PHYSICOCHEMICAL AND SENSORY CHARACTERISTICS OF ROSÉ SPARKLING WINE PRODUCED WITH MERLOT GRAPES IN "CAMPANHA GAÚCHA"

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ABSTRACT – This work evaluated the potential of the Merlot grape produced in Campanha Gaúcha region for the production of sparkling wines. The base wines were made through direct pressing (T1) and cold pre-fermentative maceration (CPM) with 6 (T2), 24 (T3) and 48 (T4) hours of duration. Afterwards, the second fermentation of treatments was conducted by the Champenoise method. The results obtained in the physicochemical analysis demonstrate the potential of elaborating sparkling wines with higher alcohol content from this cultivar in the region. In the sensory analysis, all sparkling wines received excellent scores for overall quality and the best results, in general, were observed in the sparkling wine made with 24 hours of CPM (T3). From the results obtained, we can suggest the Merlot grape as an alternative for the production of sparkling wines in the region, requiring more in-depth studies on maturation time and typology of the product to be prepared.

***Index terms**: Oenology, viticulture*, *Vitis vinifera* L.

CARACTERÍSTICAS FÍSICO-QUÍMICAS E SENSORIAIS DE ESPUMANTE ROSÉ PRODUZIDO COM A UVA MERLOT NA CAMPANHA GAÚCHA

RESUMO – Este trabalho avaliou o potencial da uva Merlot produzida na região da Campanha Gaúcha para a elaboração de vinhos espumantes. Os vinhos base foram elaborados através de prensagem direta (T1) e maceração pré-fermentativa (MPF) com 6 (T2), 24 (T3) e 48 (T4) horas de duração. Após, foi conduzida a segunda fermentação dos tratamentos pelo método Champenoise. Os resultados obtidos na análise físico-química demonstram a potencialidade de elaboração de espumantes mais alcoólicos a partir dessa cultivar na região. Na análise sensorial, todos os espumantes receberam pontuações excelentes para a qualidade geral e os melhores resultados, de maneira geral, foram observados no espumante elaborado com 24 horas de MPF (T3). A MPF de 48 horas (T4) também propicia bons resultados, destacando o aporte de aromas frutados. A partir dos resultados obtidos, podemos sugerir a uva Merlot como alternativa para produção de espumantes na região, necessitando estudos mais aprofundados sobre tempo de maturação e tipologia de produto a ser elaborado.

Termos para indexação: enologia, viticultura, *Vitis vinifera* L.

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INTRODUCTION

Sparkling wine has great commercial relevance in Brazil. In the last 20 years, there was an increase of more than 700% in the commercialization of sparkling wines, surpassing, in 2018, 18 million liters sold in Brazil (Mello, 2019). However, not all sparkling wines sold in Brazil are domestically produced. Even with the quality of Brazilian sparkling wine, which has been gaining international recognition, the volume of imported sparkling wines is still high (Ibravin, 2020a). The reasons behind this accentuated importation are the most varied: the low cost of foreign sparkling wine, diversity of varieties and types, quality, accessibility of sparkling wines highlighted in specialized contests or the product marketing.

Sparkling wines are basically produced by two processes, the champenoise and the charmat. The champenoise, or traditional method, consists of a second fermentation, carried out inside the bottle, from a "base" wine, providing the natural formation of carbon dioxide. These sparkling wines have specific sensory characteristics, generally more complex and evolved than those found in sparkling wines elaborated by the charmat process (Buxaderas and López-Tamames, 2012), which are appreciated by the consumer. In the charmat method, the second fermentation is carried out in specially designed tanks and then destined for bottling (Guerra et al., 2019).

Rio Grande do Sul state is responsible for a large part of the wine production in Brazil. In 2019, 666,423 tons of grapes were produced in the state (IBGE, 2020). In 2018, the state sold 19.5 million liters of sparkling wine (Ibravin, 2020b). In addition to the region of Serra Gaúcha, the main producer in the state and country, other production hubs stand out, such as the Campanha Gaúcha.

In Brazil, among the cultivars used for the production of sparkling wines, Chardonnay, Pinot Noir, Riesling Itálico, Glera, Moscato Branco and Moscato Giallo stand out (Mello and Machado, 2017). However, Merlot (*Vitis vinifera* L.) is one of the most appreciated cultivars worldwide, considering that in 2015, 266 thousand hectares of planted area were registered, representing 3% of the total area of vineyards (OIV, 2017). Its cultivation is mainly used for the production of red wines. Despite presenting interesting characteristics for the production of sparkling wines, its use as a base for sparkling wine is still not widespread (Caliari et al., 2014; Guerra et al., 2019).

Thus, considering the importance of sparkling wines for national vitiviniculture, the objective of this work was to study the potential of cv. Merlot in the production of sparkling wines by the Champenoise method, and its influence on the physicochemical and sensory characteristics of the elaborated products.

MATERIALS AND METHODS

The vinification process used Merlot cultivar grapes, clone M8 (Vivai Cooperativi Rauscedo, Italy) on rootstock Paulsen 1103, from a 14 year old vineyard located in the municipality of Bagé / RS (31º13›48 «S 53º58›58» W), altitude 355 meters. The vineyard was implanted over an eutrophic red-yellow Latosol Argisol (Santos et al., 2013). The vines are conducted in a simple espalier, pruned in a double sporonated cord, with 1.2 m spacing between plants and 3.0 m between rows. Yield in the 2016 harvest was 7.0 T ha^{-1}.

The harvest was carried out on February 17, 2016. The grapes were stored in plastic boxes suitable for transportation and taken to Universidade Federal do Pampa - Campus Dom Pedrito, where they were stored in a cold chamber (4 °C for 24 h). Subsequently, the grapes were weighed and processed to make the base wine. The treatments were defined based on the designation of four methods for obtaining the musts: T1 = direct pressing; T2 = pressing after 6 hours of cold pre-fermentative maceration (CPM); T3 = after 24 hours CPM; and T4 = after 48 hours CPM.

After manual destemming, the T1 base wine berries were pressed directly, and the other treatments (T2, T3 and T4), suffered the CPM process according to the periods previously described before being pressed. The four treatments were placed separately in large glass bottles, with a capacity of 14 L, sealed with a silicone stopper and Müller valve (air-lock system), for alcoholic fermentation. After the treatment maceration periods (T2, T3 and T4), they were also pressed (all treatments were pressed in a manual hydraulic press).

In all vinifications, 100 $mg.L^{-1}$ of potassium metabisulfite (BASF SE, Ludwigshafen, Germany) were added as an antioxidant and 5 $g.hL^{-1}$ of the pectolytic enzyme ColorPect VR-C® (Amazon Group Ltda, Bento Gonçalves, Rio Grande do Sul, Brazil) to assist the previous cleaning process (débourbage) in T1 and to facilitate the extraction of skin components, especially anthocyanins, in the other treatments. For the preparation of T1 base wine, in addition to the enzyme, 30 $g.hL^{-1}$ of charcoal (Carbone Ultra®, Amazon Group Ltda., Bento Gonçalves, Rio Grande do Sul, Brazil) were added. In treatments with CPM, 75 $g.hL^{-1}$ of silica (30-Sil®, Amazon Group Ltda., Bento Gonçalves,

Rio Grande do Sul, Brazil) and 20 $g.hL^{-1}$ of gelatin (Lik-Gel®, Amazon Group Ltda., Bento Gonçalves, Rio Grande do Sul, Brazil) were added after pressing the pomace to assist in the prior cleaning of the must (débourbage).

After the prior cleaning, the musts were transferred to 4.6-liter bottles and yeast was prepared and inoculated to start alcoholic fermentation. 30 $g.hL^{-1}$ of dry active yeast Saccharomyces cerevisiae bayanus (Maurivin AWRI R2®, AB Biotek, Sydney, Australia) and 20 $g.hL^{-1}$ of fermentation activator Gesferm Plus® (Amazon Group Ltda., Bento Gonçalves, Rio Grande do Sul, Brazil). The fermentation was carried out under initial refrigeration at 15 ºC (48 hours), and at 20 °C for 11 days, with daily measurements of density and temperature. At the end of this fermentation, a racking was carried out (separating the coarse lees from the clear fraction) and were added 30 $mg.L^{-1}$ of potassium metabisulfite, to avoid malolactic fermentation. Subsequently, cold stabilization (30 days) was carried out in order to prepare the base wine for filling.

The method used for foam formation was the champenoise. 10 liters of each treatment were used. In the tirage liquor, 25 $g.L^{-1}$ of sugar (sucrose) were added. In the inoculation of yeasts for the foam formation, the yeast Maurivin AWRI R2® (30 $g.hL^{-1}$) was used. 20 $g.hL^{-1}$ of yeast extract Yeast Extract Powder® (MP Biomedicals LLC, Solon, OH, United States) and 20 $g.hL^{-1}$ of clarifier prepared based on bentonite and potassium alginate (Algiclar®, Amazon Group Ltda., Bento Gonçalves, Rio Grande do Sul, Brazil) were added before filling in "champagne" bottles with bidule and "corona" lid. The bottles were conditioned horizontally for 30 days, for alcoholic fermentation, at 16 °C. Maturation on lees was carried out for 60 days. Subsequently, the sparkling wines were subjected to the process of "remuage" in wooden "pupitres" for eight days in order to sediment the lees in the spouts of the bottles. Afterwards, they were placed with the spouts down, in a cold chamber (0 °C) for nine days, for fixing these lees and facilitating the "disgorgement" process.

For this process, an equipment that freezes the spout of the bottles was used, allowing lees to be removed as a result of the internal pressure of the bottle that expels the ice block from the bottle spout. Then, the bottles were sealed (cork stopper and wire cage). Three bottles (repetitions) of each treatment were stored in a controlled environment (8 °C and in the absence of light) until the physicochemical and sensory analysis of the sparkling wines were carried out.

The grape must analysis was performed on the WineScan SO_2 equipment (Foss Analytics, Hillerød, Denmark) using the Fourier-transform infrared spectroscopy (FTIR) method. Four samples were collected and obtained on average: 17 °Brix of total soluble solids, 1,082 $g.mL^{-1}$ of initial density, 102.5 $meq.L^{-1}$ of total acidity and pH 3.64. All physico-defined analysis of the wines were performed at the Wine Chemistry Laboratory of the Universidade Federal do Pampa - Campus Dom Pedrito, following the methodologies of Rizzon (2010) for alcohol, total acidity, volatile acidity, pH, total and free SO_2, sugars and dry extract. The methodologies of Ribéreau-Gayon et al. (2006) were used for spectrophotometric analysis (intensity and color tonality, total polyphenol index - TPI - and anthocyanins). Spectrophotometric analysis was performed on UV / VIS equipment (UV-2000A®, Instrutherm, São Paulo, SP, Brazil). To assist the sparkling wine analysis process, a vacuum pump was used to remove carbon dioxide.

Sensory analysis was conducted on the premises of the experimental winery at the Universidade Federal do Pampa - Campus Dom Pedrito. The sensory panel was composed of 12 winemakers. Initially, a sparkling rosé (test sample) was served to calibrate the senses and explain the evaluation form to the participants. Then, the sparkling wines elaborated in the research were served. The samples were served at 8 °C and identified with a three-digit random code. Quantitative descriptive sensory analysis (DQA) of the samples was performed and specific characteristics of the sparkling wines were selected to compose the analyzes: visual (color intensity, effervescence intensity, foam quality and bubble size), olfactory (fruity, yeast, fineness and undesirable odor), taste (sweetness, intensity of taste, distinctiveness, acidity, undesirable taste, persistence) and general quality. A parametric evaluation scale from 0 to 9 was used, according to the intensity of each of the descriptors.

The experiment was conducted in a completely randomized design with four treatments, described above, and three repetitions per treatment. The analysis results were statistically evaluated by ANOVA® and Tukey® (HSD) analysis of variance at the level of 5% significance between the means, using the Statistix 8.0 program.

RESULTS AND DISCUSSION

The alcoholic strength of the base wines did not differ, as expected, being around 11.7% vol. The base wine made by direct pressing (T1) showed higher total acidity and lower volatile acidity and pH, while treatments where there was maceration obtained higher values in the spectrophotometric analysis, also as expected (Table 1).

Table 1 - Physicochemical analysis of the base wines of cultivar Merlot, under different methods of elaboration, in Campanha Gaúcha, vintage 2016: T1 - direct pressing; T2 - cold pre-fermentative maceration (CPM) for 6 hours; T3 - CPM for 24 hours; T4 - CPM for 48 hours

Variables	T1	T2	T3	T4
Alcohol (% vol.)	11.76 ^{A}	11.78 ^{A}	11.67 ^{A}	11.71 ^{A}
Total acidity (meq.L^{-1})	96.4 ^{A}	89.5 ^{B}	91.6 ^{B}	90.3 ^{B}
pH	3.63 ^{B}	3.71 ^{A}	3.72 ^{A}	3.76 ^{A}
Volatile acidity (meq.L^{-1})	0.29 ^{C}	0.31 ^{BC}	0.41 ^{A}	0.35 ^{B}
Total SO_2 (mg.L^{-1})	56.5 ^{A}	57.4 ^{A}	51.2 ^{B}	36.4 ^{C}
Free SO_2 (mg.L^{-1})	7.4 ^{B}	7.6 ^{B}	8.7 ^{A}	7.1 ^{B}
Dry extract (g.L^{-1})	23.3 ^{A}	22.6 ^{B}	22.4 ^{B}	22.4 ^{B}
Density (20 °C)	0.9934 ^{A}	0.9931 ^{B}	0.9932 ^{AB}	0.9931 ^{B}
PTI	4.8 ^{C}	9.3 ^{B}	11.5 ^{AB}	12.7 ^{A}
Total anthocyanins (mg.L^{-1})	49.2 ^{C}	58.0 ^{BC}	66.4 ^{B}	89.5 ^{A}
Tonality	1.27 ^{A}	0.91 ^{B}	0.83 ^{C}	0.85 ^{C}
Intensity	0.14 ^{D}	0.25 ^{C}	0.30 ^{B}	0.35 ^{A}

$^{A, B, C, D:}$ Different letters on the line indicate a 5% difference, according to the Tukey test.

Brazilian legislation establishes that sparkling wines, except sparkling muscatels, must have 10 to 13% vol. (BRASIL, 1988a). Therefore, we can consider the levels found were high, given that with the addition of sucrose for the foam formation, there is an increase of just over 1% vol. approximately (Rizzon et al., 2000). This high alcohol content is the result of the maturation that the cultivar tends to achieve (Pons et al., 2018). In addition, alcoholic fermentation was successfully completed in all treatments (final density 0.993 g.mL^{-1}).

For total acidity, the values ranged from 89.5 to 96.4 meq.L^{-1}. The T1 treatment showed a higher concentration than the others, which can be explained by the interrelation of the potassium contents of the musts, since the maceration (applied in T2, T3 and T4) extracts a greater amount of potassium from the skin, reducing the acidity of the wine. (Zocche et al., 2016; Stein et al., 2018). On the other hand, direct pressing to obtain the must does not apply maceration, justifying the higher acidity for T1.

Regarding pH, an inverse relationship to total acidity is observed, since T1 wine had the lowest value. The observed pH values were high, between 3.63 and 3.76, decreasing the wine's ability to protect itself against oxidation (Guerra, 1998). However, this is not necessarily a problem, given that most sparkling wines are intended for being consumed young, resulting in rapid commercialization and consumption.

The volatile acidity remained within the limits established by the legislation (maximum of 20 meq.L^{-1}), for all base wines. However, the treatments showed a difference, where maceration contributed to the increase in the values of volatile acidity (Ribéreau-Gayon et al., 2003).

The low concentration of free sulfur dioxide (Table 2) is essential for a sparkling base wine, as high rates of free SO_2 can hinder the second alcoholic fermentation (Lona, 2006). All treatments showed values below 9 mg.L^{-1}. The total SO_2 concentration is in accordance with Brazilian legislation (Ordinance No. 229, of October 25, 1988).

Regarding the dry extract, there were levels between 22.4 and 23.3 g.L^{-1}, suitable for sparkling wines (Poerner et al., 2010; Guerra et al., 2019). These levels are related to the characteristics of the cultivar and the stage of maturation of the vinified grapes (T1, even with direct pressing and without maceration, showed color input), in addition to the longer maceration period (T2, T3 and T4) (Flanzy, 2003).

In relation to spectrophotometric analysis, the longer the maceration time, the higher the values of color intensity, anthocyanins and total polyphenol index (TPI); and the lower the color tonality. All of these results were

expected, since the color tonality is the quotient between yellow and red, and the higher this value, the greater the predominance of the former (Ribéreau-Gayon et al., 2006). In addition, the longer time of contact with the skin and seeds, results in greater extraction of phenolic compounds as a whole (Aleixandre-Tudo and Toit, 2018).

Table 2 - Physicochemical analysis of sparkling wines of the cultivar Merlot of Campanha Gaúcha, Safra 2016

Variables	T1	T2	T3	T4
Alcohol (% v/v)	12.64 ^{AB}	12.37 ^{BC}	12.72 ^{A}	12.29 ^{C}
Total acidity (meq.L^{-1})	82.80 ^{A}	79.57 ^{C}	79.47 ^{C}	84.93 ^{A}
Corrected volatile acidity (meq.L^{-1})	1.27 ^{B}	1.14 ^{BC}	1.01 ^{C}	1.97 ^{A}
Total SO_2 (mg.L^{-1})	46.1 ^{A}	43.8 ^{AB}	36.2 ^{BC}	28.9 ^{C}
Free SO_2 (mg.L^{-1})	9.93 ^{A}	9.67 ^{A}	9.73 ^{A}	10.1 ^{A}
pH	3.90 ^{A}	3.88 ^{A}	3.88 ^{A}	3.82 ^{A}
Dry extract (g.L^{-1})	24.2 ^{AB}	24.8 ^{A}	23.1 ^{B}	24.0 ^{AB}
Density (20 ˚C)	0.9933 ^{A}	0.9931 ^{A}	0.9922 ^{B}	0.9931 ^{A}
PTI	9.33 ^{D}	12.5 ^{C}	12.6 ^{B}	14.4 ^{A}
Total anthocyanins (mg.L^{-1})	3.1 ^{C}	21.6 ^{B}	32.8 ^{A}	38.2 ^{A}
Tonality	1.67 ^{A}	1.20 ^{B}	1.07 ^{C}	1.0 ^{D}
Intensity	0.06 ^{D}	0.10 ^{C}	0.12 ^{B}	0.18 ^{A}
Reducing sugars (g.L^{-1})	3.46 ^{B}	4.31 ^{A}	1.39 ^{D}	1.91 ^{C}

$^{A, B, C, D:}$ Different letters on the line indicate a 5% difference, according to the Tukey test.

There was a small decrease in total acidity in all treatments, as well as a significant increase in pH. The spectrophotometric analysis showed the same behavior as the base wine, with an increase in color tone values (Table 2).

The alcoholic content of the sparkling wines showed high values after the foam formation process, however adequate to the current legislation (BRASIL, 1988b). The treatments showed some differences in alcoholic strength. This can be explained by the differences found in the levels of reducing sugars. One of the peculiarities of the champenoise method is that fermentations, although they take place in a similar environment, develop individually, and may differ between bottles (Buxaderas and López-Tamames, 2012). During the second fermentation there

is a reduction in the total acidity levels and an increase in the pH of the wines (Ribéreau-Gayon et al., 2006). Still, according to the same authors, despite low concentrations, sparkling wines had higher volatile acidity than the base wine, a result of the production of acetic acid by the yeast itself.

Brazilian legislation does not establish minimum and maximum limits for dry extract content. After the second fermentation, values higher than those found in the base wine were observed, which may be related to the structure and body of the sparkling wines, brought by the yeasts during maturation on the fine lees (Sartor et al., 2019). The levels of free SO_2 increased after the second fermentation. This may be a result of the secondary metabolism of yeasts, which produce SO_2 (Ribéreau-Gayon et al., 2003).

Total anthocyanins showed a noticeable reduction in the sparkling wine compared to the base wine. This is probably due to the addition of clarifier (bentonite) during foam formation (González-Neves et al., 2014). This adjuvant assists in the precipitation of wine proteins, reducing its turbidity (Jaeckels et al., 2017).

The values of intensity and tonality show that there was a variation corresponding to the time of contact of the skins with the must in the cold pre-fermentative maceration (T2, T3 and T4) and in the direct pressing (T1). Also, it was observed that, even without contact with the skin, the sparkling wine made by direct pressing (T1) presented a rosé tone. This is a result of the characteristic of this variety that also has anthocyanins in the pulp (Pastrana-Bonilla et al., 2003; Falcão et al., 2007). This leads us to

consider that the use of ripe red grapes for the production of white sparkling wines requires a greater supply of charcoal, which although can have positive aspects, the charcoal can inhibit pleasant sensory characteristics in the wine (Filipe-Ribeiro et al., 2017). It also allows us to conclude that the production of rosé sparkling wine, from red cultivars, can be done without maceration, reducing costs and steps that can influence the final quality of the product.

For all sensorially evaluated attributes, differences were found, especially for color intensity, yeast aroma (and similars), undesirable odor, fineness, distinctiveness of taste and undesirable taste (Figure 1). As for the color intensity, the T1 and T4 treatments were the ones that showed the greatest difference between them. Expected result, as these treatments also showed differences in physicochemical attributes, unlike treatments T2 and T3. For effervescence intensity, foam quality and bubble size, treatments T3 and T4 obtained the best results.

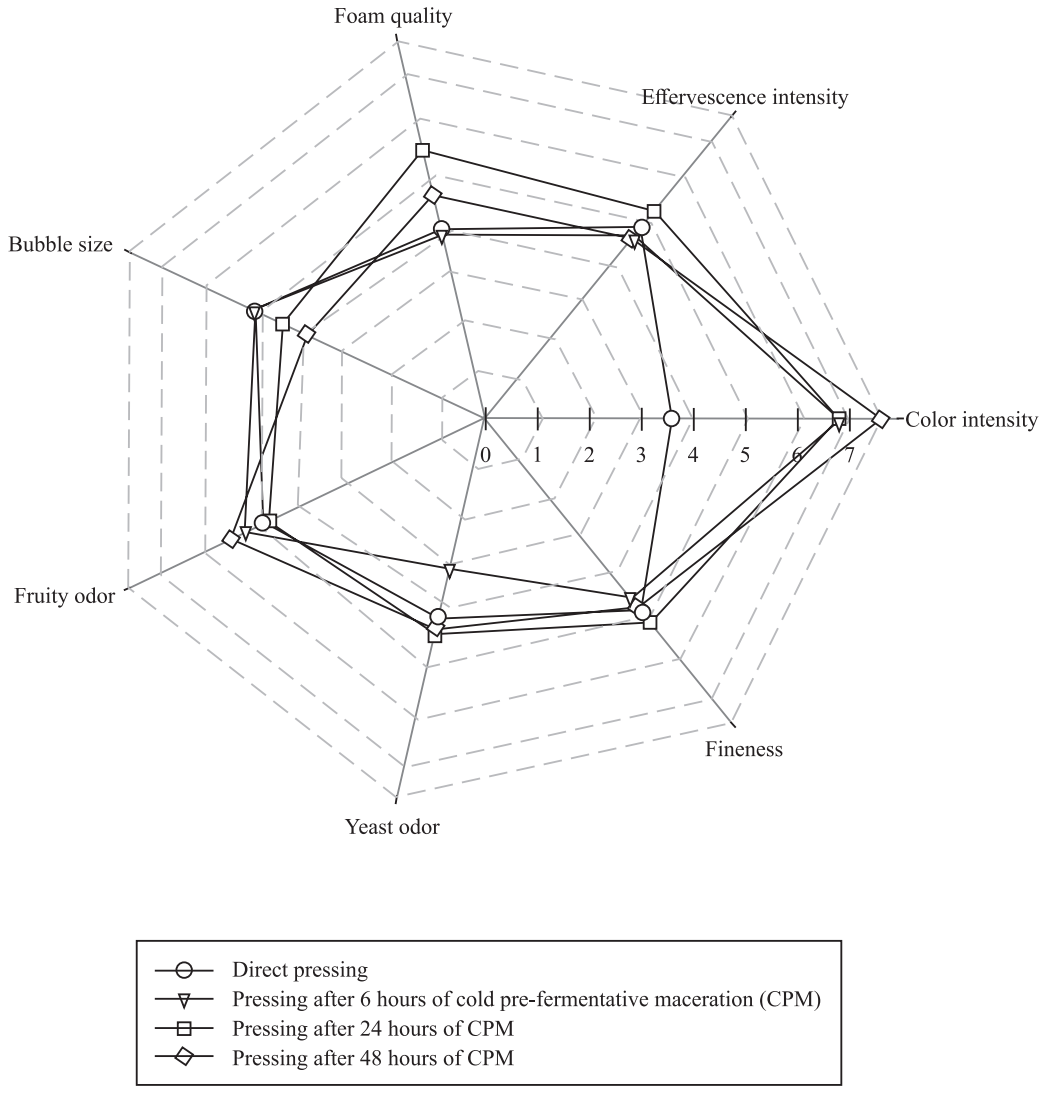

Figure 1 - Sensory variables (visual and olfactory) of sparkling wines elaborated from the cultivar Merlot in Campanha Gaúcha, Safra 2016.

The sparkling wines presented similar aromatic complexity, varying only in intensity. Although unexpected, an undesirable aroma (not specified by the evaluators) and not very intense, was perceived in T1. This may be related to the fact that red cultivars, when vinified in white, generally do not have fine and delicate aromas, which are carried away by the high dosage of clarifiers used in the search for the desired color, in addition to the differences in the aromatic constitution of the cultivars (Rizzon et al., 2000).

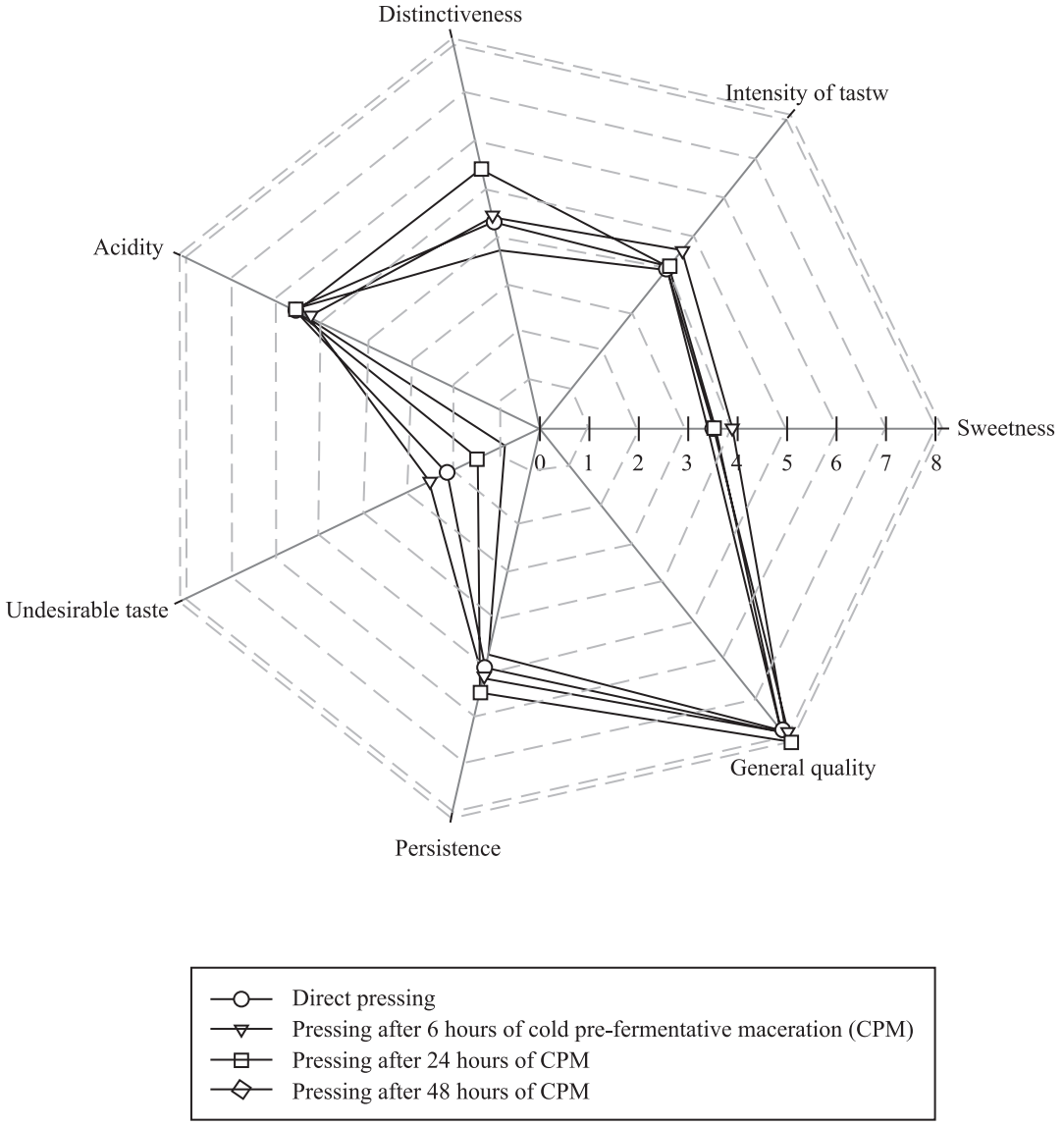

Figure 2 - Sensory variables (taste) of sparkling wines made from the cultivar Merlot in Campanha Gaúcha, Safra 2016.

All treatments presented similar evaluations for the attributes of intensity of taste, acidity and persistence of taste. For distinctiveness, the T3 treatment showed the best result. For undesirable taste, T2 showed greater intensity. T4 showed the best result for fruity aroma. In general quality, the four treatments scored close to 8 (scale 0-9), which represents a good acceptance by the judges.

The results obtained in this work indicate that the cultivar Merlot can be used in the production of rosé sparkling wines. The physicochemical analysis does not make the base wines from any of the maceration periods unfeasible (or even without maceration, as in T1) for the purpose of making quality sparkling wines. This can be proven by comparing these results with the specifics of the legislation. The excellent acceptance of the rosé sparkling wines, proven by their sensory analysis, before a table of trained winemakers, corroborates this statement.

CONCLUSIONS

The cultivar Merlot, produced in the Campanha Gaúcha, shows the potential to be used in the production of sparkling rosé wines.

Cold pre-fermentative maceration periods, especially 24 and 48 hours, favor the sensory characteristics of the products.

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