Effect of Ascorbic Acid and Yeast Strain on Sauvignon blanc Wine Quality*

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Sauvignon blanc cultivar-typical aroma is affected by different components of which 2-methoxy-3-isobutylpyrazine and 4-mercapto-4-methylpentan-2-one are probably the most important. Climatic, viticultural and oenological conditions may have a prominent effect on the levels at which these impact aroma components occur in wine. Sauvignon blanc wines were produced from grapes from two climatically different regions. Different ascorbic acid/SO_2 combinations and different *Saccharomyces cerevisiae* yeast strains were used during the production of the wines. The wines were sensorially evaluated for specific wine characteristics, namely fruity/ester aroma intensity, grassy/green pepper aroma intensity, sulphur-like aroma intensity and overall wine quality. Significant differences were observed between treatments. A commercially available preparate (ascorbic acid/meta-bisulphite) and yeast strain VL3C produced sulphur-like, low-quality wines under the conditions of this investigation. The highest quality wines were produced from pure ascorbic acid/SO_2 treatments and fermentation by the yeast strain VIN 13.

The study of wine and its sensory evaluation is a complex science. All aromas can be related to the chemical composition of wines and are only sensorially detectable when the chemical aroma components responsible occur above their threshold levels (Cavazza *et al.*, 1993). The aroma of *Vitis vinifera* L. cv. Sauvignon blanc can easily be distinguished from that of other white wine cultivars. Yet there is still disagreement about the typical aroma of Sauvignon blanc wine. The cultivar-typical aroma of these wines can be described as asparagus, grassy, green pepper and pyrazine-like (Allen *et al.*, 1988; Lacey *et al.*, 1991; Allen & Lacey, 1993). Fruity/floral-like aromas are also important in Sauvignon blanc wine and are probably caused by, amongst other things, certain monoterpenes and norisoprenoids (Marais, 1994a; Marais *et al.*, 1996; Marais *et al.*, 1999). The most common methoxypyrazines present in Sauvignon blanc were identified as 2-methoxy-3-isobutylpyrazine (ibMP) (green pepper-like aroma), 2-methoxy-3-isopropylpyrazine (ipMP) (asparagus-like aroma) and 2-methoxy-3-sec-butylpyrazine (sbMP) (Augustyn *et al.*, 1982; Allen *et al.*, 1988; Lacey et *al.*, 1991).

Sulphur-containing components also have a prominent effect on the quality of wine (Rapp *et al.*, 1985; Park & Noble, 1993). Low concentrations of sulphur components can enhance the complexity of aroma and quality, but too high concentrations often lead to unpleasant off-flavours. Darriet *et al.* (1995) identified an important volatile sulphur component, 4-mercapto-4-methylpentan-2-one (MMP) in Sauvignon blanc wine. This is the same mercapto ketone that is responsible for the characteristic cat urine, box tree or broom odour (Polak *et al.*, 1988; Darriet *et al.*, 1995; Tominaga & Dubourdieu, 1997). Because it often occurs at levels above its threshold value, MMP may have a marked effect on the complex aroma of Sauvignon blanc wine. When present at too high concentrations, it is regarded as negative and not typical for Sauvignon blanc. Besides MMP, some other mercapto components were also identified in Sauvignon blanc wine, i.e. 4-mercapto-4-methylpentan-2-ol, 3-mercaptohexan-1-ol (similar to citrus, grapefruit and passionfruit aromas) and 3-mercapto-3-methylbutan-1-ol (cooked leeks aroma) (Tominaga *et al.*, 1998a). The concentration levels and contribution of these volatile thiols to quality have been determined (Tominaga *et al.*, 1998b).

Studies showed that cooler climates are favourable for the production of more typical Sauvignon blanc wines (Allen & Lacey, 1993; Lacey *et al.*, 1991; Marais 1994b; Marais *et al.*, 1996; Marais *et al.*, 1999). Furthermore, viticultural and oenological practices play a prominent role in the composition and quality of wine. Oenological practices, like skin contact, extract higher concentrations of phenolic compounds, monoterpenes and methoxypyrazines from the skins and give wine a more complex character and higher quality (Marais, 1998). Yeasts and yeast autolysates are rich in free amino acids and can generate sulphur-containing components from precursors by enzymatic and non-enzymatic reactions (Münch & Schieberle, 1998). During fermentation, yeast and enzyme activities increase and metabolise sulphur-containing amino acids and proteins, as well as inorganic sulphates to form H_2S, CS_2 and mercaptans (Rauhut *et al.*, 1993). Some of these impact volatile thiols present in Sauvignon blanc wine, e.g. MMP, are released by yeasts through the degradation of S-cysteine conjugates (Tominaga *et al.*, 1998c). Not all yeast strains, however, are involved in the production of mercapto ketones, like MMP.

Local Sauvignon blanc wines often possess a neutral character and a lack of typical aromas like green pepper, vegetative, grassy or asparagus. They also often present undesirable sulphur-like aromas. With the increase in popularity of Sauvignon blanc world-wide, it is extremely important to produce higher quality Sauvignon blanc wines with typical aromas and to eliminate faults such as sulphur-like off-odours. It is claimed that some

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oenological practices, like the use of certain yeast strains and ascorbic acid, produce more typical, fresh/fruity Sauvignon blanc wines. The purpose of this investigation was therefore to determine the effect of ascorbic acid, SO_2 and different yeast strains on Sauvignon blanc wine quality. The knowledge gained will be applied to identify those techniques that will enhance the quality of local Sauvignon blanc wines.

MATERIALS AND METHODS

Wine production

Sauvignon blanc wines were produced during the 1998 season from grapes obtained from a warmer Robertson region and a relatively cooler Stellenbosch region. Grapes were harvested at approximately 20.5°B and divided into nine equally representative samples (60 kg per sample). The Sauvignon blanc wine production process is illustrated in Fig. 1.

Each sample was crushed and different concentrations of ascorbic acid and SO_2 added: Samples 1 – 3 (20 $g.hL^{-1}$ ascorbic acid/meta-bisulphite preparate [supplied by AEB Africa (Pty) Ltd]), samples 4 – 6 (standard + 30 $mg.L^{-1}$ free SO_2) (control) and samples 7 – 9 (10 $g.hL^{-1}$ pure ascorbic acid [Univar product no. 118 10 20] + 30 $mg.L^{-1}$ free SO_2). These three treatments will be further referred to as ascorbic acid/meta, SO_2 and pure ascorbic acid/SO_2, respectively. The ascorbic acid/meta preparate is commercially available on the local market. The standard treatment did not include the use of ascorbic acid.

All juices were subjected to skin contact for six h at 15°C and then pressed at 50 kPa. Pectolytic enzyme (2 $mL.L^{-1}$ juice) was added and the juice stored at 15°C for settling overnight. The clear juice of each sample was divided into three 20L cannisters, each containing 18L juice. The three cannisters of each sample were inoculated with *Saccharomyces cerevisiae* yeast strains VIN 13, NT 116 (South African yeast strains, supplied by Anchor Yeast) and VL3C (French yeast strain, supplied by Vintec (Pty) Ltd), respectively. Rehydration and inoculation were performed according to standard Nietvoorbij practices for small-scale white wine production. Fermentation was performed at 15°C until the wines were dry. The wines were then bottled and kept at 15°C until sensory evaluation. All treatments were triplicated.

Sensory evaluation

Wines were sensorially evaluated by an experienced panel of six judges. The panel was previously trained to evaluate the individual characteristics of Sauvignon blanc wine. Wines were evaluated eight months after bottling for fruity/ester aroma intensity, grassy/green pepper aroma intensity, sulphur-like aroma intensity and overall wine quality. A line method, as illustrated in Fig. 2, was used, i.e. evaluating the intensity of each characteristic or the quality by marking an unstructured, straight 10 cm line. The wines were also subjected to ranking, using the same sensory characteristics as above. The strongest intensity and highest quality were ranked first and the weakest or lowest, last.

Statistical analysis

The standard analysis of variance method and the Friedman two-way analysis of variance method were applied to determine the statistical differences on the results of the sensory evaluation (intensity of each characteristic and overall quality) and wine rankings, respectively (Siegel, 1956; Snedecor & Cochran, 1980). Least significant differences (LSD) were used to separate treatment means.

RESULTS AND DISCUSSION

The sensory evaluation results for wines from the Robertson and Stellenbosch regions are given in Figs. 3 and 4, respectively. Data are the means of treatments done in triplicate. The ascorbic acid/meta preparate treatment, using overall wine quality as parameter, resulted in the lowest quality wines in all cases, irrespective of yeast strain and origin of grapes. This was the result of the

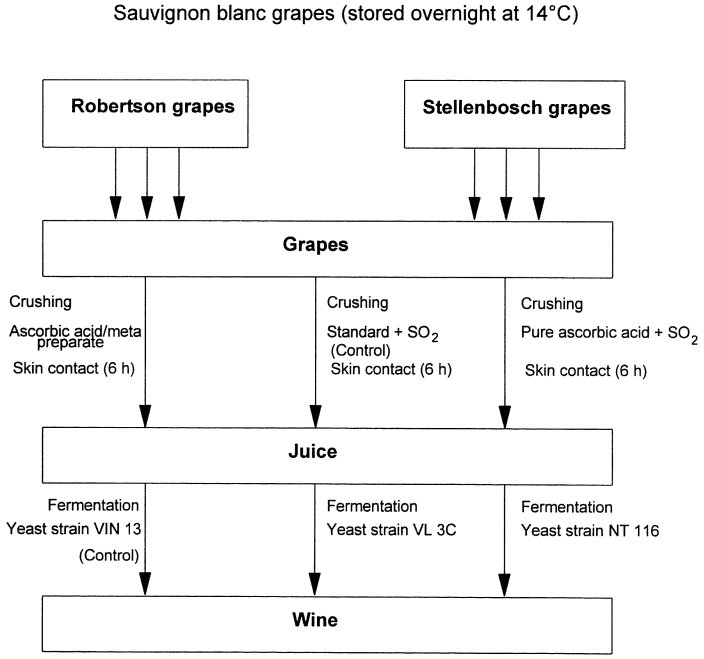

FIGURE 1
Schematic illustration of the Sauvignon blanc wine production process (1998 season).

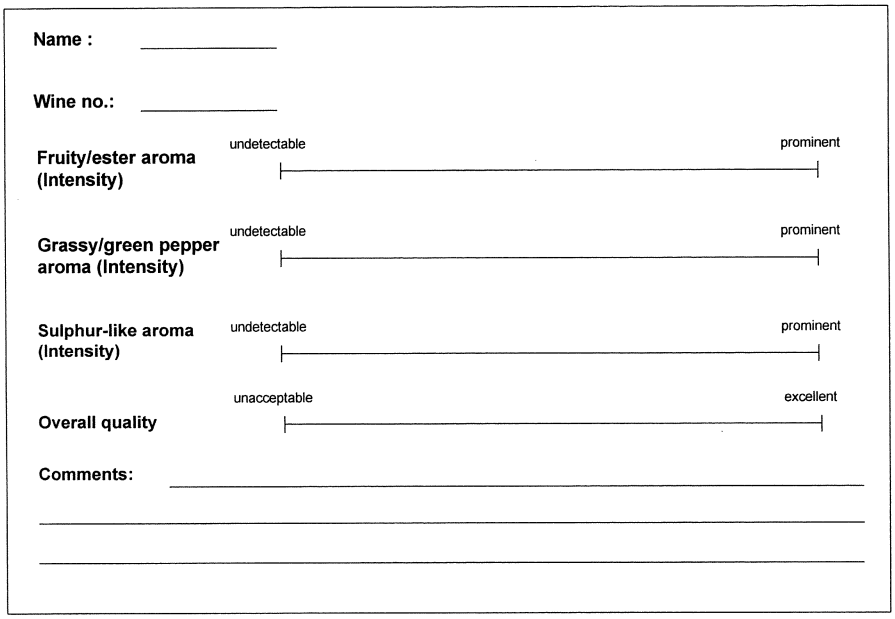

FIGURE 2
Sauvignon blanc evaluation form.

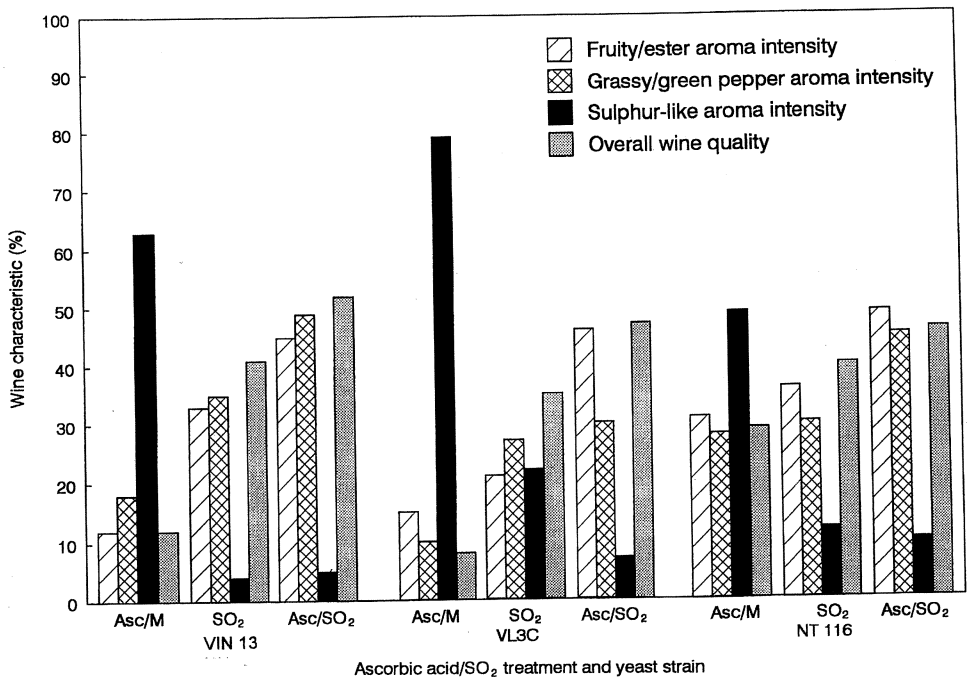

FIGURE 3
The effect of ascorbic acid/meta preparate (Asc/M), SO_2 and pure ascorbic acid/SO_2 (Asc/SO_2) treatment and yeast strain on Sauvignon blanc wine quality from the Robertson region (1998 season).

high intensities of sulphur-like aromas, which had a masking effect on the fruity/ester and green pepper-like aromas of the wines. The high intensity of sulphur-like nuances might have been caused by contaminating substances in the ascorbic acid/meta preparate and not by the known components themselves. The anti-oxidative properties of both ascorbic acid and meta bisulphite are well known and should have had no detrimental effect on wine quality if used correctly (Van Wyk, 1995). However, recent results illustrated that the use of ascorbic acid, with or without SO_2, may also lead to serious oxidation problems in bottled wines (Peng *et al.*, 1998). Treatment with pure ascorbic acid/ SO_2 produced the highest quality wines, due to low sulphur-like and relatively high fruity/ester and grassy/green pepper aroma intensities (Figs. 3 and 4).

When the data from this study, using the different yeast strains, are compared, it is clear that VIN 13 produced the highest quali-

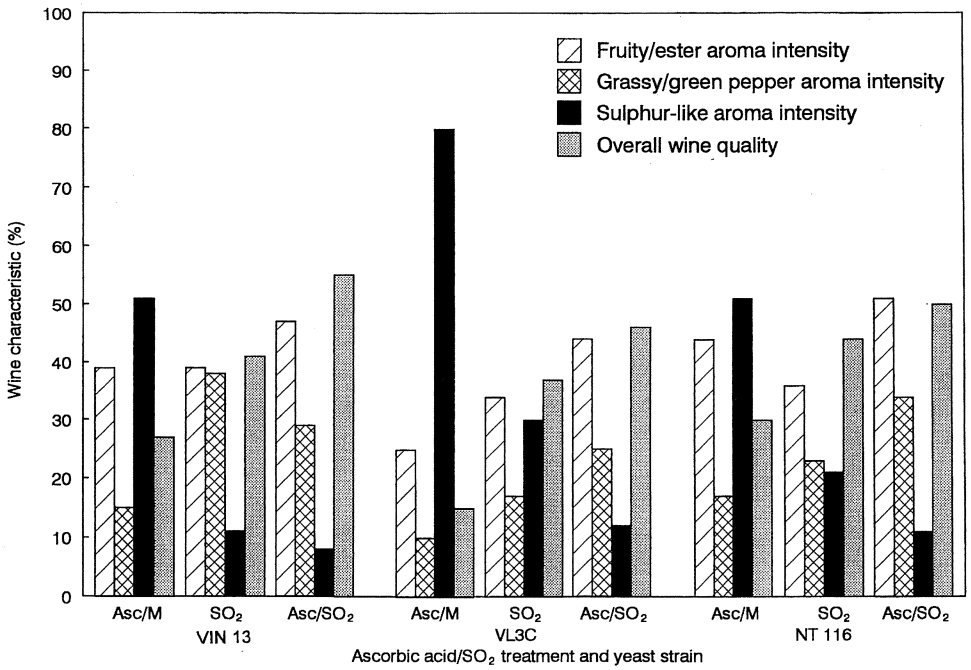

FIGURE 4

The effect of ascorbic acid/meta preparate (Asc/M), SO_2 and pure ascorbic acid/SO_2 (Asc/SO_2) treatment and yeast strain on Sauvignon blanc wine quality from the Stellenbosch region (1998 season).

ty wines, irrespective of ascorbic acid and SO_2 treatments, and the origin of grapes. The best treatment combination for the production of quality Sauvignon blanc wines was found to be the combination of ascorbic acid/SO_2 and VIN 13. The yeast strain NT 116, however, also performed well. In another study it was shown that NT 116 also produced high ester concentrations (Marais, 2001). However, in this case these components masked the typical green pepper aromas of some Sauvignon blanc wines. Instead a yeast strain, VIN 7, was recommended, which had the opposite effect, i.e. the production of relatively low ester concentrations together with the manifestation of stronger Sauvignon blanc characters. Under the conditions of this investigation, the French yeast strain VL3C did not perform well, mainly due to the formation of relatively high intensities of sulphur-like aromas. When regions are compared, no marked differences were observed on the basis of yeast strain or the ascorbic acid and SO_2 treatments.

Differences between treatments and between yeast strains were also evaluated statistically (Tables 1 and 2). These results confirmed those observed individually in Figures 3 and 4. Non-significance may be ascribed to interaction between treatments. These results were also confirmed by those of the ranking evaluations (Tables 3 and 4). Again, the wines produced from the pure ascorbic acid/SO_2 treatment were in most cases preferred to those of the other two treatments. Yeast strains were not statistically compared in the ranking evaluations.

TABLE 1

The effect of ascorbic acid/meta preparate, SO_2 and pure ascorbic acid/SO_2 treatments on Sauvignon blanc wine quality produced from grapes from the Robertson and Stellenbosch regions (1998 season).

TREATMENT	ROBERTSON REGION				STELLENBOSCH REGION			
	Wine characteristic*							
	Fruity/ester aroma intensity	Grassy/ green pepper aroma intensity	Sulphur-like aroma intensity	Overall wine quality	Fruity/ester aroma intensity	Grassy/ green pepper aroma intensity	Sulphur-like aroma intensity	Overall wine quality
Ascorbic acid/ meta preparate	19.222c	18.111c	64.000a	16.000c	36.222a	13.889b	57.500a	25.625b
Standard + SO_2 (Control)	33.333b	30.556b	12.556b	38.333b	36.556a	26.444a	7.000b	52.714a
Pure ascorbic acid/SO_2	47.000a	41.778a	7.444b	49.222a	47.222a	29.222a	10.444b	50.333a

Treatments designated by the same letter do not differ significantly ($p \leq 0.05$).

*Each value represents the average of three yeast strain (VIN 13, VL3C and NT 116) treatments.

TABLE 2

The effect of yeast strains VIN 13, VL3C and NT 116 on Sauvignon blanc wine quality produced from grapes from the Robertson and Stellenbosch regions (1998 season).

TREATMENT (Yeast strain)	ROBERTSON REGION				STELLENBOSCH REGION			
	Wine characteristic*							
	Fruity/ester aroma intensity	Grassy/ green pepper aroma intensity	Sulphur-like aroma intensity	Overall wine quality	Fruity/ester aroma intensity	Grassy/ green pepper aroma intensity	Sulphur-like aroma intensity	Overall wine quality
VIN 13	30.111a	33.778a	24.000b	35.222ab	41.889a	27.333a	15.625b	48.625a
VL3C	30.889a	22.667b	36.111a	30.222b	34.889a	17.444a	36.000a	35.125b
NT 116	38.556a	34.000a	23.889b	38.111a	43.222a	24.778a	23.750b	44.625a

Treatments designated by the same letter do not differ significantly ($p \leq 0.05$).

*Each value represents the average of three treatments (ascorbic acid/meta preparate, SO_2 and pure ascorbic acid/SO_2).

TABLE 3

Ranking evaluation of Sauvignon blanc wines from the Robertson region, produced by different ascorbic acid/SO_2 treatments and yeast strains (1998 season).

Treatment	Wine characteristic*			
	Fruity/ ester aroma intensity	Grassy/ green pepper aroma intensity	Sulphur-like aroma intensity	Overall wine quality
Ascorbic acid/meta preparate / VIN 13	41	45	23	42
Standard + SO_2 / VIN 13	36	36	41	35
Pure ascorbic acid/ SO_2 / VIN 13	31	27	44	31
Significance	NS	**	**	NS

Treatment	Wine characteristic*			
	Fruity/ ester aroma intensity	Grassy/ green pepper aroma intensity	Sulphur-like aroma intensity	Overall wine quality
Ascorbic acid/meta preparate / VL3C	49	46	19	42
Standard + SO_2 / VL3C	36	35	44	35
Pure ascorbic acid/ SO_2 / VL3C	23	27	45	31
Significance	**	**	**	NS

Treatment	Wine characteristic*			
	Fruity/ ester aroma intensity	Grassy/ green pepper aroma intensity	Sulphur-like aroma intensity	Overall wine quality
Ascorbic acid/meta preparate / NT 116	44	45	20	41
Standard + SO_2 / NT 116	37	40	43	39
Pure ascorbic acid/ SO_2 / NT 116	27	23	45	28
Significance	**	**	**	**

*Each value represents the total score of three replicates by six judges.
Lowest values = strongest intensity and highest quality.
** = Significant ($p \leq 0.05$).
NS = Not significant.

TABLE 4

Ranking evaluation of Sauvignon blanc wines from the Stellenbosch region, produced by different ascorbic acid/SO_2 treatments and yeast strains (1998 season).

Treatment	Wine characteristic*			
	Fruity/ ester aroma intensity	Grassy/ green pepper aroma intensity	Sulphur-like aroma intensity	Overall wine quality
Ascorbic acid/meta preparate / VIN 13	43	41	15	44
Standard + SO_2 / VIN 13	25	25	35	23
Pure ascorbic acid/ SO_2 / VIN 13	22	24	40	23
Significance	**	**	**	**

Treatment	Wine characteristic*			
	Fruity/ ester aroma intensity	Grassy/ green pepper aroma intensity	Sulphur-like aroma intensity	Overall wine quality
Ascorbic acid/meta preparate / VL3C	41	37	19	33
Standard + SO_2 / VL3C	27	28	31	29
Pure ascorbic acid/ SO_2 / VL3C	22	25	40	28
Significance	**	NS	**	NS

Treatment	Wine characteristic*			
	Fruity/ ester aroma intensity	Grassy/ green pepper aroma intensity	Sulphur-like aroma intensity	Overall wine quality
Ascorbic acid/meta preparate / NT 116	42	39	21	40
Standard + SO_2 / NT 116	25	29	31	26
Pure ascorbic acid/ SO_2 / NT 116	23	22	38	24
Significance	**	**	**	**

*Each value represents the total score of three replicates by six judges.
Lowest values = strongest intensity and highest quality.
** = Significant ($p \leq 0.05$).
NS = Not significant.

CONCLUSIONS

Yeast strain and the use of ascorbic acid were found to have a significant effect on wine aroma characteristics and wine quality. The combination of pure ascorbic acid/SO_2, and the yeast strain VIN 13, as well as NT 116, is recommended for the production of quality, cultivar-typical Sauvignon blanc wines under South African conditions. However, ascorbic acid should always be used judiciously.

The question arises whether the sulphur-like aroma, which occurred mainly with the use of the locally available ascorbic acid/meta preparate, was caused by MMP and/or other sulphur-containing components, i.e. do chemical analyses support the sensory data. After conclusion of this study, a new commercially available ascorbic acid/meta preparate was developed, which does not cause the observed undesirable sulphur-like aroma. However, considering the fact that locally produced Sauvignon blanc wines still often present sulphur-like off-odours, studies on the occurrence of these components should be conducted.

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