AGRONOMSKI GLASNIK 1-2/2001.
ISSN 0002-1954

Izvorni znanstveni članak
Original scientific paper

HARVEST DATE AND CONCENTRATION OF SOME HIGHER ALCOHOLS IN WHITE WINES

VRIJEME BERBE I KONCENTRACIJA NEKIH VIŠIH ALKOHOLA U BIJELIM VINIMA

Jasmina Marić

ABSTRACT

A two-year study was conducted on the influence of harvest date upon the concentration of some high alcohols in white wines Chardonnay, Rhein Riesling, Traminer, Silvaner green and Sauvignon white, in Nespeš near Zagreb, region B-1, of continental Croatia. In the year 1993 and 1994 the grapes of Chardonnay, Rhein Riesling, Traminer, Silvaner green and Sauvignon white were separately harvested in 3 terms. The must (grape juice) obtained from those white grapes, according to harvest day, differed in composition and quality. The concentration of sugar and pH increased by delay of the harvest day. The concentration of total acidity decreased by the delay of the harvest date. White wines differed in the concentration of total acidity. The concentration of n-propanol and isobutyl alcohol decreased as the harvest day was delayed while the concentration of isoamyl alcohol and 2-phenetyl alcohol increased.

Key words: harvest date, grape juice, white wines, higher alcohols

SAŽETAK

Provedena su dvogodišnja istraživanja o utjecaju vremena berbe na koncentraciju viših alkohola u bijelim vinima Chardonnay, Rajnski rizling, Traminac, Silvanac zeleni i Sauvignon bijeli podrijetlom iz Nespeša, u blizini

Zagreba, kontinentalna Hrvatska. Godine 1993. i 1994. grožđe Chardonnay, Rajnski rizling, Traminac, Silvanac zeleni i Sauvignon bijeli brano je posebice i u tri navrata. Dobiveni mošt, ovisno o vremenu berbe, razlikovao se u kemijskom sastavu i kvaliteti. Tako su se koncentracija sladora i pH povećavali pomakom datuma berbe. Koncentracija ukupne kiselosti se smanjivala pomakom datuma berbe. Bijela su se vina razlikovala u koncentraciji ukupne kiselosti. Koncentracija n-propanola i isobutanola se smanjivala kako se pomicao termin berbe dok se s druge strane koncentracija isoamilnog alkohola i 2-feniletanola povećavala.

Ključne riječi: vrijeme berbe, viši alkoholi, bijela vina

During the fermentation yeasts produce ethanol and higher molecular alcohols. These higher alcohols consist of n-propanol, isobutyl alcohol, isoamyl alcohol and 2-phetehyl alcohol. Higher alcohols can be produced through catabolism of amino acids or directly from fermented sugar. The amount of higher alcohols is influenced by the composition of medium (1, 2, 3) sugar concentration, pH, fermentation temperature, aeration (4, 5, 6) and yeast strain (7). The rate of increase varies with genetic (8, 9), grape maturity (10, 11, 12) processing and pressing (13) and yeast strains (14). The influence of these higher alcohols on the organoleptic characteristics of wine and their taste thresholds is controversial (15).

Changes in grape characteristics and composition during ripening are numerous (16, 17, 18, 19). Sugar accumulation increases rapidly and is accompanied by an increase in berry volume with the corresponding influx of water (20, 21). The rate of increase varies with genetic, environmental and vine management condition (18, 22, and 23). As berries reach full maturity, berry growth and soluble solids accumulation tend to slow and many reach a maximum. That is the date for normal harvest. Leaving the grapes in the vineyard after normal harvest date - delaying the harvest date in some cases, soluble solids per berry may continue to increase for one, two or three weeks after berries have stopped growing (21). Further delay may be accompanied by loss of berry water and volume and increase in total solutes per berry especially sugar (19). This is of particular interest to wine makers, because knowing the fact that the higher alcohols may be produced directly from fermented sugar, may be the way of gaining a higher quality of wine.

However, the accumulation of sugar is of particular interest to wine makers because of the ultimate effects on quality and composition of the future wine (24).

The influence of these higher alcohols on the organoleptic characteristics of wine and their taste thresholds is controversial (15). The aim of this study was to compare the production of higher alcohols due to harvest date – concentration of sugar in some white wine grape varieties.

MATERIAL AND METHODS

Harvest and vinification

White vine grapes used in these experiments were grown in the vineyards of Nespeš, near Zagreb, subregion Prigorje, northwest region of continental Croatia. Hand picking was done separately for each white vine cultivar. The first term was when the grapes were fully matured, the second picking was 14 days after, the third took place 14 days after the second as shown in table 1. The same technology was used for the production of white wines for all cultivars to avoid the interference of this factor. The grapes were separately processed as described: desuetude, crushed, pressed, grape juice with the addition of 50 mg/L of sulfur dioxide was stored for 24 hours in cold to settle, so cleared musts (grape juices) with the addition of the same strain of Saccharomyces cerevisiae fermented on

Table 1. Harvest dates
Tablica 1. Datumi berbe grožđa

Year Godina	Term Termin	Date Datum	Cultivar Kultivar
1993	I	23.09.93	Chardonnay
	II	07.10.93	
	III	21.10.93	
1994	I	27.09.94	
	II	10.10.94	
	III	24.10.94	
1993	I	25.09.93	Sylvaner green
	II	09.10.93	
	III	23.10.93	
1994	I	29.09.94	
	II	13.10.94	
	III	27.10.94	
1993	I	29.09.93	Traminer
	II	13.10.93	
	III	27.10.93	
1994	I	03.10.94	
	II	17.10.94	
	III	31.10.94	
1993	I	30.09.93	Sauvignon white
	II	14.10.93	
	III	28.10.93	
1994	I	04.10.94	
	II	18.10.94	
	III	02.11.94	
1993	I	02.10.93	Rhein Riesling
	II	16.10.93	
	III	30.10.93	
1994	I	06.10.94	
	II	20.10.94	
	III	03.11.94	

the temperatures between 18 °C and 22 °C, young wine was clarified with pentagel and filtrated, cold stabilized and bottled, bottles were stored in a cellar at 10 °C for two months after which analyses took place.

Analytical methods

Ethanol, total and volatile acidity, SO_2 were determined using the method proposed by O.I.V. (25). Reducing sugar was determined volumetrically by Lane Eynon method (26) and pH measured on the Beckman Expandomatic SS 2 pH-meter.

Volatile compound analysis was done by GC (Hewlett Packard 5890) using FID. Analyses of higher alcohols (1-propanol, isobutyl alcohol, isoamyl alcohol and ethyl acetate) were preformed from wine distillate. Temperature programming was as follows: HP 101 Column, 6 min isothermal at 40 °C, then linear temperature rise of 15 °C min –1 to 200 °C.

2-phenyl-ethanol was analyzed from volatile extract. Wine (500mL) was extracted for 10 hours with diclormethan in a liquid-liquid upward displacement apparatus. Gain extract was then dried over anhydrous sodium sulfate, concentrated to 10mL and stored prior GC analysis. Temperature program was: HP FFAP Column, 5 min isothermal at 60°C, then linear temperature rise of 2.5°C min –1 to 190°C and 20 min isothermal at 190°C. Determination of volatile compounds was done by the method of internal standards. The results were statistically analyzed by methods.

RESULTS AND DISCUSION

Chemical composition of grape juice

As the harvest date was delayed the concentration of sugar increased in all white vine cultivars, as shown in table 2. The increase was due to genetics of the cultivar because the increase in both years of investigation was the same for the same cultivar. For Chardonnay the increase was by 36 units, for Rheinsh Riesling 34 units, 32 units for Traminer, 29 for Sauvignon white and 22 units for Sylvaner green.

With the increase of sugar the concentration of total acidity decreased, as shown in table 2. This was due to the harvest date delay because no correlation

was found between the cultivar and total acidity decrease. The range of decrease was from 1.5 to 2.15 units.

Table 2. Chemical composition of grape juice on the harvest day
Tablica 2. Kemijski sastav mošta u vrijeme berbe

Cultivar	Year of harvest	Term of harvest	Sugar content °Oe	Total acidity g/L (tartaric acid)	pH
Chardonnay	1993	I	76.0	8.5	3.1
		II	81.0	7.6	3.2
		III	112.0	6.6	3.4
	1994	I	87.0	8.2	3.1
		II	104.0	7.4	3.3
		III	123.0	6.4	3.4
Silvaner green	1993	I	76.0	8.6	3.1
		II	85.0	7.6	3.2
		III	98.0	6.8	3.4
	1994	I	86.0	8.4	3.1
		II	95.0	7.3	3.3
		III	108.0	6.5	3.4
Traminer	1993	I	76.0	7.6	3.2
		II	82.0	6.5	3.3
		III	108.0	5.6	3.4
	1994	I	88.0	7.4	3.3
		II	105.0	6.3	3.4
		III	120.0	5.4	3.45
Sauvignon white	1993	I	76.0	8.0	3.1
		II	83.0	7.6	3.2
		III	105.0	6.5	3.3
	1994	I	85.0	7.7	3.2
		II	106.0	6.6	3.3
		III	114.0	6.1	3.4
Rhein Riesling	1993	I	76.0	7.57	3.2
		II	83.0	6.2	3.3
		III	110.0	5.5	3.4
	1994	I	89.0	7.35	3.2
		II	106.0	6.0	3.4
		III	123.0	5.2	3.45

As expected the pH values increased by about 0,2 units, as shown in table 2.

Our results are in accordance with La Rosa, W.V. et al. (24); Kliewer, W.M.et.al. (19), Marić, J. (27,28) who obtained similar results on these components in grape juice of other cultivars by the delay of harvest date.

These authors also concluded that by delay of harvest date a new composition and quality of grape juice was obtained as a start media for future white wines.

The chemical composition of grape juice is presented in table 2.

Chemical composition of white wines

The chemical composition of white wines is shown in table 3.

Table 3. Chemical composition of white wines
Tablica 3. Kemijski sastav bijelih vina

White wine	Year	Term	Ethanol vol. %	Reduced sugar g/L	Total acidity g/L (tartaric acid)	pH
Chardonnay	1993	I	9.5	1.0	7.5	3.2
		II	10.12	1.0	6.6	3.3
		III	12.25	2.2	5.9	3.4
	1994	I	10.87	1.0	7.4	3.2
		II	11.0	2.0	6.7	3.3
		III	12.42	3.5	5.6	3.4
Silvaner green	1993	I	9.5	1.0	7.5	3.2
		II	10.6	1.0	6.4	3.3
		III	12.25	1.0	5.9	3.3
	1994	I	10.5	1.0	7.5	3.2
		II	11.5	1.0	6.7	3.3
		III	12.5	1.8	5.6	3.4
Traminer	1993	I	9.5	1.0	6.5	3.3
		II	10.25	1.0	5.6	3.4
		III	12.5	2.0	4.8	3.5
	1994	I	11.0	1.0	6.6	3.3
		II	12.5	2.0	5.5	3.4
		III	12.8	3.7	4.6	3.5

White wine	Year	Term	Ethanol vol. %	Reduced sugar g/L	Total acidity g/L (tartaric acid)	pH
Sauvignon white	1993	I	9.5	1.0	7.3	3.2
		II	10.4	1.0	6.6	3.3
		III	11.0	1.0	5.7	3.4
	1994	I	10.6	1.0	6.8	3.4
		II	12.12	1.8	5.9	3.4
		III	12.5	2.5	5.2	3.5
Rhein Riesling	1993	I	9.5	1.0	6.6	3.3
		II	10.4	1.0	5.6	3.4
		III	12.5	2.0	4.6	3.5
	1994	I	11.12	1.0	6.3	3.3
		II	12.0	2.0	5.1	3.5
		III	12.5	3.6	4.3	3.5

Due to the different quality of grape juice of the same cultivar after fermentation and short maturation, white wines differed in composition and quality as presented in table 3.

The concentration of ethanol increased with the last harvest by 2 units. The concentration of total acidity in general decreased in wines by 1 unit in comparison with the original grape juice. The decrease of total acidity in white wines was reserve to the delay of harvest date and it varied ranging from 1.5 to 2.0 units. The pH values increased with the last harvest by 0.2 units. These results are in accordance with the results of other authors (8, 27, and 28).

Higher alcohols

The concentration of total high alcohols increased with the last harvest as shown in table 4. These results are in accordance with Ough, C. S. et al. (6), Marić, J. (28).

The concentration of 1-propanol and isobutyl alcohol decreased with the last harvest date. The decrease was more evident in all white wines in the harvest of 1994. These results are in accordance with Ough, C. S. et al. (6), Marić, J. (28) which outlined that the production of 1-propanol and isobutyl alcohol depend on the harvest year and not on sugar accumulation.

Table 4. Concentration of high alcohols in white wines
Tablica 4. Koncentracija viših alkohola u bijelim vinima

White wine	Year	Term	1-propanol	Ethyl acetate	Isobutyl alcohol	Isoamyl alcohol	2-phenyl ethanol
Chardonnay	1993	I	19.11	16.72	44.88	70.81	10.70
		II	13.38	17.59	40.29	113.97	43.96
		III	9.98	19.13	27.20	115.08	59.70
	1994	I	32.36	134.14	65.66	74.65	9.28
		II	20.74	68.13	56.76	135.68	84.56
		III	13.82	39.30	36.92	146.36	103.65
Silvaner green	1993	I	18.25	18.33	36.25	63.18	10.89
		II	12.32	19.29	30.11	85.42	22.35
		III	8.63	20.36	23.08	62.93	30.70
	1994	I	27.36	135.28	56.23	73.72	19.89
		II	18.73	74.36	42.72	125.76	86.92
		III	14.45	30.21	33.18	140.83	109.82
Traminer	1993	I	17.25	25.62	30.05	59.07	11.63
		II	12.92	24.34	27.84	75.93	14.50
		III	10.42	28.23	21.07	64.54	21.10
	1994	I	30.44	148.68	54.22	74.25	25.30
		II	19.55	80.12	40.27	116.26	93.81
		III	14.52	45.73	29.66	138.82	117.25
Sauvignon white	1993	I	15.21	24.66	30.02	58.32	11.23
		II	11.34	23.73	26.63	76.28	13.46
		III	9.32	26.12	20.18	64.10	23.03
	1994	I	29.77	145.92	52.46	74.28	25.42
		II	19.56	79.82	39.62	120.12	92.18
		III	13.43	44.37	28.73	136.92	118.52
Rhein Riesling	1993	I	12.91	20.62	28.07	58.17	10.63
		II	10.97	22.45	25.73	76.94	12.80
		III	8.52	26.34	21.09	65.56	21.04
	1994	I	25.46	143.85	52.55	73.25	24.30
		II	17.76	78.12	41.23	115.15	91.25
		III	12.42	43.85	29.75	146.68	116.72

The concentration of total isoamyl alcohol and 2-phenyl alcohol increased with the last harvest. These results are in accordance with Marić, J. (28) that obtained similar results researching the same problem. These two high alcohols according to above-mentioned authors, have good influence on white wine aroma in the range of 200 mg/L for isoamyl alcohol and 100 mg/L for 2-phenyl alcohol. Isoamyl and 2-phenyl alcohol are usually found in wines in the mentioned concentrations.

CONCLUSION

This study has demonstrated the changes in grape juice composition and quality that can occur according to a three term of harvest period of white vine grape cultivars.

Grape juice of white vine grapes included in this study improved with the delay of harvest date. The improvement was the increase of sugar concentration-which is a source of higher alcohols. The study has shown a decrease in total acidity and increase in pH values which generally did not interfere with the harmony and quality of white wines, on the contrary they obtained a new composition. After fermentation the white wines, from the same cultivar differed in the concentration of higher alcohols. The concentration of total higher alcohols increased with the last harvest. The concentration of 1-propanol and isobutyl alcohol decreased with the last harvest. Isoamyl alcohol and 2-phenyl alcohol increased in all white wines with the last harvest date.

This study has shown the relationship between the media and concentration of higher alcohols in white wine that can be of a practical importance to wine makers who desire higher quality of their wines.

LITERATURE

1. **Äyrapää, T.** (1971): J. Inst. Brew.77: 266-76.
2. **Reazin, G., H. Scales, A. Andreasen** (1973): J. Agric. Food Chem. 21:50-4.
3. **Schulthess, D., L. Ettlinger** (1978): J. Inst. Brew. 84:240-3.
4. **Guidici, P., O. Silvestroni, G. Ghidoni** (1985): Vignevini 12:51-7.
5. **Harvalia, A.** (1976): Bulletin de l' O: I: V: 49:222-23.
6. **Ough, C. S., J. F. Guymon, E. A. Crowell** (1966): J. Food Sci. 31: 620-5.

7. **Soufleros, E., A. Bertrand** (1979): Connaiss. Vigne Vin. 13: 181-98.
8. **Marais, J., C. J. van Wyk** (1986): S. Afr. J. Enol. Vitic. 7:26-35.
9. **Simpson, R. F., G. C. Miller** (1983): Vitis. 22: 51-63.
10. **Guanta, Y. Z., C. L. Bayanove, R. L. Baumes, R. E. Cordonnier** (1985): J. Sci. Food Agric. 36:857-62.
11. **Marais, J.** (1987): Vitis. 26: 231-45.
12. **Park, S. K., J. C. Morrison, D. O. Adams, A. C. Noble** (1991): J. Agric. Food Chem. 89:514-8.
13. **Cordonnier, R., C. Bayonove** (1981): Connaiss. Vigne Vin 15:269-86.
14. **Gudici, P., P. Romano, C. Zambonelli** (1990): Can. J. Microbiol. 36: 61-4.
15. **Rankine, B. C.** (1967): J. Sci. Food Agric. 18:583-9.
16. **Coombe, B. G.** (1973): ACTA Hortic. 34: 261-269.
17. **Coombe, B. G.** (1992): Am. J. Enol. Vitic. 43:101-110.
18. **Harris, J. M., P. E. Kriedemann, J. V. Possingham** (1968): Vitis. 7: 106-119.
19. **Kliwer, W. M.** (1965): Am. J. Enol. Vitic. 16: 101-110.
20. **Christensen, L. P.** (1975): Am. J. Enol. Vitic. 26: 188-194.
21. **Coombe, B. G.** (1973): ACTA Hortic. 34: 261-269.
22. **Kliwer, W. M., A. J. Anticliff** (1970): Am. J. Enol. Vitic. 21: 26-34.
23. **Kliwer, W. M.** (1970): Am. J. Enol. Vitic. 21: 37-47.
24. **LaRosa, W. V., U. Nielsen** (1957): Am. J. Enol. Vitic. 105-111.
25. Recueil des methodes internationales d' analise des vins ET des môunts, Edition Officielle, O.I.V. Paris (1990).
26. **Amerine, M. A., C. S. Ough** (1974): Wine and Must Analysis, John Wiley and Sons, New York.
27. **Marić, J.** (1991.): Ampelografska i enološka svojstva sorti Chardonnay i Pinot Blanc, Magistarski rad, Zagreb.
28. **Marić, J.** (1999.): Promjene kemijskog sastava i senzornih svojstava vina Chardonnay tijekom starenja u boci, Doktorska disertacija, Zagreb.

Adresa autora - *Author's address*:
Dr sc Jasmina Marić
Department of Viticulture and Enology
Faculty of Agriculture University of Zagreb
Svetošimunska 25
10000 Zagreb – Croatia
Phone: 239-3921; Fax: 239-3834

Primljeno: 10. 5. 2001.