Effect of Grape Temperature and Yeast Strain on Sauvignon blanc Wine Aroma Composition and Quality.

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The study focused on the production of Sauvignon blanc wines from grapes grown in sub-optimal climatic conditions. Grape temperatures of 10°C and 25°C at harvest, and fermentation with different *Saccharomyces cerevisiae* yeast strains, i.e. VIN 13, VIN 7, NT 116 and NT 7, were investigated over three seasons (1998, 1999 and 2000). The highest quality wines were produced from the cooler 10°C grapes. Choice of yeast strain was complicated by effects of factors such as grape temperature, grape maturity and season. In general, the highest ester concentrations and lowest higher alcohol concentrations were produced by NT 116, and the highest wine quality by NT 7. Strain VIN 7 yielded the lowest ester levels, which in some cases were preferred, since the masking effect of esters was diminished with the result that Sauvignon blanc wines with more pronounced cultivar-typical green notes and consequently higher quality could be produced. Therefore when Sauvignon blanc grapes, known to produce neutral wines, are used, factors such as low temperature at harvest and yeast strains suitable for these conditions should be considered.

Various climatic, viticultural and oenological factors affect Sauvignon blanc grape and wine composition and quality (Allen & Lacey, 1993; Marais *et al.*, 1996; Kotseridis *et al.*, 1997; Marais, 1998; Marais *et al.*, 1999). It is common knowledge that the most typical and highest quality, green pepper/asparagus-like Sauvignon blanc wines are produced from grapes grown in cool climate countries, or cooler locations in warmer climates. Within a vineyard, quality can be further enhanced by effective light radiation management within the canopies. Grapes from hot climates are usually not suitable for the production of typical Sauvignon blanc wines, because high temperatures and light radiation levels affect the formation and retainment of impact methoxypyrazines at perceivable levels negatively (Marais *et al.*, 1999). It was also demonstrated that grape temperature at harvest affects Sauvignon blanc wine quality (Marais, 1998). Oenological practices, such as skin contact, may also be applied to produce higher quality wines (Marais, 1998). Although it is not known whether yeasts produce or liberate methoxypyrazines, some do produce specific mercaptans. The latter compounds are responsible for positive passion fruit or negative cat urine aromas (Dubourdieu *et al.*, 1993; Darriet *et al.*, 1995; Tominaga *et al.*, 1996). Apart from this, yeasts also produce other aromas, which may enhance or mask the sought-after Sauvignon blanc aromas. For example, esters and higher alcohols may play an important role in the perception of the typical Sauvignon blanc aroma. Levels of these components are affected differently by different yeast strains (Mateo *et al.*, 1992; Nicolini *et al.*, 2000).

The majority of Sauvignon blanc wines produced in South Africa do not have the above-mentioned cultivar-typical characteristics, mainly as a result of climatic effects. There is a need to optimise these aromas by means of viticultural and/or oenological practices. Much success has already been achieved by means of canopy management (Marais *et al.*, 1996; Hunter & Le Roux, 1997; Marais *et al.*, 1999).

The aim of this study was to utilise grape temperature and yeast strain to enhance the cultivar-typicity and quality of Sauvignon blanc wine. For this purpose grapes which historically yielded neutral wines were used.

MATERIALS AND METHODS

Wine Production

Vitis vinifera L. cv. Sauvignon blanc grapes from two vineyards in the Stellenboch region, i.e. Klawervlei (1998 season) and the Nietvoorbij experiment farm (1999 and 2000 seasons), were used. In each season grapes (1440 kg) were harvested at ripeness (between 21°B and 22°B) and divided into two equal, representative parts and stored overnight at 10°C and 25°C, respectively. After storage, each part was crushed and subjected to six hours skin contact at the same storage temperatures. The skins and juices were then separated and the juices, after pectolytic enzyme (0.5 g/hL Ultrazym) addition, allowed to settle overnight at 14°C. During the 1999 season only, ascorbic acid (10 g/hL) was added to the juices. After settling, each juice was racked and divided into four equal parts, each part inoculated with a different commercial *Saccharomyces cerevisiae* yeast strain, i.e. VIN 13, VIN 7, NT 116 and NT 7. Fermentations were performed at 14°C. Before and after fermentation, SO_2 levels were retained at 30 mg/L free and 50 mg/L total. Other treatments were according to standard Nietvoorbij procedures for small-scale, white wine production. The whole experiment was done in triplicate. The treatment, VIN 13 (10°C), was used as control.

2-Methoxy-3-isobutylpyrazine (ibMP)

The wines were analysed for ibMP according to the technique of Harris *et al.* (1987), as adjusted by Lacey *et al.* (1991) (see also Marais *et al.*, 1996).

Esters and higher alcohols

Esters and higher alcohols were extracted from the wines by

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Freon 11 and the extracts analysed by gas chromatography (Marais, 1986). The esters analysed were iso-butyl acetate, iso-amyl acetate, hexyl acetate, 2-phenylethyl acetate, ethyl butyrate, ethyl hexanoate, ethyl octanoate and ethyl decanoate. The higher alcohols analysed were iso-butanol, iso-amyl alcohol, hexanol and 2-phenyl ethanol. All values were expressed as relative concentrations.

Wine quality

Wines were sensorially evaluated for fruitiness/ester-like intensity, green pepper/asparagus intensity and overall wine quality by a panel of six experienced judges. A line method was used, i.e. evaluating the intensity of each characteristic or overall wine quality by making a mark on an unstructured, straight 10 cm line. The left-hand and right-hand ends of the line were indicated by the terms, "undetectable" and "prominent" for intensities, and by "unacceptable" and "excellent" for quality, respectively. Wines were also ranked for yeast strain preference, according to the above-mentioned wine quality characteristics.

Statistical analyses

Statistical differences between treatments were determined by applying standard analysis of variance methods to the data of individual seasons. Least significant differences (LSD) were calculated to facilitate comparison between treatment means. The Levene test was used to test homogeneity of variances between seasons (Snedecor & Cochran, 1980).

RESULTS AND DISCUSSION

Grape Temperature

Grapes at 10°C yielded significantly higher quality wines with higher acetate and ethyl ester concentrations than grapes at 25°C (Tables 1, 2 and 5). These results confirmed those obtained in a previous study, where grape temperatures of 0°C and 20°C were compared (Marais, 1998). Differences between seasons were observed. For example, differences between 10°C and 25°C treatments were of a higher degree during the 1999 season than during the other two seasons. This was the result of spontaneous fermentation during the settling of the 25°C juices, which led to ineffective settling and eventually wines with low ester levels, as well as the formation of H_2S. Higher alcohol concentrations differed between 10°C and 25°C treatments, but a clear pattern could not be observed between seasons. The reason for higher higher alcohol concentrations at 10°C than at 25°C in the 2000 season, which is contrary to the other two seasons, is not clear (Table 1). Since quality differences between 10°C and 25°C were so obvious, sensory rankings between these two parameters were not performed.

TABLE 2

Effect of grape temperature (average of four yeast strains – VIN 13, VIN 7, NT 116, NT 7) on Sauvignon blanc wine quality (three seasons).

Season and grape temperature	Wine quality (%)		
	Fruity/ester intensity	Green pepper/ asparagus intensity	Overall wine quality
1998			
10°C	53.4a	36.4a	59.7a
25°C	47.3a	33.0a	54.7a
1999			
10°C	53.5a	37.9a	56.0a
25°C	15.1b	22.6b	23.3b
2000			
10°C	37.1a	34.5a	49.5a
25°C	26.7b	26.9b	41.8b

Treatments (each season and wine quality characteristic viewed separately) designated by the same letter do not differ significantly ($p \leq 0.05$).

TABLE 1

Effect of grape temperature (average of four yeast strains – VIN 13, VIN 7, NT 116, NT 7) on Sauvignon blanc wine composition (three seasons).

Season and grape temperature	Aroma components (relative concentration)											
	iBuac	iAmac	Hexac	2Pheac	EtC4	EtC6	EtC8	EtC10	iBuOH	iAmOH	HexOH	2PheOH
1998												
10°C	15.01a	88.02a	43.94a	4.22a	1.92a	9.82a	13.48a	4.80a	10.79a	61.48a	7.46a	9.46a
25°C	14.66a	76.42b	27.42b	3.91b	1.64a	8.58b	12.22b	4.79a	12.13a	65.62a	5.83b	10.37a
1999												
10°C	12.44a	94.23a	45.30a	6.96a	1.18a	12.12a	15.38a	5.02a	9.52b	60.91a	7.95b	11.86b
25°C	4.34b	10.88b	5.03b	5.79b	1.12b	4.21b	5.59b	2.04b	19.49a	58.69a	10.13a	18.13a
2000												
10°C	12.11a	63.21a	36.05a	7.86a	1.39a	9.37a	11.65a	4.26a	13.43a	66.74a	8.24a	15.33a
25°C	10.55b	50.68b	18.41b	7.28a	1.29a	7.86b	10.38b	3.72b	10.26b	61.56a	6.46b	14.64a

Treatments (each season and aroma component viewed separately) designated by the same letter do not differ significantly ($p \leq 0.05$).

iBuac = iso-Butyl acetate; iAmac = iso-Amyl acetate; Hexac = Hexyl acetate; 2Pheac = 2-Phenylethyl acetate; EtC4 = Ethyl butyrate; EtC6 = Ethyl hexanoate; EtC8 = Ethyl octanoate; EtC10 = Ethyl decanoate; iBuOH = iso-Butanol; iAmOH = iso-Amyl alcohol; HexOH = Hexanol; 2PheOH = 2-Phenyl ethanol.

TABLE 3

Effect of yeast strain (average of two grape temperatures – 10°C and 25°C) on Sauvignon blanc wine composition (three seasons).

Season and yeast strain	Aroma components (relative concentration)											
	iBuac	iAmac	Hexac	2Pheac	EtC4	EtC6	EtC8	EtC10	iBuOH	iAmOH	HexOH	2PheOH
1998												
VIN 13	12.52c	79.52bc	31.01b	3.53c	1.62a	9.35b	14.35a	5.41a	11.05b	64.03ab	6.73ab	8.86b
VIN 7	14.97b	64.67c	31.45b	4.11b	1.65a	9.36b	11.98b	4.22b	14.55a	64.90ab	7.36a	11.60a
NT 116	13.58bc	86.67ab	39.22a	5.11a	1.93a	7.22c	11.36b	4.46b	7.23c	56.29b	5.85c	11.78a
NT 7	18.26a	98.02a	42.03a	3.05c	1.92a	10.88a	13.70a	5.10a	13.01ab	68.98a	6.64b	7.45b
1999												
VIN 13	6.66c	45.58b	19.97b	5.15c	1.05a	7.66bc	10.99ab	4.04a	13.77b	58.30ab	8.95ab	14.25a
VIN 7	9.01ab	50.69b	26.98a	7.62b	1.21a	8.55ab	10.12ab	3.32ab	18.36a	68.45a	9.15ab	16.38a
NT 116	10.17a	71.66a	29.49a	8.14a	1.26a	6.74c	9.03b	3.22b	12.67b	59.38ab	8.30b	15.96a
NT 7	7.73bc	42.31b	24.20ab	4.60d	1.08a	9.72a	11.81a	3.52ab	13.23b	53.07b	9.76a	13.41a
2000												
VIN 13	9.16c	58.46b	25.63b	8.74a	1.25b	8.68b	13.07a	4.67a	10.34c	66.87ab	6.47c	16.04b
VIN 7	13.23a	52.47bc	25.40b	7.26bc	1.27b	9.65a	11.63b	4.33ab	16.42a	76.59a	7.44b	19.70a
NT 116	11.74b	70.24a	34.19a	8.04ab	1.84a	7.47c	8.87d	3.02c	7.71d	51.58c	6.74bc	14.81b
NT 7	11.20b	46.60c	23.69b	6.24c	1.00b	8.67b	10.50c	3.93b	12.92b	61.56bc	8.76a	9.39c

Treatments (each season and aroma component viewed separately) designated by the same letter do not differ significantly ($p \leq 0.05$).

iBuac = iso-Butyl acetate; iAmac = iso-Amyl acetate; Hexac = Hexyl acetate; 2Pheac = 2-Phenylethyl acetate; EtC4 = Ethyl butyrate; EtC6 = Ethyl hexanoate; EtC8 = Ethyl octanoate; EtC10 = Ethyl decanoate; iBuOH = iso-Butanol; iAmOH = iso-Amyl alcohol; HexOH = Hexanol; 2PheOH = 2-Phenyl ethanol.

Yeast strain

The effect of yeast strain on Sauvignon blanc wine composition and quality is shown in Tables 3, 4 and 6. The four yeast strains chosen are some of the most important commercial strains used in white wine production in South Africa. When each season was viewed separately, it was difficult to give preference to one strain, because all of them appeared to be quality-enhancing. A few strains, however, stood out: Strain NT 116 was associated with the production of the highest ester and the lowest higher alcohol levels. Some of the highest quality wines were produced by strain NT 7. Strain VIN 7 was associated with the highest green pepper/asparagus nuances in each of the three seasons, and also produced the highest quality wines in 1999, the only season in which measurable ibMP concentrations occurred (data not given). These ibMP levels, however, did not differ statistically between treatments. When data were averaged over seasons, the above-mentioned trends were confirmed (Table 6).

Sensory ranking of the wines confirmed individual evaluation results to a great extent (Table 7). Irrespective of season, yeast strains NT 7 and NT 116 yielded more intense fruity/ester-like wines than strains VIN 7 and VIN 13. Conversely, the sought-after green nuances were more prominent with the two last-mentioned strains, because these aromas were probably not masked by intense fruity/ester-like aromas. With respect to the overall quality of the wines, personal preference played a role to some extent, but eventually, strains NT 7 and VIN 7 appeared to be the

TABLE 4

Effect of yeast strain (average of two grape temperatures – 10°C and 25°C) on Sauvignon blanc wine quality (three seasons).

Season and yeast strain	Wine quality (%)		
	Fruity/ester intensity	Green pepper/ asparagus intensity	Overall wine quality
1998			
VIN 13	51.5a	32.3a	59.3a
VIN 7	44.8a	38.2a	55.3a
NT 116	49.3a	33.0a	54.8a
NT 7	55.8a	35.3a	59.2a
1999			
VIN 13	32.9a	31.5ab	40.2b
VIN 7	38.2a	39.2a	49.3a
NT 116	33.6a	23.9b	34.9b
NT 7	32.6a	26.3b	34.2b
2000			
VIN 13	29.5ab	30.5a	44.9ab
VIN 7	24.0b	35.4a	39.0b
NT 116	38.4a	28.0a	48.2a
NT 7	35.6ab	28.9a	50.4a

Treatments (each season and wine quality characteristic viewed separately) designated by the same letter do not differ significantly ($p \leq 0.05$).

TABLE 5

Effect of grape temperature (average of four yeast strains – VIN 13, VIN 7, NT 116, NT 7) on Sauvignon blanc wine composition and quality (average of three seasons – 1998, 1999, 2000).

Grape temperature	Aroma composition (relative concentration)			Wine quality (%)		
	Acetate esters	Ethyl esters	Higher alcohols	Fruity/ester intensity	Green pepper/ asparagus intensity	Overall wine quality
10°C	143.12a	30.13a	91.61b	47.99a	36.27a	55.03a
25°C	78.45b	21.15b	100.56a	29.72b	27.50b	39.91b

Treatments (each aroma group and wine quality characteristic viewed separately) designated by the same letter do not differ significantly ($p \leq 0.05$).
Heterogeneity of year variances were found in all the variables, except higher alcohols, and weighed analyses were performed to correct this problem (Snedecor & Cochran, 1980).
Acetate esters = Sum of iso-butyl acetate, iso-amyl acetate, hexyl acetate and 2-phenylethyl acetate.
Ethyl esters = Sum of ethyl butyrate, ethyl hexanoate, ethyl octanoate and ethyl decanoate.
Higher alcohols = Sum of iso-butanol, iso-amyl alcohol, hexanol and 2-phenyl ethanol.

TABLE 6

Effect of yeast strain (average of two grape temperatures – 10°C and 25°C) on Sauvignon blanc wine composition and quality (average of three seasons – 1998, 1999, 2000).

Yeast strain	Aroma composition (relative concentration)			Wine quality (%)		
	Acetate esters	Ethyl esters	Higher alcohols	Fruity/ester intensity	Green pepper/ asparagus intensity	Overall wine quality
VIN 13	101.98b	27.38a	95.22b	37.96a	31.46bd	48.13a
VIN 7	102.62b	25.76ab	110.30a	35.68a	37.61a	47.86a
NT 116	129.08a	22.14c	86.10c	40.45a	28.29d	45.97a
NT 7	109.46b	27.27ab	92.73bc	41.33a	30.19cd	47.93a

Treatments (each aroma group and wine quality characteristic viewed separately) designated by the same letter do not differ significantly ($p \leq 0.05$).
Heterogeneity of year variances were found in all the variables, except higher alcohols, and weighed analyses were performed to correct this problem (Snedecor & Cochran, 1980).
Acetate esters = Sum of iso-butyl acetate, iso-amyl acetate, hexyl acetate and 2-phenylethyl acetate.
Ethyl esters = Sum of ethyl butyrate, ethyl hexanoate, ethyl octanoate and ethyl decanoate.
Higher alcohols = Sum of iso-butanol, iso-amyl alcohol, hexanol and 2-phenyl ethanol.

best. These results are in agreement with the tendencies in Table 6, where individual data were averaged over seasons.

In general, it was difficult to choose between the yeast strains studied in this investigation. Choices were affected by grape maturity, grape temperature, location and season, which affected wine composition. Examples are: The grapes of the 2000 season were harvested at a higher ripeness (approximately 23°B) than in the other two seasons. This resulted in a phenolic character which was more pronounced with strain VIN 7 specifically, and the reason for its low preference in the 2000 season (Table 7). During the 1999 season the wines had higher ibMP levels and, as mentioned, settling of the 25°C juices was ineffective, because spontaneous fermentation set in.

Yeast strain can play an important role in fermentation of juices that usually yield neutral Sauvignon blanc wines. Green pepper/asparagus aromas present in low intensities may be masked by too high fruity/ester-like intensities. Therefore, in this case, yeast strains with the ability to produce low ester concentrations are recommended for the production of higher quality Sauvignon blanc wines. On the other hand, yeast strains that produce high concentrations of esters, like the locally-developed NT 116, may be suitable for the production of wines, such as the local, usually neutral, Chenin blancs.

CONCLUSIONS

The approach in this study was to exploit the potential of grapes which historically produced neutral Sauvignon blanc wines.

TABLE 7

Preference of Sauvignon blanc wines in terms of yeast strain used (grape temperatures 10°C and 25°C averaged) (1998, 1999 and 2000 seasons individually and averaged).

Preference	Season and yeast strain			Averaged
Fruity/ester-like intensity				
	1998	1999	2000	
1	NT 7	VIN 7	NT 116	NT 7
2	NT 116	NT 7	NT 7	NT 116
3	VIN 7	VIN 13	VIN 13	VIN 7
4	VIN 13	NT 116	VIN 7	VIN 13
Green pepper/asparagus intensity				
	1998	1999	2000	
1	VIN 7	VIN 7	VIN 13	VIN 7
2	VIN 13	VIN 13	NT 7	VIN 13
3	NT 7	NT 7	VIN 7	NT 7
4	NT 116	NT 116	NT 116	NT 116
Overall wine quality				
	1998	1999	2000	
1	VIN 7	VIN 13	NT 7	NT 7
2	NT 7	VIN 7	NT 116	VIN 7
3	NT 116	NT 7	VIN 13	VIN 13
4	VIN 13	NT 116	VIN 7	NT 116