

# Influence of Fermentation Temperature on the Quality of 'Žilavka' Wines

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Tihomir PRUSINA<sup>1</sup>  
Stanka HERJAVEC<sup>2</sup>(✉)

## Summary

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'Žilavka' is the autochthonous white grape variety of Herzegovina and there is a great interest of local winemakers to produce 'Žilavka' wines, which are characterised with a fine balance between the fermentation bouquet and grape-based aromas. The fermentation temperatures of some wineries in Herzegovina often can exceed 30°C what results with inferior overall wine quality. In this research changes in concentration of higher alcohols and sensory properties caused by fermentation at different temperatures in 'Žilavka' wines were investigated. Compared to fermentation at the temperature above 26°C, fermentation at 15°C and 20°C caused significant decrease in the concentration of total higher alcohols and individual isoamyl alcohol and isobutanol only in one year of the research. There were no differences in concentration of 1-propanol and ethyl acetate among all tested wines in both years. The best sensory evaluated were the wines fermented at 20°C, while the wines produced at the temperature above 25°C were of the most inferior quality.

## Key words

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fermentation temperature, higher alcohols, sensory properties

<sup>1</sup> Faculty of Agriculture, Biskupa Čule 10, 88000 Mostar, Bosnia and Herzegovina

<sup>2</sup> Faculty of Agriculture, Department of Viticulture and Enology, Svetošimunska 25, Zagreb, Croatia

✉ e-mail: [herjavec@agr.hr](mailto:herjavec@agr.hr)

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## Introduction

Fermentation temperature is one of the most important factors for producing quality white wines and it is one of the features over which the winemaker has the greatest control. The preference in most wine producing regions is to conduct white wine fermentation at about 15°C, but some European wineries still prefer fermentation temperatures between 20 and 25°C (Jackson, 2000). The quality of the majority white wines is defined by a fruity character primarily due to the lower concentration of higher alcohols, one of the most significant compounds of fermentation bouquet. Several authors have reported that the formation of higher alcohols is markedly influenced by winery practices, so that the concentration of these compounds in the wine markedly depends on fermentation temperature (Castellari et al., 1995; Garcia et al., 1994). Variety is the main factor influencing higher alcohols in the wines, but varietal characteristics of the grapes can be modified with the temperature fermentation and type of clarification (Aragon et al., 1998). According to Klingshirn et al. (1998) synthesis of higher alcohols is favoured by the presence of suspended material in fermenting musts and the wines made from juices containing larger particles of the sediment were found to be higher in higher alcohol contents. Clarification affects wine quality and white must is clarified before fermentation to favor the retention of a fruity character (Jackson, 2000). The main objective of this study was to examine the effect of different fermentation temperatures on the higher alcohols concentration and sensory properties of 'Žilavka' wine. The objective of this work was also to establish an optimal fermentation temperature for a production of 'Žilavka' wines with the best recognized grape-based aromas.

## Material and methods

### Vinification

'Žilavka' white wine grapes from the wine region of Herzegovina, vineyard Blizanci, were harvested during the 1998 and 1999 seasons, destemmed and crushed. In both years of research the free-run juice was treated with 90 mg/L SO<sub>2</sub> and allowed to settle overnight at 13°C. The juice was racked and was used in following treatments of spontaneous fermentation: the first control treatment was fermented at the temperature above 25°C, the second treatment was represented by fermentation at 20°C, while the third one included fermentation at 15°C. All treatments were done in triplicate in 50 L glass bottle. Two racking were carried out before bottling and bottles were stored in a cellar at 15°C. The samples of all treatments were chemically analysed just after bottling and two months afterwards tested by sensorial evaluation.

## Chemical analyses

The common analyses of basic wine components were carried out on the wines using standard methods (OIV, 2001). The higher alcohols and ethyl acetate were performed by Gas Chromatography (GC) method (Majdak et al., 2002).

### Sensory analysis

The wines from the 1998 and 1999 harvest seasons were subjected to sensory evaluation by the ranking method and by the Buxbaum method of 20 point (13) with a panel of nine (1998 year) and seven judges (1999 year). Determination of statistical significance was done according to literature (Amerine and Roessler, 1976).

### Statistic analysis

One-way analysis of variance (ANOVA) and Least Significant Difference (LSD) comparison test of SAS (SAS Institute, Cary, NC, USA) were used to interpret differences in mean, if any, at the 95% and 99% confidence level.

## Results and discussion

### Basic chemical composition of wines

Results given in Table 1 show that there were no marked differences among all tested wines in respect to basic chemical composition in both years of the research. Smaller differences were established in the reducing sugar concentration, namely complete sugar degradation was finished only in wines from 1998 year.

### Concentration of higher alcohols and ethyl acetate

The quality of white wines greatly depends on the concentration of higher alcohols. According to Rapp and Versini (1986) concentration of total higher alcohols below 300 mg/L certainly contribute to desirable aroma complexity of wine. The results presented in Table 2 show that all tested wines from 1998 year contained relatively low amount of total higher alcohols (140.25 - 200.00 mg/L), which did not exceed 200 mg/L. Contrary to this, remarkably large content of higher alcohols in wines from 1999 year (356 - 397 mg/L) was near to 400 mg/L, which according to previously mentioned authors, regarded as a negative quality factor. The significant differences in concentration of higher alcohols among the wines of all treatments were established in 1998 year only. The wines fermented at 15°C and at 20°C contained significantly lower concentration of total higher alcohols and individual isoamyl alcohol and isobutanol compared to wines made by fermentation at temperatures above 25°C. In 1999 year however, fermentation temperature had no influence on the level of higher alcohols in tested wines. Must clarification in 1998 year

**Table 1.** Chemical composition of 'Žilavka' wines

Compounds	Year	Treatments			LSD	
		Fermentation at above 25 °C	Fermentation at 20 °C	Fermentation at 15 °C	5 %	1 %
Alcohol (vol.%)	1998	11.77 Aa	11.60 Bb	11.68 Bb	0.11	0.16
	1999	11.63 Aa	11.75 Bb	11.75 Bb	0.09	0.13
Total acidity (g/L)	1998	5.4 Aac	5.3 Aa	5.5 Bc	0.08	0.12
	1999	6.2	6.2	6.2	n.s	n.s
Volatile acidity (g/L)	1998	0.31 Aa	0.34 Aa	0.42 Bb	0.04	0.06
	1999	0.28 Aa	0.19 Bb	0.19 Bb	0.01	0.02
pH	1998	3.40 Aab	3.38 Bb	3.35 Bb	0.04	0.06
	1999	3.38	3.34	3.35	ns	ns
Reducing sugars (g/L)	1998	1.7 Aa	5.0 Bb	5.2 Bb	1.07	1.54
	1999	1.2	1.0	1.0	ns	ns

Different letters beside the mean of a compound denote a significant difference among treatments (A, B, C for 5 %; a, b, c for 1 %). The same letter beside the mean of a compound denotes no significant difference among treatment (A, B, C for 5 %; a, b, c for 1 %).

**Table 2.** Concentration of higher alcohols mg/L and ethyl acetate mg/L in 'Žilavka' wines

Compounds	Year	Treatments			LSD	
		Fermentation at above 25 °C	Fermentation at 20 °C	Fermentation at 15 °C	5 %	1 %
1-Propanol	1998	12.50	12.00	13.50	ns	ns
	1999	23.25	23.75	25.00	ns	ns
Isobutanol	1998	27.25 Aa	19.75 Bb	15.50 Cc	2.03	2.92
	1999	45.25 Aa	50.50 Bb	45.25 Aa	2.03	2.92
Isoamyl alcohol	1998	162.25 Aa	126.50 Bb	111.25 Cb	12.88	18.52
	1999	286.75 Aa	322.75 Bb	285.75 Aa	5.53	7.96
∑ Higher alcohols	1998	200.00 Aa	158.25 Bb	140.25 Cb	15.04	21.63
	1999	358.75 Aa	397.00 Bb	356.00 Aa	6.23	8.96
Ethyl acetate	1998	30.00 Aa	31.75 Aa	41.50 Bb	4.04	5.81
	1999	38.25	39.75	37.00	ns	ns

Different letters beside the mean of a compound denote a significant difference among treatments (A, B, C for 5 %; a, b, c for 1 %). The same letter beside the mean of a compound denotes no significant difference among treatment (A, B, C for 5 %; a, b, c for 1 %).

**Table 3.** Results of sensory evaluation of 'Žilavka' wine by ranking method

Treatment	1998 year		1999 year	
	Order	Rank total	Order	Rank total
Fermentation at 20 °C	1	11**	1	8*
Fermentation at 15 °C	2	16	2	16
Fermentation at above 25 °C	3	27**	3	18

1998 year—any rank total outside 13-23 range is significant at  $P < 5\%$ ; 12-24 at  $P < 1\%$ ; 1999 year—any rank total outside 10-18 range is significant at  $P < 5\%$ ; 8-20 at  $P < 1\%$ .

was slow. We supposed that differences in higher alcohol is in accordance with Klingshirn (1987) who also established that the wines produced of more clear musts contained lower concentrations of isobutanol and isoamyl alcohol. According to Ribereau-Gayon et al. (2000) ethyl acetate has a significant influence on the quality of wine at very low concentration (50-80 mg/L). Our results showed that all tested wines had concentration of ethyl acetate below 50 mg/L in both year of research.

**Table 4.** Results of sensory evaluation of 'Žilavka' wine by Buxbaum method

Treatment	1998 year	1999 year
Fermentation at 15 °C	17.8 *	17.6
Fermentation at 20 °C	18.5 **	17.9 *
Fermentation at above 25 °C	17.4	17.4
* LSD 5%	0.62	0.39
**LSD 1%	0.85	0.54

### Sensory properties of wines

Results of sensory evaluation by the ranking method (Table 3) and the Buxbaum method (Table 4) show that lower fermentation temperatures had generally positive influence on the 'Žilavka' wine quality. In 1998 year the best overall quality were the wines fermented at 20 °C. These wines were characterised by a fine pronounced varietal flavours, very good harmonised with fruity aromas of fermentation what could be linked to the lower concentration of higher alcohols. The wines fermented at 15 °C were lower in the quality, due to less recognizable varietal

aroma, what in our opinion probably could be related to the greater concentration of fruity esters which masked characteristic varietal aroma. Du Plessis (1977) also reported that the loss of the fruitiness of white wines may result from the excessive production of higher alcohols associated with juice containing high levels of suspended solids, because at higher levels their penetrating odors mask the wine's aromatic finesse. The same author also reported negative correlation between the concentration of isoamyl and isobutyl alcohol and the wine quality. Herjavec (1986) found that the lower fermentation temperatures significantly reduce concentration of higher alcohol and improve Welshriesling wine quality.

### Conclusion

The current study shows that the quality of 'Žilavka' wine greatly depends on the fermentation temperatures values. The best quality of 'Žilavka' wines originated from Herzegovina vineyards was obtained through fermentation at 20°C of optimally clarified must. Fermentation at this temperature results in optimal balance between the fermentation bouquet and grape-based aromas.

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