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Effect of storage time and temperature on the formation of dimethyl sulphide and on white wine quality[1])

by

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Der Einfluß der Lagerungsdauer und -temperatur auf die Bildung von Dimethylsulfid und auf die Qualität von Weißwein

Zusammenfassung. — Weine der Sorten Chenin blanc, Colombar und Riesling wurden bei 0, 10, 20 und 30 °C 16 Wochen lang gelagert. In periodischen Abständen wurden gaschromatographische Bestimmungen des Dimethylsulfidgehaltes (DMS) und sensorische Qualitätsprüfungen zum Nachweis des charakteristischen Reifebuketts vorgenommen. Gleichzeitig wurden Äthylacetat (EtAc) und Sortenbukett untersucht. Sowohl die DMS-Konzentration als auch das Reifebukett nahmen mit der Dauer der Lagerung und der Höhe der Lagerungstemperatur zu. Ferner ging die EtAc-Konzentration zurück, und das Sortenbukett wurde schwächer.

Zwischen der DMS-Konzentration und dem Flaschenreifebukett der Weine wurde eine hochsignifikante Beziehung nachgewiesen, womit die Bedeutung von DMS für die Weinqualität unterstrichen wird. Ferner wurde eine signifikante Beziehung zwischen der EtAc-Konzentration und dem Sortenbukett festgestellt. Außerdem wurde gefunden, daß die DMS-Bildung in den Weinen der einzelnen weißen Sorten mit unterschiedlicher Geschwindigkeit ablief.

Introduction

Studies over recent years have established the importance of dimethyl sulphide (DMS) to the flavour and quality of a number of foods and beverages. Since it has a very low odour threshold, it can contribute to flavour even when present in minute quantities.

In the field of beer research, DMS was first reported by Ahrenst-Larsen and Hansen (1). Research workers subsequently established the significance of DMS as a normal flavour component of beer (2, 8, 9, 12, 13).

The precursors of DMS and the biochemical pathway for the formation of DMS are two aspects which are not fully known and completely understood, but it is generally accepted that S-methyl methionine (SMM) is a precursor (2, 8, 9, 10, 12, 14, 17, 18, 19).

In contrast to beer, little is known about DMS occurrence in wine and nothing about the mechanism of its formation and the factors affecting this phenomenon. In beer, the formation of DMS occurs during fermentation with the interaction of certain enzymes while in wine DMS is formed after bottling.

du Plessis and Loubser (6) investigated the bouquet of "late harvest" white wines and indicated that, in low concentrations, DMS contributes to this full-bodied sweet

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bouquet, the so-called bottle bouquet. LOUBSER and DU PLESSIS (11) found that matured white wines contained higher concentrations of DMS (up to 400 μg/l) than young wines and pointed out the possibility of DMS formation in bottled wine and its contribution to bottle bouquet.

Since the advent of gas chromatography much work has been done on evaluating the critical components of bouquet and aroma of liquor and food. Many research workers attempted to establish relationships between the chemical composition of a flavour and its sensory evaluation by a test panel (3, 4, 5, 7, 16, 21). More specifically in the field of DMS, ANDERSON *et al.* (2) analysed lager beers for DMS and sensorily scored them for the intensity of DMS aroma. They found an approximately linear response in flavour to the concentration of DMS between 30 and 60 μg/l.

Some workers found that the quality of certain foods and beverages could reasonably accurately be predicted from time, temperature and the decomposition of SMM to DMS interrelationships (12, 20).

Since DMS has an effect on wine quality, this investigation was carried out to gain insight into the effect of temperature and storage time on the formation of DMS in dry white wines.

Materials and methods

Wines made from the cultivars Chenin blanc, Colombar and Riesling, grown on the experimental farm, Nietvoorbij, in the Stellenbosch area, served as basic material for this study. No fungicides were used in the vineyards. The wines were made from free run juice and fermented at 12 °C. The same quantities of SO_2 were added in all the treatments. The bottles were flushed with high-purity N_2, the wines immediately bottled with a free SO_2 content of approximately 25 mg/l and corked.

The wines were stored in the dark at 0, 10, 20 and 30 °C. Samples were drawn for analysis and sensory evaluation at the following stages:

I immediately after bottling
II 1 week after bottling
III 3 weeks after bottling
IV 7 weeks after bottling
V 16 weeks after bottling.

1. Analysis

The wines were analysed quantitatively by gas chromatography for DMS and ethyl acetate (EtAc) by the headspace method as adapted by LOUBSER and DU PLESSIS (11).

2. Sensory evaluation (SE)

Sensory evaluation was carried out by a panel of 12 judges by means of a 9-point scoring system developed at this Institute (15). The judges were also asked to indicate the quantity of varietal (young wine) and maturation (bottle) bouquet on a 10-point scale. These results were statistically correlated with the gas chromatographic values.

Results and discussion

The detailed results for Chenin blanc, Colombar and Riesling are given in Table 1. The correlation coefficient values of the relationship between DMS and ma-

Table 1

Effect of time and temperature on the SE, varietal bouquet, maturation bouquet, EtAc and DMS in Chenin blanc, Colombar and Riesling wines

Einfluß von Zeit und Temperatur auf SE, Sortenbukett, Reifebukett, EtAc und DMS bei Weinen von Chenin blanc, Colombar und Riesling

Treatment	SE (%)					Varietal bouquet (10-point scale)					Maturation bouquet (10-point scale)					EtAc (mg/l)					DMS (µg/l)				
(°C)	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V
Chenin blanc																									
0	63.4	57.5	63.4	62.6	66.3	3.72	3.49	4.02	3.53	4.13	0.43	0.75	0.62	1.08	1.51	53.65	51.17	51.91	49.71	44.36	0	0	0	0	0
10	62.8	56.9	60.4	61.6	64.3	3.85	3.51	3.73	3.53	3.87	0.46	0.59	0.71	1.06	1.54	54.90	53.73	52.64	48.41	45.77	0	0	0	0	0
20	64.5	60.7	61.9	61.0	61.3	3.77	3.39	3.53	3.00	2.64	0.43	0.64	1.06	1.39	2.57	56.34	53.96	50.31	45.07	41.03	0	0	0	1.79	6.91
30	64.5	61.9	61.9	58.7	59.0	4.08	3.26	2.54	1.42	1.03	0.33	1.43	2.71	3.61	6.03	56.60	51.08	49.21	44.29	41.20	0	1.90	4.60	12.30	25.73
Colombar																									
0	61.9	65.7	63.4	69.5	64.1	4.78	4.10	4.30	4.31	5.00	0.89	0.75	1.62	1.56	1.35	65.25	60.18	59.53	56.58	58.26	0	0	0	0	0
10	60.6	69.0	62.5	65.8	60.6	4.15	4.00	3.92	3.75	3.94	0.96	0.82	1.49	1.41	1.53	70.23	62.64	61.14	60.11	60.50	0	0	0	0	3.88
20	67.0	65.2	66.9	63.1	61.6	4.53	3.85	3.59	3.36	2.33	0.93	0.87	1.77	2.59	2.81	65.90	60.92	60.86	58.44	61.89	0	0	0	10.51	19.80
30	64.7	69.5	61.9	69.9	61.0	4.49	3.51	2.74	1.67	1.22	1.00	2.03	3.18	5.18	5.72	65.30	61.87	58.22	54.40	55.93	0	2.23	11.30	29.21	75.03
Riesling																									
0	63.7	61.1	59.1	61.0	61.6	4.58	2.93	3.33	3.00	3.90	0.67	0.93	0.98	1.33	1.41	73.47	74.18	71.13	69.06	63.05	0	0	0	0	0
10	65.0	56.2	55.3	57.4	57.5	4.25	2.93	3.27	2.92	3.08	0.76	0.86	1.13	1.06	1.00	74.27	74.69	70.08	68.65	64.76	0	0	0	0	0
20	63.7	58.4	55.3	60.0	57.0	4.07	3.14	2.71	2.20	1.87	0.71	1.09	1.13	1.75	3.08	75.70	71.29	66.42	62.71	53.82	0	0	2.67	9.86	29.03
30	61.1	58.9	62.5	60.7	59.3	3.24	2.29	1.80	1.39	1.13	0.47	1.90	3.18	4.92	6.31	72.83	67.20	62.88	59.98	48.46	0	5.60	11.34	47.91	85.86

I = Immediately after bottling.
II = 1 week after bottling.
III = 3 weeks after bottling.
IV = 7 weeks after bottling.
V = 16 weeks after bottling.

SE = Sensory evaluation.
EtAc = Ethyl acetate.
DMS = Dimethyl sulphide.

turation bouquet, as well as between EtAc and varietal bouquet are shown in Table 2.

1. Effect of storage time

When the specific effect of storage time is considered (Table 1), it is clear that DMS concentration and maturation bouquet increased with an increase in time. This tendency occurred with all three cultivars. The EtAc concentration and varietal bouquet decreased with an increase in storage time. The cultivars differed with respect to the effect of storage time on the sensory evaluation. The SE of the Chenin blanc and Riesling wines decreased significantly within the first week after bottling and remained constant thereafter for the rest of the 16-week period. The SE of the Colombar wine remained constant for the first 7 weeks after bottling and decreased slightly at 16 weeks.

2. Effect of temperature

An increase in storage temperature caused a significant increase in DMS concentration and maturation bouquet in all the three cultivars — a similar tendency to that of storage time (Table 1). The EtAc concentration and varietal character decreased with an increase in storage temperature. The specific effect of temperature had no significant effect on the SE of any of the wines.

3. Maturation bouquet

The combined effect of storage time and temperature on the formation of DMS and maturation bouquet is of great importance. From the results it is clear that the maturation bouquet developed so rapidly at temperatures of 20 °C and higher that it overshadowed the varietal character of which the decrease was proportionally slower than the increase of the maturation bouquet (cf. Table 1). This is of great importance to wine-makers in the warmer wine producing countries, who wish to market fresh fruity wines. Furthermore, it is also important to the consumer who wants to keep wines in this condition, to store the wines at temperatures of approximately 10 °C and lower.

4. Relationship between DMS formation and maturation bouquet

An important result is the highly significant relationship between DMS formation and maturation bouquet for all three cultivars (Table 2). In conjunction with

Table 2

Correlation coefficients between DMS and maturation bouquet as well as between EtAc and varietal bouquet of Chenin blanc, Colombar and Riesling wines

Korrelationskoeffizienten für DMS und Reifebukett sowie EtAc und Sortenbukett der Weine von Chenin blanc, Colombar und Riesling

Correlations	Chenin blanc	Colombar	Riesling
DMS-conc. vs. maturation bouquet	0.943**	0.871**	0.941**
EtAc-conc. vs. varietal bouquet	0.573**	0.431*	0.719**

DMS = Dimethyl sulphide. * = Significant at $P \leqslant 0.05$.
EtAc = Ethyl acetate. ** = Highly significant at $P \leqslant 0.01$.

the work done earlier at this Institute (6) it is a clear indication that DMS is an important contributor to bottle maturation bouquet in white wines. If the contribution of maturation bouquet as a quality factor is considered in white wines, these findings are of special importance to the fact that an objectively determined component can be related to a subjective one.

5. Varietal bouquet

In contrast to the increase in maturation bouquet, the rapid decrease of varietal bouquet at temperatures of 20 °C and higher, as well as the preservation of this bouquet for relatively long periods at temperatures lower than 10 °C, is of equally great importance (Table 1). The varietal bouquet should not necessarily be seen here as a characteristic quality of a specific cultivar, but more as the fruity flavour of a young wine. This explains the linear relationship between varietal bouquet and EtAc concentration in all the three cultivars (Table 2). From the results it was clear that in this particular investigation EtAc could in all probability be regarded as an indicator related to the varietal young wine bouquet and is important in this respect.

6. Differences in DMS formation among the cultivars

The differences among the cultivars with respect to the formation of DMS and maturation bouquet as determined by sensory evaluation are of great importance. In this investigation slightly more DMS developed in Riesling than in Colombar, while in Chenin blanc only approximately one third of the amount of DMS in Colombar was formed — yet the values of the maturation bouquet, as judged by the panel, were practically similar (Table 1, V values, 30 °C). In the case of Riesling and Chenin blanc stored for 16 weeks at 30 °C, the judges found the maturation bouquet too heavy and therefore affecting quality negatively. In the case of Colombar, the maturation bouquet was of a higher hedonic quality. This tendency decreased with a concomittant decrease in storage time and temperature.

These differences among the cultivars could be ascribed to different possible causes such as the composition of the basic material, e.g. the acidity, sugar content, the concentration of DMS precursor(s) present and the possible formation of other sulphur containing components together with DMS in some cultivars. Furthermore, important factors such as soil type, origin of grapes, annual differences and different winemaking techniques could all affect the ageing potential of wines and emphasize the complexity of the ageing process in a wine.

7. Wine Quality

The total sensory evaluation values i.e. wine quality (Table 1) did not show the same drastic changes that were observed in the individual varietal and maturation bouquets. Since the changes in the wine quality factor viz. bouquet, from a varietal to a maturation character, were not necessarily detrimental, wine quality was not markedly affected.

The finding that under specific conditions, significant changes could arise in the character of white wines within one week after bottling, is of practical importance. The highly significant relationship between DMS concentration and maturation bouquet gives a strong indication of the importance of DMS as contributor to the quality of white wines. The differences among the cultivars with respect to the formation of DMS and maturation bouquet is of great practical value. These differences among cultivars and the fact that the formation of DMS and maturation

bouquet could to a large extent be controlled with temperature, could make important contributions to the determination of the precursors of DMS and the investigation to predict the ageing potential of young wines. Further studies in this respect are at present being undertaken.

Summary

Wines of the cultivars Chenin blanc, Colombar and Riesling were stored at 0, 10, 20 and 30 °C for 16 weeks. The wines were analysed periodically by gas chromatography for dimethyl sulphide (DMS) and sensorily evaluated for the characteristic maturation bouquet to investigate the effect of storage time and temperature on the formation of DMS. Ethyl acetate (EtAc) and varietal bouquet were investigated simultaneously. It was found that both DMS concentration and maturation bouquet increased with an increase in storage time and temperature. Furthermore, the EtAc concentration and varietal bouquet decreased.

A highly significant relationship was found between DMS concentration and the bottle maturation bouquet of the wines confirming the important contribution of DMS to wine quality. Furthermore, a significant relationship was found between EtAc concentration and varietal bouquet. It was also found that the rate of formation of DMS in white wines differed among the different cultivars.

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