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Sulfur dioxide dinamic in Sauvignon Blanc and Neuburger dry white wines

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RESEARCH ARTICLE

Abstract

The aim of this study is to evaluate the sulfur dioxide dinamic in two dry white wines Sauvignon blanc and Neuburger produced in Tarnave vineyard in order to check if there is any grape cultivar influence on this compound addition. Four wines (Sauvignon blanc 2018 and 2019 and Neuburger 2018 and 2019) were analysed for the free and total SO_2 content during the four stages of vinification and storage: harvest, fermentation, maturation and storage for two years. At the maturation stage, for all these samples the following parameters were also measured: alcohol content (%), total acidity (g/L tartaric acid), volatile acidity (g/L acetic acid), dry extract (g/L), non-reducingdry extract (g/L), relative density at 20°C, total sugars (g/L), glucose and fructose (g/L). For the samples studied in this work, it was determined an increasing concentration of free and total SO_2 starting with harvest continuing with fermentation, maturation, the firsty ear of storage and finishing with the second year of storage. Only for the free SO_2 at the harvest stage, a cultivar influence was observed. In this study, the limits were between 6.25±1.25 mg/L and 32.55±1.25 mg/L for the dosed free SO_2 and between 65.25±0.25 mg/L and 190.40±4.60 mg/L for total SO_2. The analyzed wines kept their varietal characteristics and organoleptic properties, as Qualified Denomination of Origin (DOC) Târnave wines, with an admitted SO_2 content.

Keywords: sulfur dioxide, Sauvignon blanc dry white wine, Neuburger dry white wine, Târnave vineyard

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INTRODUCTION

Târnave vineyardis a prestigious and significant viticultural area of Transylvania, Romania (Chedea et al., 2021). The landmark of this viticultural winemaking region are its quality white wines with a specific flavor and a good sugar/acidity balance (Iliescu et al., 2010; Cudur et al., 2014; Călugăr et al., 2018). The established white wine grape cultivars of Târnave vineyards are Fetească regală, Fetească albă, Riesling italian, Sauvignon blanc, Muscat Ottonel, Pinot gris and Neuburger (Iliescu et al., 2010; Cudur et al., 2014; Călugăr et al., 2018). During the winemaking process, the issue of wine oxidation is very important. While uncontrolled oxidation can lead to serious flaws like browning and flavor degradation, appropriate oxidation can help improve wine quality by adding flavor and color depth (Waterhouse et al., 2016; Díaz et al., 2021). In must and wine as well as in other beverages and foods, sulfur-containing compounds are commonly utilized as preservatives and antioxidants (Ribéreau-Gayon, 2006). Sulfites are usually added during the winemaking process, taking into account the pH and type of wine in order to maintain the product's quality over time (Mandrile et al., 2020). Sulfites are widely used in the winemaking process as potassium or sodium metabisulfite, forming in solution pH-dependent speciation (Mandrile et al., 2020). Sulfites, despite being frequent and approved wine additives, are classed as allergens because they may cause bronchial spasms, hives, and bronchoconstriction in hypersensitive people (Gastaminza et al., 1995; Mandrile et al., 2020). Because of this, the level of SO_2 in final wine products must be checked and regulated (Mandrile et al., 2020). In this context the legal limits for total SO_2 are at 150 mg/L in red wines and at 200 mg/L in white wines as set by the Regulation (EU) No 606/2009 (Mandrile et al., 2020).

The aim of this study is to evaluate the sulfur dioxide dinamic in two dry white wines Sauvignon blanc and Neuburger produced in Tarnave vineyard in order to check if there is any grape cultivar influence on this compound addition. As for Sauvignon blanc wine there are studies on sulfites addition (Díaz et al., 2021; Xiaotong et al., 2021; Makhotkina et al., 2013; Makhotkina et al., 2014; Coetzee et al., 2013), to our knowledge there are no studies on Neuburger wines concerning this matter.

MATERIALS AND METHODS

Chemicals

All used chemicals (0.02N iodine, sulfuric acid1:3 - H_2SO_4, starch solution 1%, 1N potassium hydroxide - KOH, 96% alcohol, sodium hydroxide - NaOH, phenol red, phenolphthalein, tartaric acid- $C_4H_6O_6$, ethanol 96% vol., neutral lead acetate- Pb $(CH_3COO)_2 \times 3H_2O$, nicotinamide adenine dinucleotide phosphate, adenosine-5'-triphosphate, hexokinase/glucose-6-phosphate-dehydrogenase, phosphoglucose-isomerase) were purchased from Nordic Chemicals, Cluj-Napoca, Romania.

Plant materials

The grapes grown in Târnave vineyard were harvested at the optimal fruit maturityin the period 12 to 20 September 2018 and 15 to 23 September 2019, having the appropriate health status for further winemaking processing.

Samples

One vintage from 2018 and one from 2019 of Sauvignon blanc and Neuburger wines respectively (4 wines), were taken in this study. The wines were obtained following the classical technology of the white wines making process (Coldea et al., 2014), except for the inoculation stage with yeasts. In the production of the analysed wines there were not added yeasts, the yeasts used for fermentation were those already existing on the surface of the berries at the time of harvesting. The following treatments were performed during the winemaking, fermentation, maturation and storage phases. Sulfur dioxide, utilized in the form of an aqueous solution with a concentration of 5-6 %, is applied at a rate of 1 L/t to avoid oxidation of the must after the grapes are destemmed and crushed. The alcoholic fermentation was stopped by sulfitation with 1 mL SO_2/L wine. After a resting period, wine was racked in another tank and bentonized with 100 g/hL bentonite. The wine that has been treated with bentonite is allowed to rest for 7 to 20 days before being filtered through porous cellulose filters. In Table 1, the samples taken in this study are described.

Table 1. Analysed wine samples

Sample	Description
S2018h	Sauvignon blanc wine from 2018 at harvest stage
S2019h	Sauvignon blanc wine from 2019 at harvest stage
N2018h	Neuburger wine from 2018 at harvest stage
N2019h	Neuburger wine from 2019 at harvest stage
S2018f	Sauvignon blanc wine from 2018 at fermentation stage
S2019f	Sauvignon blanc wine from 2019 at fermentation stage
N2018f	Neuburger wine from 2018 at fermentation stage
N2019f	Neuburger wine from 2019 at fermentation stage
S2018m	Sauvignon blanc wine from 2018 at maturation stage
S2019m	Sauvignon blanc wine from 2019 at maturation stage
N2018m	Neuburger wine from 2018 at maturation stage
N2019m	Neuburger wine from 2019 at maturation stage
S2018s2019	Sauvignon blanc wine from 2018 stored and analysed in 2019
N2018s2019	Neuburger wine from 2018 stored and analysed in 2019
S2018s2020	Sauvignon blanc wine from 2018 stored and analysed in 2020
N2018s2020	Neuburger wine from 2018 stored and analysed in 2020
S2019s2020	Sauvignon blanc wine from 2019 stored and analysed in 2020
N2019s2020	Neuburger wine from 2019 stored and analysed in 2020
S2019s2021	Sauvignon blanc wine from 2019 stored and analysed in 2021
N2019s2021	Neuburger wine from 2019 stored and analysed in 2021

Free and total sulfur dioxide (g/L) has been assessed at four technological stages: harvest (S2018h, S2019h, N2018h, N2019h), fermentation (S2018f, S2019f, N2018f, N2019f), maturation (S2018m, S2019m, N2018m, N2019m) and storage. In the storage stage sulfur dioxide was measured in two following years after the wine production, 2019 (S2018s2019, N2018s2019) and 2020 (S2018s2020, N2018s2020) for the wines obtained in 2018 and 2020 (S2019s2020, N2019s2020) and 2021 (S2019s2021, N2019s2021) for the wines obtained in 2019.

At the maturation stage, for all these samples (S2018m, S2019m, N2018m, N2019m) the following parameters were measured: alcohol content (%), total acidity (g/L tartaric acid - $C_4H_6O_6$), volatile acidity (g/L acetic acid - CH_3COOH), dry extract (g/L), non-reducing dry extract (g/L), the relative density at 20°C, total sugars (g/L) and monosaccharides glucose and fructose (g/L) (Table 2).

Chemical analysis

Free and total sulfur dioxide content

Free and total sulfur dioxide (g/L) it was determined using a modified iodometric method from ASRO-SR 6182-13:2009, through titration with iodine 0.02 N.We used 25 mL of wine sample, 2.5 mL of 1:3H_2SO_4, and 1 mL of 1% starch solution for the determination of free SO_2, and then titrated with iodine until the color changed.To determine the total SO_2, 25 mL of the sample was added over 12.5 mL of KOH and allowed to react for 15 minutes. After that, 5 mL of H_2SO_4 and 1 mL of starch solution were added, followed by titration with iodine until the color changed (ASRO-SR 6182-13, 2009).

Alcohol content

Alcohol content (% vol) was determined using the Dujardin-Salleronelectric ebulliometer and a10% standard solution (v/v), made of 96% (v/v)alcohol of and distilled water, following the producers manual of instructions (https://www.dujardin-salleron.com/documents/fiches/589b20d4a2332--160350---ft-ebulliometer-en.pdf).

Total acidity measurement

Total acidity, expressed in g/L tartaric acid ($C_4H_6O_6$) was determined by the titration method with 0.1N sodium hydroxide, in the presence of the phenolred indicator using a mixture of 10 mL of wine sampleand 10 mL of distilled water, titrated with 0.1N sodium hydroxide, stirred, following thechange of the sample color. The titration is continued after adding the sodium hydroxide solution until the indicator turns orange, according to ASRO-SR 6182-1 (2008) (Sîrbu et al., 2022).

Volatile acidity measurement

Volatile acidity, expressed in g/L acetic acid (CH_3COOH) was determined by the distillation method, separating volatile acids from the wine by steam distillation and titrated with a solution of 0.1 N sodium hydroxide in the presence of phenolphthalein as indicator. To release the salts of volatile acids from the wine, before being entrained by water vapor, the sample is acidified with tartaric acid, according to ASRO-SR 6182-2 (2008) (Sîrbu et al., 2022).

Density measurement

Density at 20°C was measured using the hydrostatic balance with a precision of 1 mg, according to method OIV-MA-AS2-01A (2012). The method involves immersing the cylinder filled up with a solution of known density and thermometer in liquid, stir and then checking the equipment to see the density of the liquid method (OIV-MA-AS2-01A, 2012).

The total dry extract contet

The total dry extract (g/L) is determined indirectly, based on the relative density of dealcoholised wine. The amount of sucrose dissolved in 1liter of water to achieve the same density as the dealcoholized wine serves as the unit of measurement for extract (OIV-MA-AS2-03B, 2012).

The non-reducing dry extract

Expressed in g/L, the non-reducing dry extract is known as the difference between the total dry extract and the residual sugars (total sugars content) (Sîrbu et al., 2022).

Total sugars contet

Total sugars (g/L) are determined by their reducing action on an alkaline solution of a copper salt, according to method OIV-MA-AS311-01A (2009). The first step involves clarification of the wine with neutral lead acetate. After that it was mixed 25 mL of the alkaline copper salt solution, 15 mL water and 10 mL of the clarified solution and added a few small pieces of pumice stone. Using a reflux condenser, the mixture reaches the boiling point in 2 minutes and is kept boiling for exactly 10 minutes. This is followed by titration with sodium thiosulfate solution, 0.1

M and expressing of results. The amount of sugar, expressed as invert sugar, contained in the test sample is given in a table by number (n '- n) of mL of sodium use thiosulfate (OIV-MA-AS311-01A, 2009).

Glucose and fructose contet

Monosaccharides glucose and fructose (g/L) have been determined by an enzymatic method using the spectrophotometer adjusted to a wavelength of 340 nm, making measurements using water as a reference, according to method OIV-MA-AS311-02 (2009).

Statistical analysis

The experimental data was analysed with the program Statview 5.0 performing one-way analysis of variance (ANOVA), followed by a Fisher protected least significant difference (PSLD) test. P values lower than 0.05 were considered significant while *p* values between 0.05 and 0.1 were considered as tendencies.

RESULTS AND DISCUSSIONS

The free SO_2 of a wine, together with its pH, determine how much SO_2 is available in the active, molecular form to help protect the wine from oxidation and spoilage. Free SO_2 can be hard to predict how much will be lost, and at what rate, to binding or to aeration (https://www.extension.iastate.edu/wine/total-sulfur-dioxide-why-it-matters-too/). Total Sulfur Dioxide (TSO_2) is the portion of SO_2 that is free in the wine plus the portion that is bound to other chemicals in the wine such as aldehydes, pigments, or sugars (https://www.extension.iastate.edu/wine/total-sulfur-dioxide-why-it-matters-too/).

For the samples studied in this work, Figures 1(a) and 2(a) show the increasing concentration of free SO_2 as determined for the four wines starting with harvest continuing with fermentation, maturation, first year of storage and finishing with the second year of storage. This progressive increment of free and total SO_2 amount was also observed by Coldea et al. (2015) for the storage of a Sauvignon blanc wine.

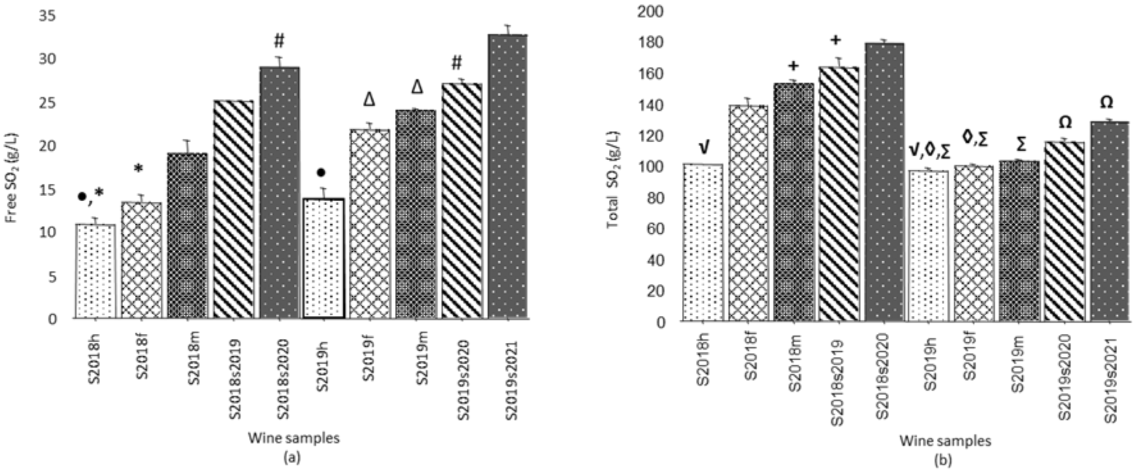

Figure 1. (a) Free sulfur dioxide in Sauvignon blanc wine samples (2018-2019); (b) Total sulfur dioxide in Sauvignon blanc wine samples (2018-2019).

Note: The differences between the samples from a graphic are statistically different ($p < 0.05$) excepting the variants with the same letter which are statistically non-significant ($p > 0.05$). * - statistically non-significant when compared with S2018f, • - statistically non-significant when compared with S2019h, # - statistically non-significant when compared with S2018s2020, Δ - statistically non-significant when compared with S2019f, √ - statistically non-significant when compared with S2018h, + - statistically non-significant when compared with S2018m, ◊ - statistically non-significant when compared with S2019h, Σ - statistically non-significant when compared with S2019m, Ω - statistically non-significant when compared with S2019s2020.

In our study the total SO_2 had a rise from one wine processing stage to another but not always statistically significant (Figure 1(b) and Figure 2 (b)). Thus from Figures 1(b) and 2(b) it can be seen that the differences for Sauvignon blanc samples S2019h, S2019f and S2019m, S2018m and S2018s2019 (Figure 1 (b)) and for Neuburger N2019h and N2019f (Figure 2(b)) are not statistically significant.

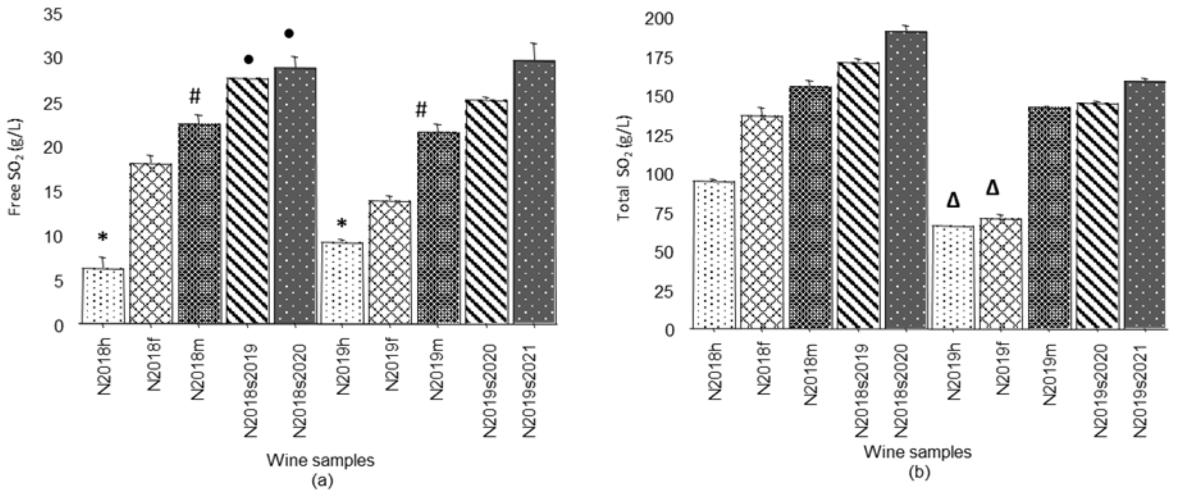

Figure 2. (a) Free sulfur dioxide in Neuburger wine samples (2018-2019); (b) Total sulfur dioxide in Neuburger wines samples (2018-2019)

Note: The differences between the samples from a graphic are statistically different ($p < 0.05$) excepting the varinats with the same letter which are statistically non-significat ($p > 0.05$). *- statistically non-significant when compared with N2018h,#- statistically non-significant when compared with N2018m, • - statistically non-significant when compared with N2018s2019, Δ - statistically non-significant when compared with N2019h.

After harvest the must of the Sauvignon blanc contains more free SO_2 than the one of Neuburger vintages (Figure 1(a) and Figure 2 (a)). The statistical analysis indicate that at harvest for both Neuburger and Sauvignon there is no difference when compared the two vintage years (2018 and 2019) (N2018h non different of N2019h and S2018h non different from S2019h). Contrary to this, for the same year the differences between the two must varieties are statistically significant (N2018h statistically different of S2018h and N2019h of S2019h). The variety influence is also indicated by the fact that the difference between N2018h and S2019h is statistically significant.

It is considered that the best wines are obtained with moderate amounts of initial sulfur dioxide and Țârdea (2007) recommends that the doses of SO_2 used in the primary vinification must be as low as possible, they must not exceed 100-150 mg/L total SO_2 of wine (Țârdea, 2007). Kunkee (1984) emphasizes the importance of using moderate amounts of initial sulfur dioxide. Generally, the grapes are sulphited at harvest, as they are loaded into the means of transport (buckets, tubs, tubers), using aqueous solutions of SO_2 of 5-6% concentration, in doses of 1-1.5 L/t of grapes. Doses differ depending on the phytosanitary condition of the harvest, namely 6-8 g SO_2/100 kg healthy grapes and 12-15 g SO_2/100 kg mouldy grapes. 60% of the required dose of SO_2 is administered in the grape tank, the remaining 40% is to be administered to the must in the presses or drains for extracting the must. The must is sulphited with liquefied SO_2 or aqueous SO_2 solutions, in the settling/clarification tanks before fermentation, for antioxidant protection. The SO_2's antioxidant action is given by the high oxygen consumption, protecting the must and the wine against oxidation by slowing down or accelerating the rate of oxygen consumption and diminishing the redox potential of the wine. This is why, protection of the must against enzymatic oxidation by sulphite must be carried out immediately after crushing the grapes (Vlastimil et al, 2008). Doses are moderate, usually 50-100 mg SO_2/L. For must from mouldy grapes, the dose of SO_2 used is four times higher than usual (Nick et al, 2011). Sulfitation of the wine is necessary aiming to ensure in the wine concentrations of 25-35 mg/L of free SO_2. As presented below the amount of free SO_2 measured in this study corresponds to these values.

After harvest the must of the Sauvignon blanc contains less total SO_2 than the one of Neuburger vintages (Figure 1(b) and Figure 2 (b)). The statistical analysis indicate that at harvest total SO_2 values of N2018h, S2018h, S2019h were significantly higher than N2019h.

After the fermentation the free SO_2 decreased in the following order S2019f (21.67±0.83 g/L) > N2018f (18.00±0.93 g/L) > N2019f (13.77±0.72g/L) = S2018f (13.33±0.83 g/L). The differences between the four samples after fermentation are all statistically significant excepting for N2019f compared with S2018f. During fermentation, while most of the measured sulfur dioxide in wine is added to the must, yeasts also produce considerable amounts (Boulton et al., 1999). Due to SO_2 in the molecular state, there is an antiseptic action (bacteriostatic and bactericidal) inhibiting or destroying yeasts and bacteria in must during fermentation and wine during the later phases. Thus, unwanted microorganisms such as molds, yeasts and acetic bacteria are killed because of the lack of oxygen. The only ones resistant to this oxygen reduction are the fermentation yeasts *Saccharomycetae* (Capece et al, 2020). After the fermentation the total SO_2 decreased in the following order S2018f (138.33±5.83 g/L) > N2018f (136.70±5.10

g/L) > S2019f (100.43±0.43 g/L) > N2019f (70.83±1.67 g/L). The differences between the four samples after fermentation are all statistically significant excepting for N2018f compared with S2018f.

At maturation stage the free SO_2 decreased as follows: S2019m (23.90 ±0.10 g/L) > N2018m (22.50±1.05 g/L) > N2019m (21.50±1.00 g/L) > S2018m (19.00±1.50 g/L) with statistically significant differences between S2018m and S2019m and N2018m and S2018m. For the same vinification phase, the total SO_2 decreased in the following order: N2018m (155.62±3.59 g/L) > S2018m (153.33±1.67 g/L) > N2019m (141.25±1.25 g/L) > S2019m (103.15±0.65 g/L), all the concentrations being statistically significant different excepting for N2018m compared with S2018m.

The free SO_2 concentrations in the analysed stored wines decreased in the following order: S2019s2021 (32.55±1.25 g/L) > N2019s2021 (29.50±2.00 g/L) > S2018s2020 (28.75±1.25 g/L) = N2018s2020 (28.75±1.25 g/L) > N2018s2019 (27.50±0.01 g/L) > S2019s2020 (26.90±0.60 g/L) > N2019s2020 (25.15±0.35 g/L) = S2018s2019 (25.00±0.01 g/L). No statistically significant differences were found between the two stored vintages for both years (N2018s2019, S2018s2019, N2018s2020, S2018s2020, N2019s2020, S2019s2020, N2019s2021 and S2019s2021). The differences were significant for Neuburger wine N2019s2020 and N2019s2021. In case of the Sauvignon blanc stored samples S2018s2019 was statistically different from S2018s2020, S2019s2020 from S2019s2021and S2018s2020 and S2019s2021. The first year of storage did not determine significant differences for the Sauvignon 2018 and Sauvignon 2019 (S2018s2019 being statistically nonsignificant from S2019s2020).

The total SO_2 concentrations in the analysed stored wines decreased in the following order: N2018s2020 (190.40±4.60 g/L) > S2018s2020 (179.65±1.15 g/L) > N2018s2019 (171.25±1.25 g/L) > S2018s2019 (163.75±6.25 g/L) > N2019s2021 (158.00±2.50 g/L) > N2019s2020 (144.75±0.75 g/L) > S2019s2021 (127.75±2.25 g/L) > S2019s2020 (115.65±1.85 g/L). The differences were significant when almost all the stored samples were compared excepting N2018s2019 from S2018s2019, N2018s2020 from S2018s2020 and, S2019s2020 from S2019s2021.

Once the wine was obtained at the end of maturation stage (samples: S2018m, S2019m, N2018m, N2019m) the following parameters were assessed: alcohol content (%), total acidity (g/L tartaric acid – $C_4H_6O_6$), volatile acidity (g/L acetic acid – CH_3COOH), dry extract (g/L), non-reducing dry extract (g/L), the relative density at 20°C, total sugars (g/L) and monosaccharide glucose and fructose (g/L) as presented in Table 2.

Table 2. Analytical values of Sauvignon blanc and Neuburger wines produced in 2018-2019 at SCDVV Blaj at the maturation stage

Cultivar	**Harvest year**	**Alcohol** (min 8.00-max 14.20 % vol)*	**Total acidity** (min 3.80-max 14.20 g/L $C_4H_6O_6$)*	**Volatile acidity** (min 0.08-max 1.10 g/L CH_3COOH)*	**Total sugars** (max 5.0g/L)**	**Total dry extract** (min 21.00 g/L)**	**Non-reducing dry extract** (min 16.00 -max 25.00 g/L)**	**Glucose+ Fructose** (min. 0.1-max. 20.0 g/L)***	**Density** (min 0.98-max 1.04 g/cm^3)*
Sauvignon blanc (S2018m)	2018	12.62	5.23	0.35	1.92	23.50	21.58	0.16	0.99
Sauvignon blanc (S2019m)	2019	13.96	5.10	0.29	2.04	23.40	21.36	0.14	0.99
Neuburger (N2018m)	2018	13.77	5.55	0.47	2.04	25.60	23.56	0.17	0.99
Neuburger (N2019m)	2019	14.11	5.47	0.24	1.92	21.40	19.48	0.11	0.99

Note: * the maximal and minimal values were reported as published by Er and Atasoy (2016)
** the maximal and minimal values were reported as published by Țârdea (2007)
*** the maximal and minimal values were reported as published by Coelho et al (2018)

The values for total sugars were between 1.92 g/L and 2.04 g/L with the highest and lowest values can be found in both varieties. The alcohol content of the analyzed wines, recorded the highest value for N2019m sample, with 14.11 % vol. and the lowest for S2018m sample, with 12.62 % vol. In all studied wines, the non-reducing dry extract levels were within limits imposed for the high-quality wines from the Târnave vineyard (min. 16 g/L), with the lowest value of 19.48 g/L for N2019m sample and with the highest value 23.56 g/L for N2018m sample. In Table 1 the standard minimal and maximal values for all the all physical-chemical analyses were included as found in Er and Atasoy (2016), Țârdea (2007) and Coelho et al (2018).

As already stated before, sulfur dioxide has important roles in winemaking, in both must and finished wines, including enzyme inhibition and antimicrobial and antioxidant effects. Sulfur dioxide improves the quality of wine by preserving the freshness and primary aromas of grapes, eliminates the "fatigue" of wine due to the phenomenon of strong oxidation and aeration. SO_2 causes a lower redox potential (Eh) in wine by fixing oxygen, favorable to organoleptic properties (Therelfall and Morris, 2002).

However, limits to sulfite concentrations in wines have been established, because besides the health concerns about excessive sulfites at here are also detrimental sensory effects (Makhotkina et al., 2014). For instance too much free SO_2 can be perceptible to consumers, by masking the wine's own fruity aromas and inhibiting its ability to undergo the cascade of oxygen-using reactions that happen when it "breathes", or, in high enough concentrations, by contributing a sharp/bitter/metallic/chemical flavor or sensation (https://www.extension.iastate.edu/wine/total-sulfur-dioxide-why-it-matters-too/).Table 3 present the sensorial characteristics of the analysed wines at storage stage.

Table 3. Sensorial analysis of Sauvignon blanc and Neuburger wines at storage stage

Cultivar	Harvest year	Appearance	Colour	Aroma/ Bouquet	Taste	Acidity
Sauvignon blanc (S2018s2019)	2018	excellent limpidity	white yellow	pleasant, specific	pleasant, dry, soft wine, balanced	medium
Sauvignon blanc (S2019s2020)	2019	excellent limpidity	yellow	pleasant, specific	pleasant, dry, soft wine, balanced	medium
Neuburger (N2018s2019)	2018	excellent limpidity	white yellow	pleasant, non-specific	pleasant, dry, soft wine, balanced	medium
Neuburger (N2019s2020)	2019	excellent limpidity	yellow	pleasant, non-specific	pleasant, dry, soft wine, balanced	medium

As there is presented in Table 3 all the wines had a excellent limpidity, a yellow or white yellow colour, a pleasant specific aroma for the Sauvignon blanc wines (S2018s2019, S2019s2020) and a pleasant non-specific aroma for the Neuburger wines (N2018s2019, N2019s2020). All the wines are pleasant, balanced with a dry taste and a medium acidity (Table 3).

This study showed the effectiveness of moderate SO_2 additions (60 mg/L SO_2 additions to must) protecting volatile and non-volatile compounds in the wine and could have a significant impact on the way Sauvignon blanc musts are handled in the cellar (Coetzee et al., 2013).

CONCLUSIONS

The results obtained for the two varieties of wines under study, Sauvignon blanc and Neuburger, indicate a sulfur dioxide content located at values below the maximum limit allowed by the legislation in force (free SO_2 at 50.0 mg/L and total SO_2 at 200 mg/L in white wines). For this study the limits were between 6.25±1.25 mg/L (at harvest) and 32.55±1.25 mg/L (at storage) for the dosed free sulfur dioxide. For total sulfur dioxide the values were between 65.25±0.25 mg/L (at harvest) and 190.40±4.60 mg/L (at storage).

In the technological stage of obtaining dry white wines, at the end of the alcoholic fermentation, the dosed free sulfur dioxide had values between 13.33±0.83 and 21.67±0.83 mg/L. The values obtained for total sulfur dioxide are between 70.83±1.66 and 138.33±5.83 mg/L. During the maturation stage of the wine, the dosed free sulfur dioxide had values between 19.00±1.50 and 23.90±0.10 mg/L. The values obtained for total sulfur dioxide are between 103.15±0.65 and 155.63±3.59 mg/L. In the storage stage, the preparation of the wine for bottling, the free sulfur dioxide had values between 25.15±0.35 and 32.55±1.25 mg/L. The values obtained for total sulfur dioxide are between 115.65±1.85 and 190.40±4.60 mg/L.

For the samples studied in this work, it was determined an increasing concentration of free and total SO_2 starting with harvest continuing with fermentation, maturation, first year of storage and finishing with the second year of storage. Only for the free SO_2 at the harvest stage, a cultivar influence was observed. The analyzed wines kept their varietal characteristics and organoleptic properties, so that the quality of these dry white wines is of Qualified Denomination of Origin (DOC) Târnave, with an admitted sulfur dioxide content.

Author Contributions: A.D.S. Wrote the paper, performed the analyses, collected the data; V.S.C. Writing, supervision and project administration; L.L.T. Visualization and supervision; H.S.R. Statistical analysis; F.D.S. Contributed to data collection. All the authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare that they do not have any conflict of interest.

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