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Research Article

Comparison of the chemical and aromatic profile of 'Sauvignon Blanc' wines produced in the high-altitude region of Santa Catarina/Brazil and in Marlborough/New Zealand

Comparação do perfil químico e aromático de vinhos 'Sauvignon Blanc' elaborados em região de altitude de Santa Catarina - Brasil e em Marlborough - Nova Zelândia

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ABSTRACT

The objective of this work was to quantify the chemical compounds and the varietal aroma of Sauvignon Blanc wines produced in the high-altitude (above 900 meter) regions of Santa Catarina/Brazil and compare them with New Zealand Sauvignon Blanc wines, a world reference country for the style of this variety. For the chemical and aromatic description, wines from nine wineries from the altitude regions from the 2013 vintage and nine commercial wines from the 2013 vintage from the winegrowing region of Marlborough/New Zealand were selected. Classical analyzes and quantification of phenolic and aromatic compounds of the wines were carried out. In comparison, altitude Sauvignon Blancs have lower residual sugar content, making altitude wines drier than New Zealand wines. Among the 35 compounds identified, 19 contributed individually to the aromas of 'Sauvignon Blanc', with several esters, higher alcohols and terpenes having a similar influence in both regions. However, the varietal thiols 3MH and 3MHA stand out in New Zealand wines, with a great impact on the aroma. The aromatic compounds of high-altitude Sauvignon Blanc wines from Santa Catarina State were consistent between the two evaluated vintages. The compounds that most contributed to the high-altitude Sauvignon Blanc aromas were: isoamyl acetate, ethyl hexanoate, ß-damascenone and ethyl butanoate, related to fruity (apple, pear, banana) and floral aromatic descriptors.

KEYWORDS: *Vitis vinifera* L. Volatile compounds. Altitude wines.

RESUMO

O objetivo deste trabalho foi quantificar os compostos químicos e o aroma varietal de vinhos de Sauvignon Blanc elaborados nas regiões de altitude elevada catarinense) e comparar estes com os vinhos Sauvignon Blanc neozelandeses, país de referência mundial para o estilo desta variedade. Para a descrição química e aromática foram selecionados vinhos de nove vinícolas das regiões de altitude da safra 2013 e nove vinhos comerciais da safra 2013 da região vitícola de Marlborough/Nova Zelândia. Foram realizadas as análises clássicas e quantificação dos compostos fenólicos e aromáticos dos vinhos. Os vinhos Sauvignon Blanc produzidos em SC com altitude acima de 900m possuem menor teor de açúcar residual, caracterizando os vinhos de altitude mais secos do que os vinhos neozelandeses. Dentre os 35 compostos identificados 19 contribuíram individualmente para os aromas de 'Sauvignon Blanc', sendo vários ésteres, álcoois superiores e terpenos com influência similar nas duas regiões. Porém destaca-se nos vinhos neozelandeses os tiois varietais 3MH e 3MHA com grande impacto no aroma. Os compostos aromáticos dos vinhos Sauvignon Blanc de elevada altitude de SC apresentaram consistência entre as duas safras avaliadas. Os compostos que mais contribuíram para os aromas de vinhos Sauvignon Blanc produzidos em

SC com altitude acima de 900 m foram: acetato de isoamila, hexanoato de etila, ß-damascenona e butanoato de etila, relacionados a descritores aromáticos frutados (maçã, pera, banana) e floral.
PALAVRAS-CHAVE: *Vitis vinifera* L. Compostos voláteis. Vinhos de altitude.

INTRODUCTION

The high altitude region of Santa Catarina State/Brazil is characterized by presenting its vineyards at an altitude ranging from 900 to 1400 meters above sea level. The 'Sauvignon Blanc' wines made in this region have specific characteristics: high complexity, aromatic quality and typicality, which differentiates them from 'Sauvignon Blanc' wines made in other wine-growing regions, due to the adaptation of this variety to the edaphoclimatic conditions of the altitude region of Santa Catarina (BRIGHENTI *et al.* 2013, MARCON FILHO 2016, WURZ *et al.* 2018). Wines made from ‘Sauvignon Blanc’ grapes have a marked acidity with fresh, sharp, and pungent flavor and aromas (GOODE 2012).

Aroma is one of the most important factors in the identity, typicality, and quality of a wine. The aroma of ‘Sauvignon Blanc’ wine is determined by relatively few volatile compounds and is typically described with notes of bell pepper, asparagus, currant, boxwood, peach, pomelo and passion fruit. The herbaceous or vegetative character of Sauvignon Blanc wines (e.g. pepper and asparagus) is mainly attributed to the presence of compounds from the pyrazine group (ALLEN *et al.* 2011). "Tropical" aroma notes (e.g. passion fruit and pomelo) have been attributed to the presence of varietal thiols (also referred to as volatile thiols), formed during alcoholic fermentation (HERBST-JOHNSTONE *et al.* 2011). These aromatic compounds are intensely odorous, exhibiting extremely low thresholds of perception in a range of parts per trillion, and thus contribute to the varietal aromas of wine even at low concentrations (MARCON FILHO 2016).

However, other grape-derived aroma compounds, such as monoterpenes, C13-norisoprenoids, C6-aldehydes and C6-alcohols, as well as aromatic compounds derived from chemical and biological transformations during fermentation and bottle aging, such as esters, higher alcohols and fatty acids, may also contribute to the aroma complexity of 'Sauvignon Blanc' wines (HERBST-JOHNSTONE *et al.* 2013).

Eighty percent of the total grape production area in New Zealand is a combination of three major cultivars: Sauvignon Blanc, Pinot Noir and Merlot (NEW ZEALAND WINEGROWERS 2020). The Marlborough wine region alone represents 70% of the national production area (NEW ZEALAND WINEGROWERS 2020), with 85% of this region’s production area being Sauvignon Blanc, as well as being the largest production area of Pinot Noir (WINE MARLBOROUGH 2019). The flavors and aromas of New Zealand's Sauvignon Blanc have dazzled wine critics around the world, and arguably it is the wine that sets the international benchmark for the style of this variety (GOODE 2012).

The worldwide success of New Zealand's Sauvignon Blanc has totally changed the face of the country's industry. In the last decade, a multidisciplinary and multicenter research program has been underway in New Zealand. The aim of this program was to address a knowledge gap, recognized by the New Zealand wine industry, as

success in the international market was already taking place in sales, but the industry needed a solid foundation of knowledge to understand what differentiated the New Zealand 'Sauvignon Blanc' from other regions. With ongoing research, the New Zealand 'Sauvignon Blanc' production system has effectively become a model, with research results on this variety having applicability extending beyond New Zealand, and beyond 'Sauvignon Blanc' (MARCON FILHO 2016).

Currently, Sauvignon Blanc is the most planted white variety in the altitude region of Santa Catarina (VIANNA *et al.* 2020). Due to the lack of information on the aromatic profile of these wines in the region (CALIARI *et al.* 2014, CALIARI & ZANUS 2020), a work was carried out in partnership with the University of Auckland in New Zealand with the objective of quantifying the chemical compounds and the varietal aroma of commercial wines from 'Sauvignon Blanc' produced in the high altitude regions of Santa Catarina/Brazil, and later, to compare them with Sauvignon Blanc wines from Marlborough/New Zealand.

MATERIAL AND METHODS

This work was carried out at the University of Auckland - New Zealand, in 2014, comparing commercial wines made with the Sauvignon Blanc variety from two different wine regions: the high-altitude region of the state of Santa Catarina/Brazil and wines from the region of Marlborough/New Zealand.

Commercial wines of ‘Sauvignon Blanc’, vintage 2013, were selected from nine wineries located in the altitude regions of Santa Catarina between 900 and 1427 m, in the municipalities of São Joaquim, Urubici, Urupema, Painel, Campo Belo do Sul and Água Doce. Nine commercial wines from the Marlborough region – New Zealand, vintage 2013, came from companies associated with the University of Auckland program, which are available for chemical and aromatic description.

Two samples (750 ml bottle) were taken from each winery to carry out the characterization of chemical compounds and aromatic profile in 'Sauvignon Blanc' wines. One of the samples was stored as a control, and the other was transported to University of Auckland in New Zealand, for chemical and phenolic analysis. The samples were kept in a room with controlled temperature (±18º C) until the moment of analysis. Immediately after opening the bottles, the quantification of volatile compounds (thiols, esters, terpenes, norisoprenoids, cinnamates, fatty acids, six-carbon compounds and higher alcohols) was carried out. The remainder of each sample was divided into aliquots and frozen for analysis of methoxypyrazines, polyphenols and classic analyzes (alcohol content, total acidity, volatile acidity, pH, residual sugar, free and total SO_2 content and wine color).

The quantification of esters, terpenes, norisoprenoids, cinnamates, fatty acids, six-carbon compounds and higher alcohols were performed by solid-phase microextraction in headspace mode (HS-SPME), combined with gas chromatography with mass detector (GC- MS), using the method previously described by HERBST-JOHNSTONE *et al.* (2013).

The analyzes of varietal thiols: 3-mercaptohexyl acetate (3MHA) and 3-mercaptohexanol (3MH), considered the key compounds of New Zealand Sauvignon Blanc wines, were performed by GC-MS according to the methodology originally

described by HERBST-JOHNSTONE *et al.* (2013). The method used to quantify methoxypyrazines was developed by PARR *et al.* (2007) using HS-SPME-CG-MS.

All samples were analyzed with gas chromatography− mass spectrometry (GC, Agilent 6890 N; MSD, Agilent 5973 inert). The MS was in electron impact mode, with electron multiplier voltage at 1953 V, the source at 230 °C, the quad at 150 °C, emission was 34.6 µA and the electron energy at 69.9 eV. The capillary used was HP-Innowax from J&W Scientific (60 m × 252 µm × 0.25 µm).

Total phenolic content was established by the Folin–Ciocalteu assay, as described by BAJČAN *et al.* (2013). In a 50 mL volumetric flask, 1.0 mL of wine or gallic acid standard and 5.0 mL of 18 Ohm water were added. To this, 0.25 mL of Folin–Ciocalteu reagent and 3.0 mL of 20% sodium carbonate were added. The flasks were brought to volume with distilled water and placed at room temperature, shielded from light for 90 min. The sample absorbance was then measured at 765 nm. Folin–Ciocalteu reagent was obtained from Sigma-Aldrich (St. Louis, MO).

Phenolic compounds were determined by HPLC using the method described by OLEJAR *et al.* (2015). Wine and standard solutions were filtered through 0.2-µm syringe filter and 20 µL of the filtrate were injected into an Agilent 1100 HPLC with UV/Vis detector (Santa Clara, CA) and an ESA Coulochem III electrochemical detector (Waltham, MA). Chromatography occurred at 1.0 mL/min over 30 min at 40 °C on a 3.0 × 100 mm, 3 µm, Supelco Ascentis RP-amide column (Bellefonte, PA). Analyte separation was performed using a gradient elution of mobile phase A: 30 mmol phosphate buffer at pH 2.6, and mobile phase B: a mix (30:10:60) of 100 mmol phosphate buffer, methanol, and acetonitrile at pH 2.6. The gradient was 0–10 min 12% B, 10–15 min 30% B, 15–17.5 min 55% B, 17.5-21 min 55% B, 21–23 min 100% B, and 23–25 min 0% B. Detection of analytes was done at 280, 305, 320 and 365 nm, as well as at 450 and 750 mV. Methanol, etanol and acetonitrile were obtained from Scharlau (Sentmenat, Spain). 18-Ohm water was produced with a Barnsted Nanopure water system (Thermo Scientific, Waltham, MA). The standards anhydrous gallic acid (≥ 98%), (+) - catechin (≥ 98%), epicatechin (≥ 98%), caftaric acid (≥ 98%), 2-S-glutationiltrans-caftaric acid (GRP) (≥ 98%), p-coutaric (≥ 98%), caffeic acid (≥ 98%) and p-coumaric acid (≥ 98%) were obtained from Sigma-Aldrich (Darmstadt, Germany).

The classic analysis: alcohol content, total acidity, volatile acidity, pH, residual sugar, free and total SO_2 content were determined by FTIR (Foss Wine Scan). The color of the wines was performed in a UV-Vis spectrophotometer at 420 nm of absorbance with the procedure described by ILAND *et al.* (2004). The 420 nm absorbance was measured using a Helios Alpha UV–Vis Spectrophotometer (Thermo Fisher Scientific Inc., USA) with a 10 mm pathlength cell, using water as blank.

For each sample, a duplicate reading was performed and when a variation > 10% was detected, a third reading was performed. The experimental design used was completely randomized with nine samples for the altitude regions of Santa Catarina/Brazil and nine samples for the region of Marlborough/New Zealand. Data

were subjected to analysis of variance (ANOVA) by the 'F Test' at 5% probability of error.

RESULTS AND DISCUSSIONS

Among the chemical compounds quantified, residual sugar, p-coumaric acid and some aromatic compounds stood out in the difference between the New Zealand wines and the Brazilian wines evaluated.

Regarding the residual sugar content, 1.9 g L^{-1} was observed for altitude wines and 4.5 g L^{-1} for New Zealand wines (Table 1). Altitude wines can be characterized as drier than New Zealand wines. Regarding the values of residual sugars, all samples are classified as dry wines (BRASIL 2018). Residual sugar is important for the characteristic sweetness of wine, in which concentrations below 1.5 g L^{-1} are imperceptible to the human palate. The perception of sweetness is also influenced by other constituents such as alcohol, acidity and tannins in wines (JACKSON 2014). The high residual sugar content in New Zealand wines can mitigate the perceived acidity, which is generally high in Sauvignon Blanc wines.

Table 1. Comparison through classical analyzes between commercial 'Sauvignon Blanc' wines produced in high altitude regions of Santa Catarina/Brazil and in Marlborough/New Zealand, vintage 2013.

Classic Analysis	High Altitude Santa Catarina/BR	Marlborough/NZ	F Test (p < 0.05)
Color (*A420nm*)	0.12 ± 0.03	0.11 ± 0.01	ns
Ethanol (%)	12.9 ± 1.0	12.2 ± 0.2	ns
Total Acidity (*g L^{-1}*)	6.7 ± 0.4	7.0 ± 0.1	ns
pH	3.17 ± 0.08	3.27 ± 0.13	ns
Residual Sugar (*g L^{-1}*)	1.9 ± 0.4	4.5 ± 0.3	*

ns = not differ significantly by F test (p < 0.05). Average ± Standard Deviation.

Regarding the variables color (A420 nm), ethanol (%), total titratable acidity (g L^{-1}) and pH, there were no differences between wines from the two wine regions evaluated.

Eight phenolic compounds were identified for 'Sauvignon Blanc' wines from both regions belonging to the groups: flavan-3-ols (catechin and epicatechin), hydroxybenzoic acids (gallic), hydroxycinnamic acids (caftaric, *grape reaction product*-GRP, p -cutaric acid and its respective caffeic and p-coumaric hydrolyzed forms) (Table 02). Compounds from the flavonoid group were not identified in these wines. The same phenolic compounds were identified by HERBST-JOHNSTONE *et al.* (2011) in New Zealand Sauvignon Blanc wines. Polyphenols play an important role in sensory characteristics of wine, such as color, astringency, and bitterness (WURZ *et al.* 2020), and they play a major role in wine quality (CONDE *et al.* 2007). Of these polyphenols, only p-coumaric acid showed a statistical difference, with higher concentrations in New Zealand wines (Table 2), while the other phenolic compounds show similar values between high altitude wines and New Zealand wines.

According to WURZ *et al.* (2017), the importance of p-coumaric acid is related to phenomena of oxidative browning that the musts or white wines can suffer. These

compounds, rich in hydroxyl groups, are the first phenolic substances to be oxidized by the phenoloxidase enzymes in the respective quinones. These quinones are involved in reactions that lead to the appearance of compounds, with colorings ranging from yellow to brown, in musts. According to KILMARTIN *et al.* (2001) a high redox power is required to oxidize phenols such as p-coumaric acid.

Table 2. Comparison of phenolic compounds from commercial 'Sauvignon Blanc' wines produced in high altitude regions of Santa Catarina/Brazil and in Marlborough/New Zealand, vintage 2013.

Phenolic Compound	High Altitude Santa Catarina/BR	Marlborough/NZ	F Test (p < 0.05)
	mg L^{-1}		
Total Polyphenol	196.1 ± 29.4	216.8 ± 5.8	ns
Gallic acid	0.6 ± 0.5	0.5 ± 0.1	ns
Catechin	2.0 ± 1.5	2.7 ± 0.1	ns
Epicatechin	0.9 ± 0.7	1.7 ± 0.5	ns
Caftaric acid	16.3 ± 9.0	8.0 ± 7.8	ns
GRP	4.5 ± 1.6	5.6 ± 0.4	ns
p-Coutaric acid	1.7 ± 1.3	0.8 ± 0.8	ns
Caffeic acid	5.2 ± 10.5	8.6 ± 2.4	ns
p-Coumaric acid	0.6 ± 0.8	2.3 ± 0.4	*

ns = not differ significantly by F test (p < 0.05). Average ± Standard Deviation

These results indicate a more advanced oxidation process in New Zealand wines compared to high altitude Sauvignon Blanc wines, and in this context, it is noteworthy that the harvest of 'Sauvignon Blanc' grapes in the Marlborough region is carried out mechanically, resulting in a greater oxidation process from the moment of harvest, resulting in higher values of p-coumaric phenolic compound.

For the aromatic profile, 35 compounds were identified in commercial Sauvignon Blanc wines for both regions (Table 3). Of the compounds evaluated, there was a statistical difference in the concentrations of varietal thiols (3MH and 3MHA), 3-isobutyl-2-methoxypyrazines, hexanol, decanoic acid, α-terpineol, hexyl acetate, cis-3-hexynyl acetate and ß- acetate phenylethyl with higher concentrations for wines from the Marlborough/New Zealand.

New Zealand Sauvignon Blanc wines are known for distinctive sensory characteristics that include both herbaceous (pepper, grass, tomato leaf and asparagus) and fruity (pomelo/citrus and passion fruit/tropical) aromas (BENKWITZ *et al.* 2012). These aromas are related to methoxypyrazines and 6-carbon compounds (hexanol) with herbaceous characteristics and to varietal thiols related to tropical and passion fruit aromas (MAKHOTKINA *et al.* 2013).

The harvest of 'Sauvignon Blanc' grapes in Marlborough region is carried out mechanically. Generally, the effects of oxidation resulting from mechanical harvesting are related to loss of wine quality (ARFELLI *et al.* 2010). However, authors have reported that higher concentrations of 3MH and 3MHA (ALLEN *et al.* 2011) and 6-carbon compounds such as hexanol and its ester derivatives (HERBST-JOHNSTONE *et al.* 2013) are present in low concentrations in wines made from grapes harvested manually, but in high concentrations in wines harvested mechanically, positively influencing the wine aroma.

Table 3. Comparison of thiols, methozypyrazine, cinnamate, C6-compounds and fatty acids from commercial 'Sauvignon Blanc' wines produced in high altitude regions of Santa Catarina/Brazil and in Marlborough/New Zealand, vintage 2013.

Compound	High Altitude Santa Catarina/BR	Marlborough/NZ	F Test ($p < 0.05$)
	Varietal Thiols (ng L^{-1})		
3-mercaptohexan-1-ol	224 ± 222	6652 ± 6642	*
3-mercaptohexan-1-ol acetate	11 ± 28	892 ± 484	*
	Methoxypyrazine (ng L^{-1})		
3-isobutyl-2-methoxypyrazine	0.5 ± 0.3	1.5 ± 0.6	*
	Cinnamate (µg L^{-1})		
Ethyl (di)hydrocinnamate	1.2 ± 0.9	1.0 ± 0.0	ns
Ethyl cinnamate (trans)	1.7 ± 0.2	1.8 ± 0.0	ns
	C6 Compounds (µg L^{-1})		
Hexanol	1629 ± 690	3350 ± 132	*
	Fatty acids (µg L^{-1})		
Hexanoic acid	3.5 ± 1.0	3.1 ± 0.6	ns
Octanoic acid	5.7 ± 1.0	7.0 ± 1.2	ns
Decanoic acid	5.8 ± 2.0	11.7 ± 0.4	*

ns = not differ significantly by F test ($p < 0.05$). Average ± Standard Deviation

The enzymatic process that occurs in grapes due to mechanical harvesting seems to promote the formation of these compounds. The action of the lipoxygenase enzyme on unsaturated fatty acids appears to be the biochemical source of the 6-carbon compounds in the must. The formation of these compounds is linked to processes and reactions that allow greater oxidation of the must and exposure to lipoxygenase enzyme such as prolonged contact with the skin and depletion in the addition of antioxidants (HERBST-JOHNSTONE *et al.* 2013).

Although the mechanisms of formation of varietal thiols are not yet fully elucidated, there are indications that 6-carbon compounds combined with the addition of SO_2 in fermentation induce greater formation of thiols (MAKHOTKINA *et al.* 2013).

Table 4 shows the aromatic compounds of the alcohol and terpene – norisiprenoids groups, with values expressed in µg L^{-1}. Of these, twelve compounds were quantified, and only one compound showed a difference between Sauvignon Blanc wines from the two wine regions evaluated.

Table 4. Comparison of alcohol and terpene from commercial 'Sauvignon Blanc' wines produced in high altitude regions of Santa Catarina/Brazil and in Marlborough/New Zealand, vintage 2013.

Alcohol and Terpene	High Altitude Santa Catarina/BR	Marlborough/NZ	F Test ($p < 0.05$)
	Alcohol (µg L^{-1})		
Isobutanol	20028 ± 2957	20752 ± 4154	ns
1-butanol	1390 ± 608	1552 ± 424	ns
Isoamylalcohol	161879 ± 15116	168891 ± 2567	ns
Benzyl alcohol	61 ± 35	57 ± 0.0	ns
Phenylethyl alcohol	8262 ± 2268	12476 ± 6255	ns
	Terpene – Norisiprenoids (µg L^{-1})		
β-damascenone	2.7 ± 1.1	3.4 ± 2.2	ns
β-citronellol	3.8 ± 0.9	5.3 ± 1.0	ns
β-ionone	0.8 ± 0.0	0.8 ± 0.0	ns
α-terpineol	2.2 ± 0.8	5.8 ± 2.7	*

ns = not differ significantly by F test ($p < 0.05$). Average ± Standard Deviation

The aromatic compound α-terpineol presented a value of 2.2 μg L^{-1} for altitude wines from Santa Catarina/Brazil, while New Zealand wines presented average values of 5.8 μg L^{-1}. According to MARÓSTICA & PASTORE (2007), this compound is responsible for the aroma of tropical fruits, especially passion fruit, with greater predominance in New Zealand Sauvignon Blanc wine, in addition to floral notes (GONZÁLEZ-BARREIRO *et al.* 2015), has been described as a major aromatic determinant because of its high concentrations in grapevine (EMANUELLI *et al.* 2010).

The aromatic compounds of the Esters group (μg L^{-1}) are presented in Table 5, with seventeen compounds of this group being identified, of which three showed statistically significant differences between the Sauvignon Blanc wines produced in the two winegrowing regions of the present study. According to ALEXANDRE & GUILLOUX-BENATIER (2006), esters contribute directly to fruity and floral aromas.

Table 5. Comparison of aromatic compounds from commercial 'Sauvignon Blanc' wines produced in high altitude regions of Santa Catarina/Brazil and in Marlborough/New Zealand, vintage 2013.

Aromatic Compounds	High Altitude Santa Catarina/BR	Marlborough/NZ	F Test ($p < 0.05$)
Esters (μg L^{-1})			
Ethyl isobutyrate	118 ± 45	58 ± 15	ns
Ethyl butanoate	798 ± 107	694 ± 21	ns
Ethyl butanoate	14 ± 5	16 ± 13	ns
Ethyl isovalerate	30 ± 11	22 ± 15	ns
Ethyl hexanoate	1985 ± 539	1910 ± 406	ns
Ethyl octanoate	2644 ± 402	2066 ± 316	ns
Ethyl decanoate	813 ± 146	556 ± 101	ns
Ethyl dodecanoate	62 ± 26	59 ± 10	ns
Ethyl acetate	80719 ± 19904	82294 ± 42	ns
Isoamyl acetate	4917 ± 2066	7756 ± 1158	ns
Hexylacetate	230± 72	1018 ± 346	*
Cis-3-hexenyl acetate	12.4 ± 11.8	82.9 ± 6.9	*
Ethyl phenylacetate	7.2 ± 1.0	6.3 ± 0.4	ns
β-phenylethyl acetate	136 ± 29	261 ± 113	*
Methyl octanoate	1.6 ± 1.9	2.1 ± 0.8	ns
Diethyl succinate	1739 ± 442	1261 ± 1222	ns
Diethyl malate	1842 ± 184	1942 ± 768	ns

ns = not differ significantly by F test ($p < 0.05$). Average ± Standard Deviation

The three ester compounds that present differences between the evaluated wines were: Hexylacetate, Cis-3-hexenyl acetate and β-phenylethyl acetate. New Zealand wines had values 4.4 times higher for Hexylacetate, 6.6 times higher for Cis-3-hexenyl acetate and 1.9 times higher for β-phenylethyl acetate compared to Sauvignon Blanc wines from the highland region of Santa Catarina/Brazil. Acetate esters result from the reaction of acetyl-CoA with higher alcohols (STYGER *et al.* 2011). Several publications in the last decade have explored the role of technology on the uniquely high levels of 3-mercapto hexylacetate for New Zealand wines. Examples include the application of harvest and maceration treatments, as well as certain juice fining regimes (ARAUJO *et al.* 2017, OLEJAR *et al.* 2015).

Regarding the compound β-phenylethyl acetate, it is related to floral and rose aromas, with a greater predominance in young wines (PEREZ *et al.* 2022), as wine aging results in the degradation of this aromatic compound (DÍAZ-MAROTO 2005), being a compound that contributes positively to the wine, commonly desired in wine

because of its pleasant rose-like aroma.

CONCLUSION

Thirty-five aromatic compounds and eight individual phenolic compounds were identified in samples of Sauvignon Blanc wines from the high-altitude region of Santa Catarina/Brazil and the region of Marlborough/New Zealand.

It is concluded that there are similarities between Sauvignon Blanc high altitude wines from Santa Catarina/Brazil and from the region of Marlborough/New Zealand. there was a difference of only one phenolic compound and seven aromatic compounds. New Zealand wines showed higher values for compounds related to tropical fruit aromas, mainly passion fruit, and herbaceous aromas, in addition to a greater formation of thiols, which may be directly related to mechanized harvesting, widely used in New Zealand.

The compounds that most contributed to the aromas of Sauvignon Blanc from the altitude region of Santa Catarina/Brazil were: isoamyl acetate, ethyl hexanoate, ß-damascenone and ethyl butanoate, related to fruity aromatic descriptors (apple, pear, banana) and floral.

NOTES

AUTHOR CONTRIBUTIONS

Conceptualization, methodology, and formal analysis**, José Luiz Marcon Filho, Alberto Fontanella Brighenti, Leo Rufato and Douglas Wurz**; software and validation**, José Luiz Marcon Filho;** investigation**, José Luiz Marcon Filho, Douglas Wurz and Alberto Brighenti**; resources and data curation**, José Luiz Marcon Filho, Douglas Wurz and Alberto Brighenti**; writing-original draft preparation**, José Luiz Marcon Filho, Douglas Wurz and Alberto Brighenti**; writing-review and editing**, José Luiz Marcon Filho, Alberto Fontanella Brighenti, Leo Rufato and Douglas Wurz**; visualization**, José Luiz Marcon Filho, Alberto Fontanella Brighenti, Leo Rufato and Douglas Wurz**; supervision, Leo Rufato; project administration, **José Luiz Marcon Filho and Leo Rufato**; funding acquisition, **Leo Rufato**. All authors have read and agreed to the published version of the manuscript.

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INFORMED CONSENT STATEMENT

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DATA AVAILABILITY STATEMENT

The data can be made available under request.

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CONFLICTS OF INTEREST
The authors declare no conflict of interest.

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