also noted that the wines produced from the juices corresponding to squeeze 4 to 7 are coarse, stained and sold at a very low price.

Three centuries later however, some practices are no longer used, especially due to Champagne harvest organizational changes. Nowadays harvest often occurs at temperatures of 20–28 °C. These harvest conditions are increasingly common because of climate change (Briche, Beltrando, & Quénol, 2014). The direct consequence is that the press juices obtained from the third press are more colored. Also consumer taste and preferences change. Nowadays, consumers of white wine and sparkling wine want products with freshness, minerality, fruity and floral character while the "mature" characters (bouquet) is less expected (Guide Curien de la Champagne, 2015). For this reason, many winemakers are changing the way they produce wines leading to new sensory characteristics, mainly for sparkling wines. In this context, juice fractioning becomes a major challenge.

After alcoholic fermentation, wines obtained from the "Cuvée" and the "Taille" grape juices differ in regards to several enological characteristics i.e. pH, total acidity, and tartaric acid level (Blanck & Valade, 1989). The differences were also observed between a wine produced with juice of the grape berry originating from the flesh comprised between the center and the zone close to the skin, and a wine produced with the juice of grape berry released by the peripheral zone that is just under the skin, at the end of the pressing cycle (Hardy, 1990). Currently there is minimal data available regarding musts and wines produced from juices isolated during the pressing cycle, which are essential to help winemakers in their enological choices. This is particularly true for polysaccharide (PS) and oligosaccharide (OS) wine compositions which have never been studied in wines produced with grape juices isolated throughout the pressing cycle.

The polysaccharides are present in concentrations ranging from around 200 to 1500 mg/L in wine (Guadalupe, Ayestarán, Williams, & Doco, 2014). PS amounts depend on different parameters that include the grape variety, terroir, maturity stage, vintage, winemaking process, and winemaking stage (Apolinar Valiente, Romero Cascales et al., 2014). Major wine PS are derived from microorganisms which include yeast, bacteria, and fungal grape contamination (i.e. *Botrytis cinerea*) (Ciezack et al., 2010; Francioli, Buxaderas, & Pellerin, 1999), and cell wall of grape berries (Gao, Fangel, Willats, Vivier, & Moore, 2016; Vidal, Williams, Doco, Moutounet, & Pellerin, 2003; Vidal, Williams, O'Neill, & Pellerin, 2001). They are grouped into three families: 1) PS rich in arabinose and galactose (PRAGs), which comprise arabinans, arabinogalactans, and arabinogalactan proteins (AGPs), originating from grape berry cell wall (Ayestarán, Guadalupe, & León, 2004; Doco, Vuchot, Cheynier, & Moutounet, 2003); 2) PS rich in rhamnogalacturonans (RG-I and RG-II), which come, after enzymatic degradation (endogenous or/and exogenous enzymes), from the pecto-cellulosic cell walls of grape berries (Vidal et al., 2001); and 3) the mannoproteins (MPs) and glucans (GL), produced by yeasts and liberated during alcoholic fermentation and during the aging of wine on-lees (Ayestarán et al., 2004; Vidal et al., 2003; Waters, Pellerin, & Brillouet, 1994). Many previous studies described the PS composition of red wines (Apolinar Valiente, Romero Cascales et al., 2014; Guadalupe & Ayestarán, 2007; Guadalupe et al., 2014; Vidal et al., 2003) while minimal information is available regarding white still and sparkling wines. In a recent study, authors found 35% PRAGs, 35% MPs, and 25% GLs in white and rosé sparkling wines (Martínez Lapuente, Guadalupe, Ayestarán, Ortega Heras, & Pérez Magariño, 2013).

The chemical and organoleptic properties of the wine PS fraction have been largely described and several properties have been highlighted including interactions and aggregation with phenolic compounds such as tannins (Poncet-Legrand, Doco, Williams, & Vernhet, 2007) and interactions with wine aroma compounds (Chalier, Angot, Delteil, Doco, & Gunata, 2007). Moreover, the addition of AGPs, MPs or RG-II to a wine decreases the astringency sensation (Vidal et al., 2004). The influence of PS over astringency was recently re-investigated (Boulet et al., 2016; Quijada Morín, Williams, Rivas Gonzalo, Doco, & Escribano Bailón, 2014) and the models proposed by Boulet et al. (2016) confirm that PS decrease astringency perception. MPs prevent protein haze formation in white wine (Waters et al., 1994) and are involved in tartrate stability (Gerbaud et al., 1996). Also Escot, Feuillat, Dulau, and Charpentier (2001) found that some PS increased the color stability of wines, as shown for the gum Arabic added to the wine (Ribéreau-Gayon, Gloriès, Maujean, & Dubourdieu, 2012). Several authors have implicated a role of PS in sparkling wine foam properties (Abdallah, Aguié-Béghin, Abou-Saleh, Douillard, & Bliard, 2010; Coelho, Reis, Domingues, Rocha, & Coimbra, 2011; Martínez Lapuente et al., 2013). Correlations between foam properties of grape juices, base wines, and sparkling wines with PS content and composition have been shown (Girbau Sola, López Tamames, Buján, & Buxaderas, 2002). Some studies have identified yeast MPs released during autolysis as molecules involved in improving foam properties (Abdallah et al., 2010; Coelho et al., 2011). Martínez Lapuente, Guadalupe, Ayestarán, and Pérez Magariño (2015) suggested that MPs and PRAGs were not involved in foamability but were good foam stabilizers.

In contrast to the knowledge of PS fractions of grapes and wines, OS have only recently been characterized. Therefore, the information on wine OS composition and content is still limited. Ducasse, Williams, Meudec, Cheynier, and Doco (2010) first isolated and characterized the acidic OS fractions from red wines. These molecules are natural byproducts of the degradation of grape berry cell wall PS (Ducasse et al., 2010). The acidic and neutral OS detected in wines had a degree of polymerization (DP) between 2 and 50 with a large structural diversity (Bordiga et al., 2012; Doco, Williams, Meudec, Cheynier, & Sommerer, 2015; Ducasse et al., 2010). Various concentrations were analyzed with values ranging from 100 mg/L in Grignolino and Chardonnay wines (Bordiga et al., 2012) to approximately 300 mg/L in Carignan and Merlot wines (Ducasse et al., 2010). In a recent study, OS amounts highlighted for several grape varieties ranged from 33 to 111 mg/L in base wines and from 36 to 115 mg/L in sparkling wines (Esteruelas et al., 2015). The OS structure and amounts observed in wines depend on the grape cultivars and the winemaking process and can be modified by enzyme treatment (Apolinar Valiente, Williams et al., 2014; Esteruelas et al., 2015).

With regards to wine quality, astringency perception is positively related to specific glycosyl residues in the OS fraction from Tempranillo red wines (Quijada Morín et al., 2014). Recently, Boulet et al. (2016) described models based on ultraviolet