# Effect of Grape Temperature, Oxidation and Skin Contact on Sauvignon blanc Juice and Wine Composition and Wine Quality

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**Sauvignon blanc is one of the most important white wine cultivars grown in South Africa. It is well-known that climatic and viticultural factors have a major effect on Sauvignon blanc grape and wine composition and quality. Of equal importance is the effect of production factors on Sauvignon blanc wine composition and quality. The purpose of this study was to evaluate the effect of such factors. Wines were produced from grapes from two regions that were stored overnight at 0°C and 20°C. Skin contact was conducted for 15 hours at these temperatures, with as well as without SO$_2$ addition prior to fermentation. Free-run juices were used as control. Settled juices were analysed for 2-methoxy-3-isobutylpyrazine (ibMP) and monoterpenes, and the corresponding wines also for ibMP, acetate and ethyl esters, total polyphenols and total flavanoids. The wines were sensorially evaluated for fruitiness and the typical green pepper/grassy aroma of Sauvignon blanc. Grape temperature, skin contact, and oxidative and reductive conditions prior to fermentation affected some of the above-mentioned component concentrations and therefore wine quality. Generally, most component concentrations were increased by skin contact, while polyphenol and flavanoid concentrations were lower in wines produced oxidatively. It appeared that wines produced reductively from free-run as well as low temperature skin contact juices presented the highest quality.**

Sauvignon blanc is one of the most important white wine cultivars grown in South Africa. The area planted to this cultivar has increased by 99% from 2 255 (1985) to 4 479 hectares (1996) (Booysen & Truter, 1997). The typical cultivar aroma of Sauvignon blanc is described as vegetative, grassy, herbaceous, gooseberry-, asparagus- and green pepper-like. These nuances are mainly caused by a specific group of chemical components, namely methoxypyrazines. The most important contributor appears to be 2-methoxy-3-isobutylpyrazine (ibMP), which normally occurs in much higher concentrations in Sauvignon blanc grapes and wine than other methoxypyrazines (Allen et al., 1991). The preference of producers and consumers, however, is that the methoxypyrazine aromas should not be dominant or one-sided, but have to be complemented by tropical and fruity aromas. Monoterpenes, norisoprenoids, esters and higher alcohols are among the compounds that may present these types of aromas.

The majority of Sauvignon blanc wines produced in South Africa do not have the above-mentioned cultivar-typical characteristics, probably mainly as a result of climatic effects. There is a need to optimise these aromas by means of viticultural and/or oenological practices. It is therefore important to know which factors affect the formation or degradation of methoxypyrazines, monoterpenes, etc. in grapes and wine. When this knowledge is available, it can be applied to produce more typical Sauvignon blanc wines. It is well-known that climatic and viticultural factors have a major effect on Sauvignon blanc grape and wine composition (Allen & Lacey, 1993; Marais et al., 1996). Of equal importance is the effect of winemaking techniques (Kotseridis, Anocibar Beloqui & Bertrand, 1997).

Specific wine production techniques, such as skin contact (SC), may enhance the above-mentioned sought-after aromas, but a too high polyphenol concentration, which is detrimental to wine quality, may be obtained simultaneously (Singleton, Zaya & Trouesdale, 1980; Marais & Rapp, 1988). Reductive treatment of juice as opposed to oxidation thereof prior to fermentation resulted in wines with higher aroma intensities and wine quality (Singleton et al., 1980; Nicolini, Mattivi & Dalla Serra, 1991; Van Wyk, Louw & Rabie, 1996). There are, however, conflicting views on the effect of these practices on wine quality. Therefore oenological techniques to enhance the wine quality of specifically Sauvignon blanc should be evaluated thoroughly before appropriate recommendations for South African conditions can be made.

The purpose of this investigation was to determine the effect of specific wine-making techniques on aroma compound levels in, and quality of, Sauvignon blanc wines.

## MATERIALS AND METHODS

**Sauvignon blanc wine production:** Sauvignon blanc grapes from the Stellenbosch region were used during the

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1996 season and grapes from the same region as well as from the Elgin region during the 1997 season. In each case, the grapes (640 kg) were harvested at ripeness (between 21°B and 22°B) and divided into two equal, representative parts and stored overnight at 0°C and 20°C, respectively. After storage each part was further treated as follows: The grapes were again divided into two parts (part one = 200 kg; part two = 120 kg) on a representative basis. Part one was crushed and 1 m$l$ of a 10% potassium metabisulfite solution/kg grapes added to obtain approximately 30 mg/$l$ free and 50 mg/$l$ total $SO_2$ levels. The skins were immediately separated from the juice. Both the skins and juice were divided into four parts, of which two parts free-run (FR) juice were used as controls. The remaining two parts juice were recombined with two parts skins and subjected to SC for 15 hours at 0°C and 20°C, respectively. Part two was crushed without $SO_2$ addition. The crushed grapes were divided into two parts, each subjected to 15 hours SC at 0°C and 20°C, respectively. After SC, juices were separated from the skins. All juices, FR as well as SC, were further treated according to standard Nietvoorbij practices for white wine production. Vin 13 was used for fermentation. After fermentation, the wines received normal $SO_2$ additions (1 m$l$ of a 10% potassium metabi-sulfite solution/kg grapes) to obtain approximately 30 mg/$l$ free and 50 mg/$l$ total $SO_2$ levels. The whole experiment was done in duplicate during both years.

**Additional tests:** An additional investigation was conducted to test the effect of hyperoxidation and temperature on ibMP levels in wine. A commercially available, neutral Chenin blanc wine was used during two successive years (1996 and 1997). Pure ibMP was added to the wine (5$l$) at a concentration of 98 ng/$l$. The wine was divided into two parts, i.e. a 250 m$l$ part (control) for immediate analysis and a 4,75 $l$ part for further treatments. The latter was divided into two equal parts (2,37 $l$ each). The first part was treated with an excess of $H_2O_2$ (75 mg/$l$), while the second received 100 mg/$l$ $SO_2$, and each part thoroughly mixed. Each part was further divided into eight 250 m$l$ parts and stored in dark 250 m$l$ bottles. For both the $H_2O_2$ and $SO_2$ treated samples, two bottles were stored at 0°C, two at 10°C, two at 20°C and two at 30°C for three months.

**2-Methoxy-3-isobutylpyrazine (ibMP):** The ibMP concentrations were determined in all settled juice and wine samples by the technique of Harris *et al.* (1987), as adapted by Lacey *et al.* (1991) (see also Marais *et al.*, 1996).

**Monoterpenes and esters:** Monoterpenes were extracted from settled Sauvignon blanc juices and esters from the corresponding wines by Freon II and the extracts analysed by gas chromatography (Marais, 1986). The concentrations of trans-furan linalool oxide, linalool, hotrienol, alpha-terpineol, trans- and cis-pyran linalool oxide, citronellol, nerol and diendiol-1 were summed and expressed as total relative monoterpene concentrations. Similarly, the concentrations of the esters (iso-butyl acetate, iso-amyl acetate, hexyl acetate, ethyl butyrate, ethyl hexanoate,

ethyl octanoate, ethyl decanoate) were summed and expressed as total relative ester concentrations.

**Total polyphenols and total flavanoids:** Wine samples were analysed for total polyphenol concentrations (Singleton & Rossi, 1965), as well as for total flavanoid concentrations (Delcour & Janssens De Varebeke, 1985).

**Wine quality:** Wines were sensorially evaluated for fruitiness/ester-like intensity and vegetative/grassy/asparagus/green pepper intensity by a panel of six experienced judges, using a linemethod.

**Statistical analysis:** Statistical differences between treatments were determined by applying standard analysis of variance methods to the data. Least significant differences (LSD) were used to separate treatment means.

## RESULTS AND DISCUSSION

The effects of grape temperature, FR, SC, oxidative and reductive production on ibMP and monoterpene concentrations in Stellenbosch and Elgin Sauvignon blanc settled juices, as well as on ibMP, ester, polyphenol and flavanoid concentrations in the corresponding wines, and on wine quality are shown for both regions in Figures 1 and 3 to 6. Only the 1997 data, which correspond to those of the 1996 season, are presented.

2-Methoxy-3-isobutylpyrazine concentrations were higher in SC juices and wines than in those of FR, due to extraction thereof from the skins (Fig. 1), which supports the suggestion of Allen *et al.* (1989) that methoxypyrazines occur in the solid parts of the grape berry. With respect to the effect of oxidative ($O_2$) production, reductive ($SO_2$) production and temperature on ibMP levels, no clear tendency could be observed. This is supported by the results presented in Fig. 2, where hyperoxidation by $H_2O_2$ and storage temperatures as high as 30°C for three months had no effect on ibMP levels. It therefore appears that ibMP is resistant to oxidation under the conditions of these experiments.

The levels of ibMP were markedly higher in the Elgin than in the Stellenbosch juices and corresponding wines (Fig. 1), which may be ascribed mainly to climatic effects. Elgin is a cooler region (1 503 degree-days) than Stellenbosch (1 945 degree-days) (Le Roux, 1974). Similarly, Lacey *et al.* (1988) showed higher ibMP concentrations in New Zealand than in Australian Sauvignon blanc wines. It is, however, not suggested that climate is the only parameter, since factors such as canopy density and clones also affect ibMP levels.

Monoterpene concentrations were higher in 20°C than in 0°C juices for both regions (Fig. 3). Levels were also higher in SC than in FR juices (when viewed within each temperature group independently). Extraction of monoterpenes from the skins was therefore enhanced by increased temperature, which confirmed results found previously on Gewürztraminer (Marais & Rapp, 1988).
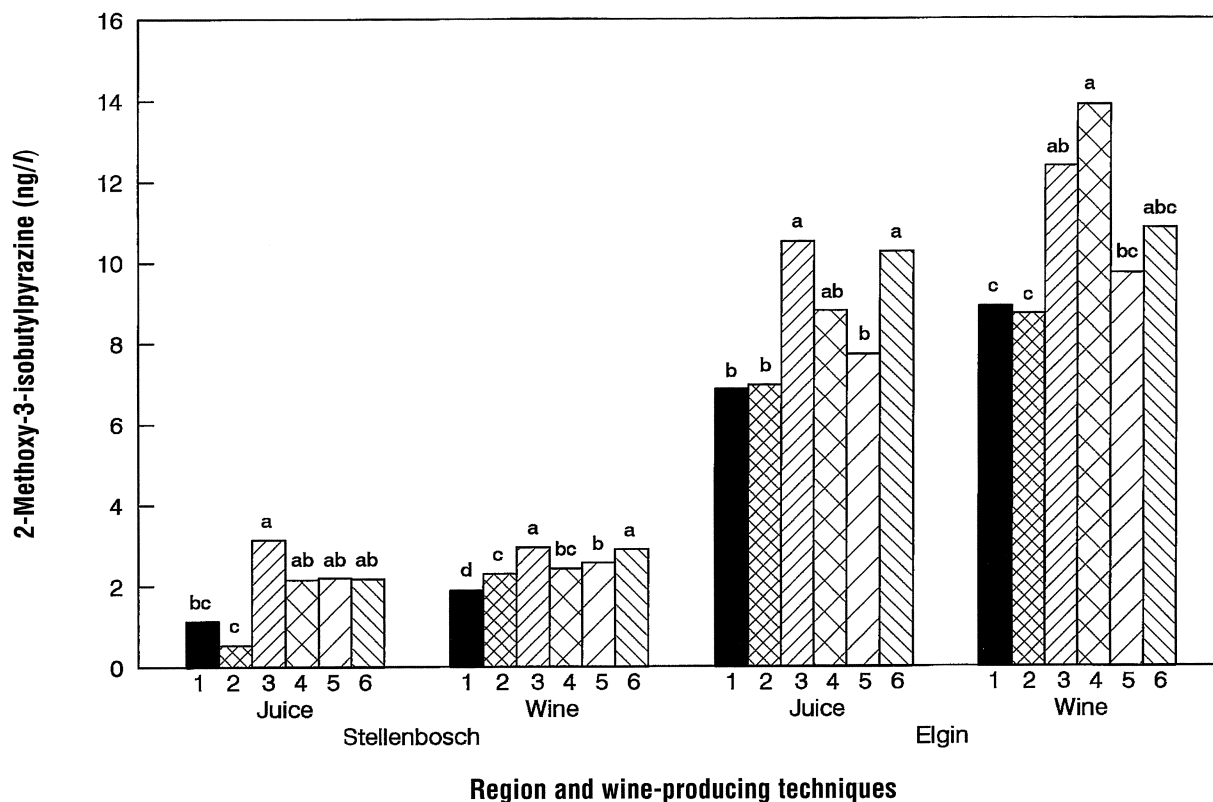
FIGURE 1

The effect of grape temperature, free-run (FR), skin contact (SC), oxidative and reductive production on 2-methoxy-3-isobutylpyrazine concentration in Stellenbosch and Elgin Sauvignon blanc settled juices and corresponding wines (1997 season) (1 = 0°C FR control, 2 = 20°C FR control, 3 = 0°C SC for 15 hours with $SO_2$ addition prior to fermentation, 4 = 20°C SC for 15 hours with $SO_2$ addition prior to fermentation, 5 = 0°C SC for 15 hours without $SO_2$ addition prior to fermentation, 6 = 20°C SC for 15 hours without $SO_2$ addition prior to fermentation). Treatments within each group designated by the same symbol do not differ significantly ($p \le 0,05$).
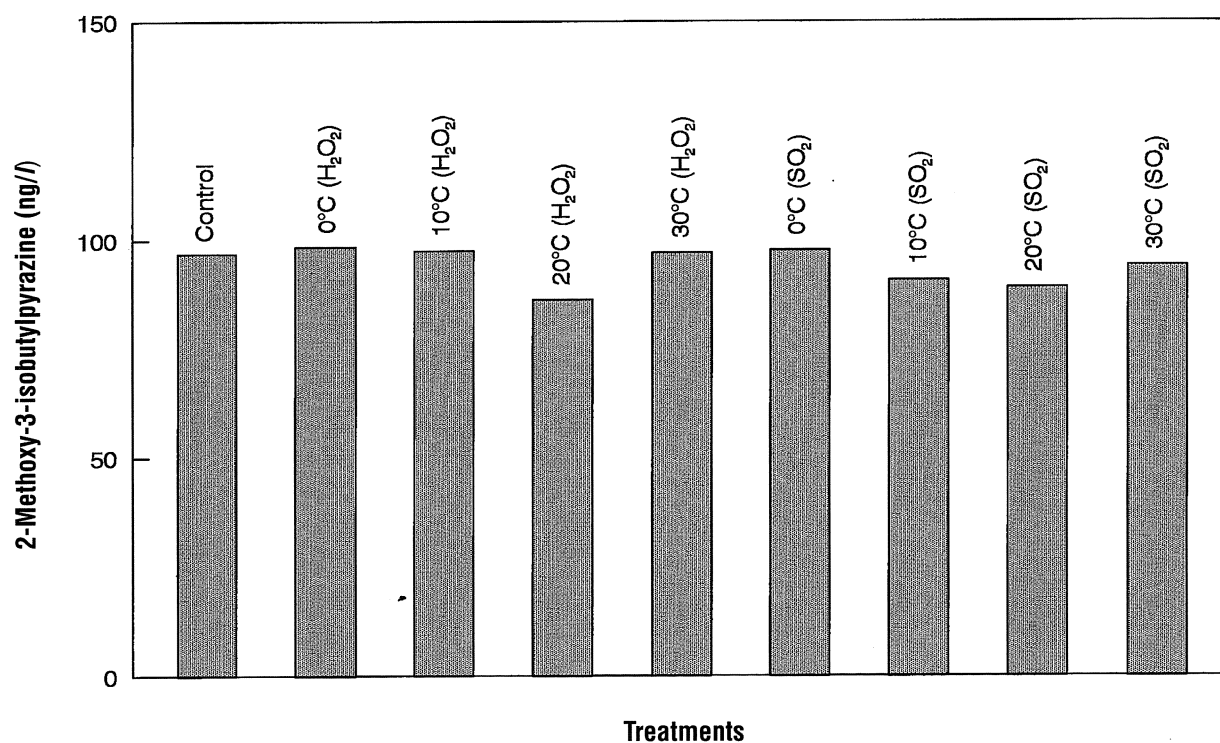


FIGURE 2

The effect of $H_2O_2$ (75 mg/$l$), $SO_2$ (100 mg/$l$) and storage temperature (0°C, 10°C, 20°C and 30°C) on 2-methoxy-3-isobutylpyrazine concentration, added at 98 ng/$l$ to a neutral Chenin blanc wine (1997 season).
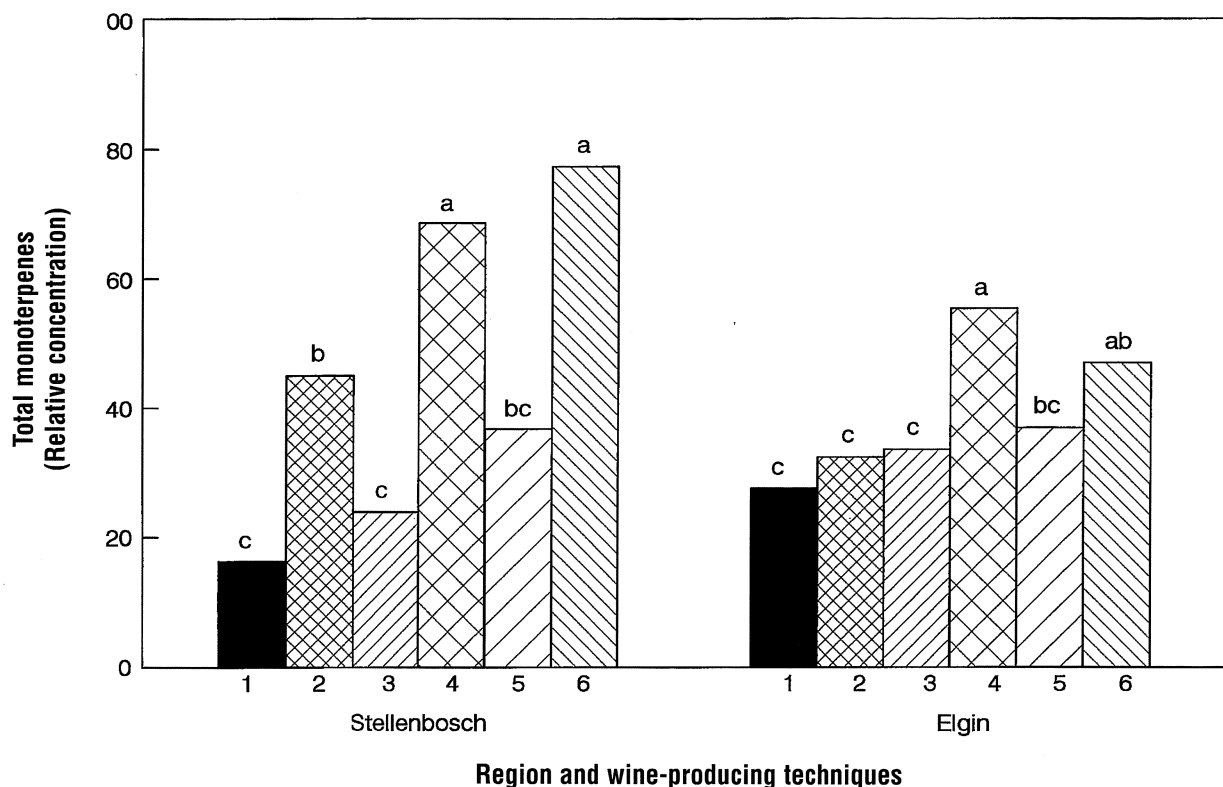
FIGURE 3

The effect of grape temperature, free-run (FR), skin contact (SC), oxidative and reductive production on total monoterpene concentrations in Stellenbosch and Elgin Sauvignon blanc settled juices (1997 season) (1 = 0°C FR control, 2 = 20°C FR control, 3 = 0°C SC for 15 hours with $SO_2$ addition prior to fermentation, 4 = 20°C SC for 15 hours with $SO_2$ addition prior to fermentation, 5 = 0°C SC for 15 hours without $SO_2$ addition prior to fermentation, 6 = 20°C SC for 15 hours without $SO_2$ addition prior to fermentation). Treatments within each group designated by the same symbol do not differ significantly (p ≤ 0,05).

Total ester concentration levels were generally of the same order for the two regions (Fig. 4). In the case of Stellenbosch, however, ester concentrations tended to be higher in 0°C than in 20°C wines. Differences in ester concentrations between wines produced from oxidised and reduced juices were not consistent. Van Wyk *et al.* (1996), however, reported higher acetate and ethyl ester concentrations in wines produced with $SO_2$ and ascorbic acid additions prior to fermentation, compared to those from hyperoxidised juices. It is probable that the effects of these treatments were more severe than those of the present study. The effect of esters on the fruitiness of the wines is discussed later.

Total polyphenol and total flavanoid concentrations were generally higher in SC than in FR wines, due to extraction from the skins (Fig. 5). These levels were lower in SC wines produced without $SO_2$ addition prior to fermentation than SC wines produced reductively, due to oxidative polymerisation and precipitation thereof. This is in agreement with Singleton *et al.* (1980), who reported increases in total phenol concentrations with an increase in SC time, as well as with increased levels of $SO_2$. Generally, polyphenol and flavanoid concentrations were higher in 20°C than in 0°C wines, due to more effective extraction (Fig. 5). Increases in 4-vinyl guaiacol, total phe-

nol, as well as monoterpene and total acetate ester concentrations in wines with an increase in SC time, and temperature were also reported previously (Marais & Rapp, 1988; Marais, 1991; Falque & Fernández, 1996). Polyphenol levels did not differ much between the two regions, while the flavanoid levels were lower in the cooler Elgin region.

With respect to wine quality, fruitiness tended to be higher in intensity in 0°C than in 20°C wines for both regions (Fig. 6). Furthermore, lower fruitiness intensity was found in oxidatively than in reductively produced wines (when viewed within each temperature group independently). This corresponds to some extent to the ester levels in the Stellenbosch wines (Fig. 4), but not to the monoterpene levels in the corresponding juices (Fig. 3), which indicates that other volatiles are also involved in the perceived fruitiness nuances. There are conflicting views on the effect of reductive as opposed to oxidative treatment of juice prior to fermentation on wine quality. However, quite a number of authors also reported increases in fruity aroma intensity, as well as wine quality of wines produced from reductive juices as opposed to those made from oxidised juices (Singleton *et al.*, 1980; Nicolini *et al.*, 1991; Van Wyk *et al.*, 1996). Naturally, wines made from oxidised juices are less sensitive to oxidation or pinking (Van Wyk *et al.*, 1996). However, oxidation of juices is not recommended and
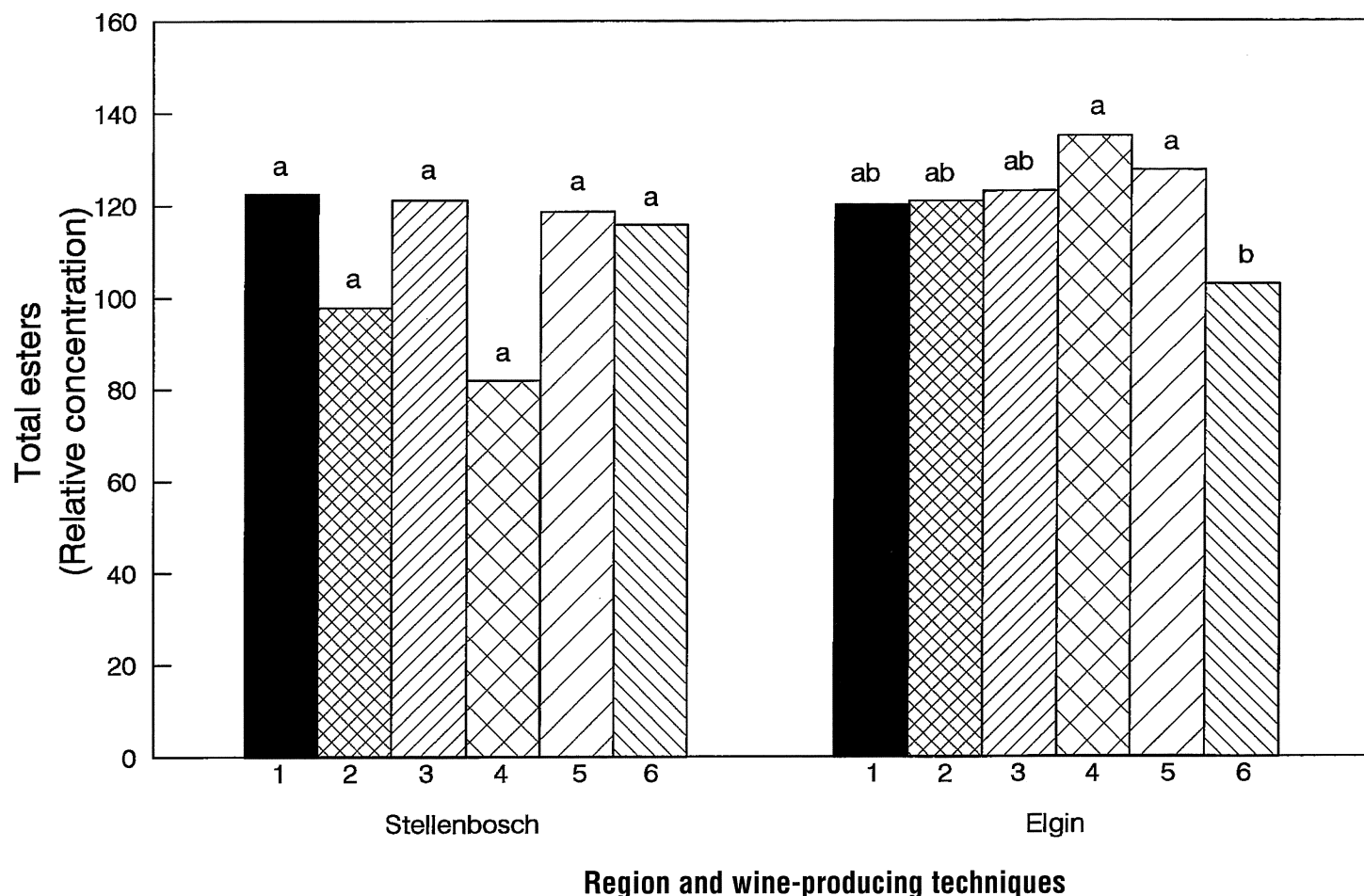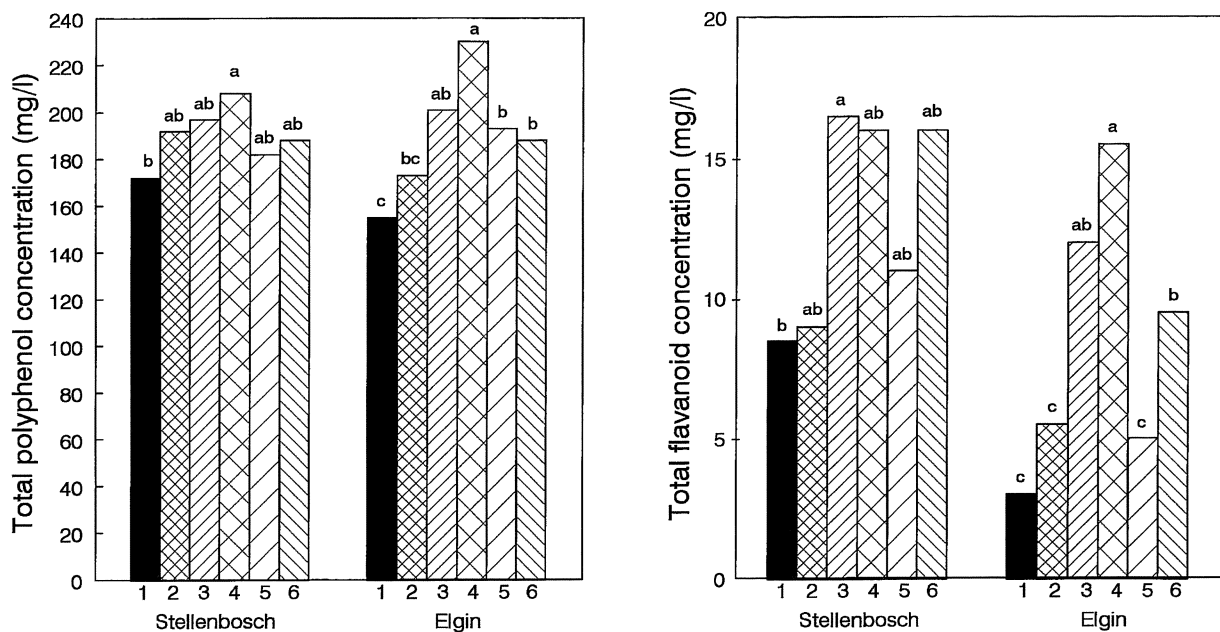
FIGURE 4

The effect of grape temperature, free-run (FR), skin contact (SC), oxidative and reductive production on total ester concentrations in Stellenbosch and Elgin Sauvignon blanc wines (1997 season) (1 = 0°C FR control, 2 = 20°C FR control, 3 = 0°C SC for 15 hours with $SO_2$ addition prior to fermentation, 4 = 20°C SC for 15 hours with $SO_2$ addition prior to fermentation, 5 = 0°C SC for 15 hours without $SO_2$ addition prior to fermentation, 6 = 20°C SC for 15 hours without $SO_2$ addition prior to fermentation). Treatments within each group designated by the same symbol do not differ significantly (p≤ 0,05).

reductive treatment of juice is commonly used to produce fresh and fruity Sauvignon blanc wines of high quality. Susceptability of reductively produced wines to pinking is a reality, but may be effectively overcome by keeping wine reductive throughout the whole wine-making process by maintaining sufficient levels of $SO_2$, especially when ascorbic acid is used.

The green pepper/grassy-like nuances tended to be higher in intensity in the 20°C than in the 0°C FR wines, while the SC wines showed the opposite tendency (Fig. 6). Apart from wine no. 3 (0°C, SC + $SO_2$), the SC wines generally showed lower intensities of the green notes than the FR wines, which again is contrary to the corresponding ibMP levels (Fig. 1). Furthermore, differences between regions with respect to ibMP levels (Fig. 1) were much more prominent than differences with respect to the perceived green pepper/asparagus aroma intensity (Fig. 6). A positive relationship between ibMP levels in the juices and wines

and the sensory evaluation of the green pepper/grassy-like nuances seems therefore not obvious under all conditions. This phenomenon may be ascribed to a masking or enhancing effect by various other aromas, and further investigations into the perception of Sauvignon blanc aroma and the components involved are needed.

When all the above-mentioned results are considered, it appears that Sauvignon blanc wine production from FR juices at temperatures as high as 20°C can still yield high-quality wines. However, when SC is applied, 20°C may be too high and too high levels of phenolic components may be extracted. Therefore low temperature SC is recommended, which corresponds to recommendations made in previous studies (Marais & Rapp, 1988; Zitzlaff, 1989). With both FR and SC techniques, juices should be treated reductively, since oxidation prior to fermentation may lead to Sauvignon blanc wines with lower aroma intensity and quality.

**Region and wine-producing techniques**

FIGURE 5

The effect of grape temperature, free-run (FR), skin contact (SC), oxidative and reductive production on total polyphenol and total flavanoid concentrations in Stellenbosch and Elgin Sauvignon blanc wines (1997 season) (1 = 0°C FR control, 2 = 20°C FR control, 3 = 0°C SC for 15 hours with $SO_2$ addition prior to fermentation, 4 = 20°C SC for 15 hours with $SO_2$ addition prior to fermentation, 5 = 0°C SC for 15 hours without $SO_2$ addition prior to fermentation, 6 = 20°C SC for 15 hours without $SO_2$ addition prior to fermentation). Treatments within each group designated by the same symbol do not differ significantly (p≤ 0,05).
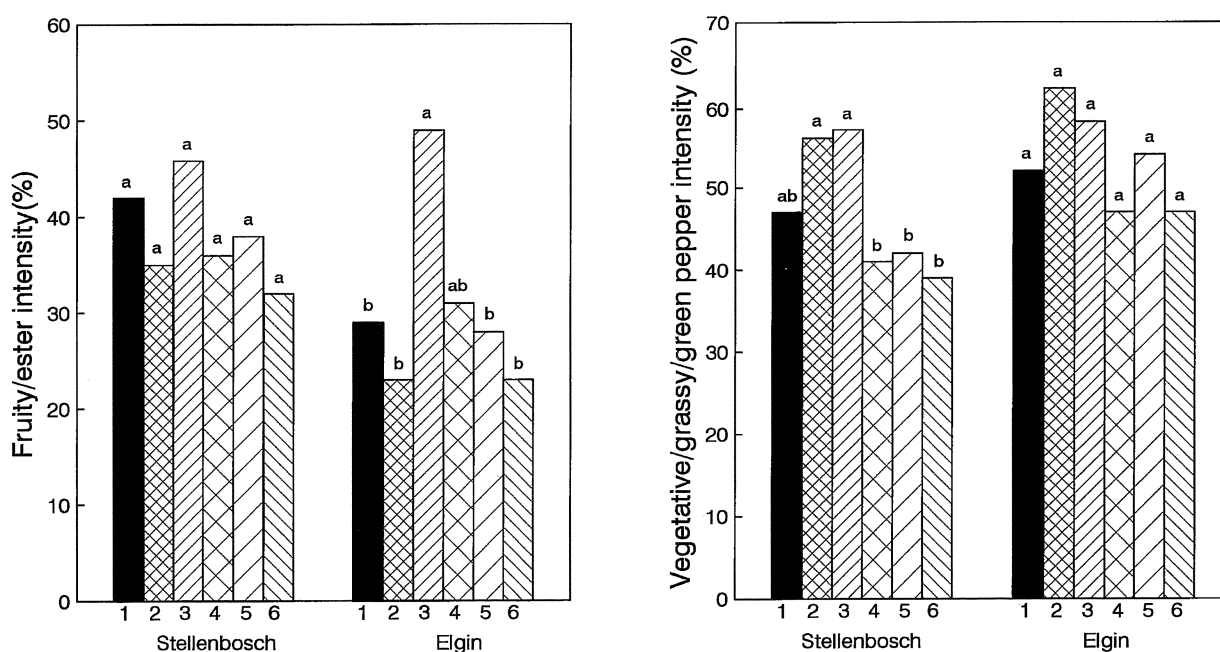


**Region and wine-producing techniques**

FIGURE 6

The effect of grape temperature, free-run (FR), skin contact (SC), oxidative and reductive production on Stellenbosch and Elgin Sauvignon blanc wine aroma intensities (1997 season) (1 = 0°C FR control, 2 = 20°C FR control, 3 = 0°C SC for 15 hours with $SO_2$ addition prior to fermentation, 4 = 20°C SC for 15 hours with $SO_2$ addition prior to fermentation, 5 = 0°C SC for 15 hours without $SO_2$ addition prior to fermentation, 6 = 20°C SC for 15 hours without $SO_2$ addition prior to fermentation). Treatments within each group designated by the same symbol do not differ significantly (p≤ 0,05).

## CONCLUSIONS

Sauvignon blanc is a cultivar that is sensitive to climatic, growth and production factors, partly due to the light-sensitive methoxypyrazines which affect its aroma and quality. It can be stated that ibMP levels are probably more affected by climatic and/or viticultural than by oenological factors. However, it is not possible to evaluate the effect of a specific group of chemical components in isolation, since wine quality is the culmination of the effects of various components. Synergism probably plays an important role and the same component can manifest differently in different media. Further studies are needed to clarify the relationship between impact aroma components and the typical aroma of Sauvignon blanc wines.

It is clear that oxidation and temperatures as high as 30°C do not affect ibMP levels in wine. However, these factors may have a major effect on other component concentrations, such as esters, monoterpenes and polyphenols, as well as on wine quality. Skin contact may enhance both desirable and undesirable component concentrations and should be conducted with care. It appears that low temperature SC under reductive conditions affects wine composition and quality positively and is therefore recommended. The temperatures at which SC was conducted in the present study, i.e. 0°C and 20°C, were chosen to obtain a relatively great difference in the lower temperature range. Future studies on Sauvignon blanc wine production should include the effect of more realistic and prevailing grape temperatures, as well as that of factors such as the use of ascorbic acid, different yeast strains and wine storage temperature.

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