Sauvignon blanc Cultivar Aroma – A Review

J. Marais

Nietvoorbij Institute for Viticulture and Oenology, Agricultural Research Council, Private Bag X5026, 7599 Stellenbosch, Republic of South Africa

Submitted for publication: September 1994
Accepted for publication: December 1994
Key words: Sauvignon blanc, cultivar aroma, methoxypyrazines, monoterpenes, C13-norisoprenoids

The typical cultivar aroma of Sauvignon blanc may be described as containing vegetative, grassy, herbaceous, gooseberry, asparagus and green pepper nuances. The chemical components responsible for these aromas are reviewed. The most important components are methoxypyrazines, especially 2-methoxy-3-isobutylpyrazine. Other components, such as 4-methyl-4-mercapto-pentan-2-one, monoterpenes, C13-norisoprenoids, C9-alcohols and C10-aldehydes may also contribute to the complexity of Sauvignon blanc aroma. Factors affecting methoxypyrazine levels and therefore the typical Sauvignon blanc cultivar aroma are, amongst others, origin/climate and level of grape ripeness. Methoxypyrazine concentrations decrease with grape ripening and under increased sunlight and temperature conditions. To produce Sauvignon blanc wines with typical aromas, vines should be cultivated in cool areas and wines stored in dark rooms to retain these aromas.

Wine aroma is an important aspect of wine quality to which aroma components typical of the grape cultivar often make an important contribution. Sauvignon blanc is a cultivar of which the typical aroma may be described as containing vegetative, grassy, herbaceous, gooseberry, asparagus and green pepper nuances. These typical nuances are not unique to Sauvignon blanc, but are also part of Cabernet Sauvignon and Semillon grape and wine aromas (Allen & Lacey, 1993; Allen, Lacey & Boyd, 1994). These nuances, considered as typical of Sauvignon blanc aroma, are caused by a specific group of chemical components, namely methoxypyrazines. Other chemical components may, however, also contribute to the complexity of Sauvignon blanc aroma.

There are differences of opinion concerning the acceptability of the typical Sauvignon blanc aroma among producers and consumers. An intense aroma may be sought-after or unacceptable. The general feeling, however, is that the typical grass-like aroma is a positive quality parameter, as long as it is not one-sided or dominant, but complemented by other herbaceous and fruity aromas.

In South Africa the area planted to Sauvignon blanc has increased from 0.2% in 1980 to 4.0% in 1993 (Anon., 1994). This represents approximately 4000 hectares. Although high-quality wines with the typical cultivar aroma are produced, a high percentage of wines still show a neutral character. Against this background, the purpose of this review is a discussion of the typical Sauvignon blanc cultivar aroma and the factors which affect it. By applying this knowledge, more typical Sauvignon blanc wines may be produced.

AROMA COMPONENTS

Methoxypyrazines: Methoxypyrazines are nitrogen-containing ring substances and are secondary products of amino acid catabolism (Murray & Whitfield, 1975; Maga, 1989). Valine, glycine and methionine are considered to be precursors of 2-methoxy-3-isopropylpyrazine (Cheng et al., 1991). However, the exact pathway for the formation of methoxypyrazines is not known (Rizzi, 1988). According to Allen (1993), indications are that the biosynthetic pathway for the formation of methoxypyrazines differs completely from that of monoterpenes and C13-norisoprenoids.

Methoxypyrazines generally occur in raw vegetables such as peas, green peppers, potatoes and beetroot (Murray & Whitfield, 1975). Data tentatively indicating the presence of methoxypyrazines in Cabernet Sauvignon grapes were first published by Bayonove, Cordonnier & Dubois (1975). Subsequently two methoxypyrazines were identified in Sauvignon blanc juice by Augustyn, Rapp & Van Wyk (1982). Since then techniques for the determination of these compounds have been refined and the low concentrations at which they occur in grapes and wine determined quantitatively (Harris et al., 1987; Lacey et al., 1991). One methoxypyrazine is important in Sauvignon blanc grapes and wine, namely 2-methoxy-3-isobutylpyrazine (ibMP), while 2-methoxy-3-isopropylpyrazine (ipMP) and 2-methoxy-3-sec-butylpyrazine (sbMP) are generally present (Fig. 1). These components have extremely low threshold values and ibMP, which normally occurs in higher concentrations than the other two, can be perceived sensorially at a concentration of 2 ng/l (2 parts per trillion) in water (Buttery et al., 1969). This can be compared to one grape berry in 500 000 tons of grapes (Allen et al., 1988).

Methoxypyrazines differ with respect to their aromas with green pepper-like aromas being typical of ibMP and pea-asparagus-like aromas typical of ipMP (Allen et al., 1988). Therefore, the complexity and nuances of Sauvignon blanc aroma will depend on, amongst other things, whether these components occur at levels above their threshold values.
In Sauvignon blanc wines from Australia, New Zealand and France, ibMP concentrations were on average seven times higher than those of ipMP, while those of sbMP were even lower (Lacey et al., 1991). From this it could be deduced that in most cases the latter two methoxyypyrazines do not contribute to the overall aroma of grapes and wine of this cultivar. This was confirmed by the use of a sniffing technique ("Charm Analysis"), showing ibMP to be the main contributor to the vegetative/green pepper aroma of a typical wine (Lavin & Acree, 1992). The contribution of ipMP was marginal, while sbMP made no contribution.

Maga (1989) also studied the contribution of these components to the typical Sauvignon blanc aroma. Results indicated that addition of ibMP at ≥ 2 ng/l caused musty and green pepper-like aromas in a model and natural wine, respectively. These results indicated that a threshold value of 2 ng/l also applies to wine. Addition of ipMP at 2 ng/l to the same wines again produced musty aromas in the model wine and earthy and leafy nuances in the natural wine. Aroma expression was also related to the concentration of the compound added. Therefore, other volatiles and individual compound concentration affect the perceived aroma. Aroma threshold values are only guidelines for aroma intensity and could change through synergistic actions with other components in the medium (Ribéreau-Gayon, Boidron & Terrier, 1975). The low threshold values of ibMP and ipMP were also confirmed by Allen et al. (1991). Addition of 1 ng/l ibMP and 2 ng/l ipMP to a neutral wine significantly affected the aroma, and 70% of the judges in the first case and 80% in the second could elicit the herbaceous/vegetative aromas.

The presence of another pyrazine, namely 3-methoxy-2-ethylpyrazine, was also reported in Sauvignon blanc grapes (Augustyn et al., 1982). The threshold value of this pyrazine is 425 ng/l (Seifert et al., 1970), and as it is probably present at extremely low concentrations, it is unlikely to make any contribution to Sauvignon blanc aroma (Lacey et al., 1991). The same reasoning applies to 2-methoxy-3-methylpyrazine (Harris et al., 1987), having a threshold value of 4000 ng/l (Seifert et al., 1970).

Other aroma components: The possibility that other components also contribute to the typical Sauvignon blanc aroma should be considered. Francis, Sefton & Williams (1992) demonstrated that extracts of components, liberated from glycosidic precursors in Sauvignon blanc under acidic conditions, showed no grass-like or asparagus-like aromas, suggesting that pyrazine-like aromas do not derive from glycosides. This, however, does not mean that other components of glycosidic origin do not play a role. Williams, Francis & Sefton (1992) added hydrolysates, released acidically and enzymatically from their precursors in Sauvignon blanc grapes, to a neutral wine. The wines were judged and eleven descriptive terms were selected. Enzyme-released hydrolysates enhanced wine aroma with respect to three nuances, namely floral, lime and indeed also grassy. The first two aromas were probably caused by monoterpenes, but the origin of the grass-like aroma was not discussed. To what extent aroma compounds are naturally released by enzymes and contribute to wine aroma remains an unanswered question. Acid-released hydrolysates enhanced eight nuances of wine aroma, namely floral, t alc, lime, pineapple, honey, toasty, oak and tea. Honey and tea-like aromas may have been caused by C_{13}^3 norisoprenoids and the oaky aroma by phenolic compounds. Addition of acid-released hydrolysates from Semillon and Chardonnay to a neutral wine gave similar results, therefore indicating that these aroma nuances are not unique to Sauvignon blanc. Although differences between Sauvignon blanc and, for example, Chardonnay appeared to be minimal, monoterpane concentration constituted a greater percentage of the total aroma concentration of Sauvignon blanc (Williams et al., 1992). In an investigation of the composition of the free and bound aroma components of this cultivar, Sefton, Francis & Williams (1994) suggested that monoterpenes may play a role in its aroma. Volatile components were released from their bound forms by acid and enzymatic hydrolysis. Monoterpenes and C_{13}^3-norisoprenoids constituted 18% and 27% of the total aroma concentration, respectively. Bluemol C was the enzyme-released C_{13}^3-norisoprenoid occurring in the highest concentration. p-Menthan-1-ene,7,8-diol being the most abundant. In a comparative study between Gewürztraminer, Weisser Riesling and Sauvignon blanc, the latter had relatively high concentrations of free trans-pyran falanool oxide, diiodol-1, cis-8-hydroxy-falanool, 2-hydroxy-1,8-cineole and bound alpha-terpineol, cis-8-hydroxy-falanool and particularly menthenediol-2 (p-menthene-7,8-diol) (Versini, Rapp & Dalla Serra, 1992).

Monoterpenes with a p-menthene structure, occurring in relatively high concentrations in bound forms in Sauvignon blanc grapes and wine, are menthenediol-1 (trans- and cis-p-menthene-1,6-8-diol), also known as trans- and cis-sorberol, and menthunediol-2 (Sefton et al., 1994; Versini et al., 1991; Versini et al., 1992). These components (Fig. 2) are oxidized derivatives of alpha-terpineol and increase in concentration during ageing of wine (Versini et al., 1992). Other alpha-terpineol derivatives of importance are 2-exo-hydroxy-1,8-cineole (Bitteur et al., 1990) and p-menthene-1,8-diol, tentatively identified by Sefton et al. (1994). Experiments showed that alpha-terpineol was virtually completely transformed to trans- and cis-p-methanone-1,8-diol at wine pH. However, according to Sefton et al. (1994) the abovementioned monocyclic monoterpenes have limited sensory impact and chemical processes, transforming favourul monoterpenes to p-menthan derivatives, will therefore diminish the sensory contribution of monoterpenes to grapes and wine.
According to Dubourdieu, Darriet & Lavigne (1993), a sulphur component, 4-methyl-4-mercapto-pentan-2-one (Fig. 3), is important in the typical cultivar aroma of Sauvignon blanc. The threshold value of this component is 0.1 ng/l in water. A component with a similar structure is probably responsible for the typical guava aroma of some South African Chenin blanc and Colombar wines (Du Plessis & Augustyn, 1981). Depending on its concentration level and the composition of wine, it also presents a cat urine aroma. The component mentioned by Dubourdieu et al. (1993) does not occur in grapes and juice, but is formed from a precursor during fermentation. The yeast strain therefore probably plays a role in the formation of this sulphur compound.

The importance of C₆-aldehydes and C₆-alcohols in the typical grassy, leafy and herbaceous-like character of unripe grapes is well known. Threshold values of n-hexanal, n-hexanol, cis-3-hexenal, trans-2-hexenal, cis-3-hexenol and trans-2-hexenol in beer are 0.35, 4, 0.02, 0.6, 13 and 15 mg/l, respectively (Meilgaard, 1975). During crushing of grapes when grape cells are broken in the presence of oxygen, high concentrations of hexanal and hexanol are formed from linoleic acid, and trans-2-hexenal, trans-2-hexenol, trans- and cis-3-hexenols from linolenic acid (Drawert et al., 1966; Cordonnier & Bayonove, 1981; Aerny & Humbert, 1993). Since these components occur in all grape juices, it appears that they are not impact components in the typical Sauvignon blanc aroma, and that their possible contribution is probably masked by the effect of other components. In addition, aldehydes are generally present in wine as bisulphite compounds due to the effect of added SO₂. Aldehydes are also reduced to the corresponding alcohols during primary fermentation.

Other components probably playing a role in the typical cultivar aroma of Sauvignon blanc are the potato-like methional and the so-called cucumber aldehyde, trans-2, cis-6-nonadienal (Augustyn et al., 1982).

![Flavourful sulphur component of Sauvignon blanc wines.](image)

**FIGURE 3**

**FACTORS AFFECTING THE DEVELOPMENT OF THE TYPICAL SAUVIGNON BLANC AROMA**

The intensity of the typical Sauvignon blanc aroma and therefore the concentrations of the components responsible for this aroma are affected by origin/climate (Allen et al., 1988; Allen & Lacey, 1993). The intensity is lower in hot areas, while in cool areas such as New Zealand it can be very prominent. Lacey et al. (1988) showed ibMP to occur in much higher concentrations in New Zealand Sauvignon blanc wines (12.6-34.5 ng/l) than in Australian wines (0.6-14.6 ng/l).

Heymann, Noble & Boulton (1986) found methoxypyrazines to be light sensitive and easily degradable to other components. This was confirmed by Maga (1989), showing that methoxypyrazine concentrations decreased more rapidly in the presence of light over 12 months' storage in clear glass bottles (up to 60%), when compared to green and amber coloured bottles (up to 40%). When bottles were stored for 12 months in the dark, concentration decreases were drastically smaller (≤4%), irrespective of glass colour. Allen (1993) demonstrated that methoxypyrazine concentrations decreased with an increase in sunlight exposure, obtained by a decrease in the number of leaf layers. In the same context Allen & Lacey (1993) proved that different pruning techniques caused significant differences in ibMP levels.

Regarding the localization of methoxypyrazines in grapes, Allen et al. (1989) suggested that these components probably occur in the solid parts of the grape berry, because Cabernet Sauvignon wines showed higher methoxypyrazine concentrations than those recorded in the corresponding juice before fermentation. This may possibly be ascribed to the extraction of methoxypyrazines from the solid parts by ethanol during fermentation or by the liberation thereof from precursors by specific yeast strains (Allen, 1994).

Methoxypyrazine concentrations decrease with grape ripening (Versini et al., 1990; Lacey et al., 1991; Allen, 1993). When compared to sugar accumulation, it was
found that the ibMP concentration decrease mainly occurred before sugar accumulation reached 50% of the final concentration (Lacey et al., 1991). They also found that a warmer year had a more pronounced effect on ibMP concentration decrease than a cooler year. The ibMP concentration decreased to a level lower than its threshold value in the warmer year, probably yielding wines without the desired, typical Sauvignon blanc aroma. On the contrary, the cooler year yielded more cultivar-typical wines.

Apart from methoxyppyrazine concentration decreases during grape ripening and/or increased sunlight exposure, monoterpenes and C<sub>13</sub>-borisoprenoid concentrations generally increase under the same conditions. To obtain a balance between the abovementioned component levels would be difficult, though Allen (1993) suggested that cool climatic conditions would benefit the development of methoxyppyrazines, as well as monoterpenes and C<sub>13</sub>-borisoprenoids.

CONCLUSIONS AND RECOMMENDATIONS

Research results indicate that the typical vegetative, grassy and green pepper-like aroma of Sauvignon blanc can mainly be ascribed to the occurrence of methoxyppyrazines, and more specifically ibMP, which normally occurs above its threshold value and in concentrations higher than those of other methoxyppyrazines. Results also suggest that components other than methoxyppyrazines may contribute to the complexity of Sauvignon blanc aroma.

Application of existing knowledge to produce cultivar-typical Sauvignon blanc wines can best be made by following certain guidelines. To accommodate the effect of macro- and mesoclimate on methoxyppyrazine concentrations, Sauvignon blanc should preferably be cultivated in cool areas or against cooler slopes in warm areas. Microclimate within the canopy can be manipulated by viticultural practices to obtain favourable conditions, that is relatively low temperature and reduced sunlight exposure, which will theoretically benefit methoxyppyrazine precursor metabolism and methoxyppyrazine retention during grape ripening. However, the negative effects of low temperature and lack of sunlight exposure on various viticultural aspects as well as on grape and wine quality in general should be borne in mind. Furthermore, to retain the typical Sauvignon blanc aroma, wines should be bottled in dark-coloured bottles and stored in dark rooms.

LITERATURE CITED


