THE INFLUENCE OF FERMENTATION TEMPERATURE ON WHITE WINE CARACTERISTICS

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Abstract: *The wine quality is influenced both by grapes and the winemaking techniques. Among the multiple options available at almost every stage from harvest to bottling, the winemakers have to choose the right options. Controlling the fermentation process is essential to improve the quality and organoleptic properties of the final product. In this paper, the effect of temperature on the physicochemical parameters of white wines, of two winemaking strategies: by controlling the temperature and by performing all the stages at cellar temperature was investigated. After bottling, the two series differ slightly in their physicochemical parameters while changes in color density and color hue resulted from increases in fermentation temperature. Fermentation progressed faster as vinification temperature increased. Both series were in accordance with Romanian legislation that indicates the minimum values for titratable acidity and alcoholic concentration.*
Keywords: *winemaking, fermentation, wine quality*

1. INTRODUCTION

Wine is one of the most consumed and popular alcoholic beverages resulting exclusively from alcoholic fermentation of fresh crushed grapes. The final alcohol content shall not be less than 8.5% volume [1]. The wine quality is influenced both by grapes used for vinification and the winemaking techniques. It can be expressed in terms of colour density and hue or by physicochemical parameters like pH, total acidity, alcohol content, sulphur dioxide and reducing sugars [2]. From all winemaking stages, the most affected by temperature is fermentation.
During fermentation, temperature influence directly and indirectly yeast metabolism. It is considered that at the upper and lower limits, temperature can cause cell death [3], [4]. The fermentation temperature directly influences the growth rate of yeast cells, especially during the exponential phase. Thereby, cell division occur every 12 h at 10 ºC, every 5 h at 20 ºC, and every 3 h at 30 ºC. Also, yeast cells experience a rapid decline in viability at the end of fermentation when temperature exceeds 20 ºC, while the cell growth is delayed and viability enhanced at cooler temperatures.
During storage, wines should be stored in cool cellars at temperatures between 15–20°C. The development of a wine should allow the development of its complexity and maturity while preserving its characteristics. Moreover, a storage below 10°C will be developed in a much longer time, but will have a reduced risk of spoilage [5].
However, the most vineries prefer to conduct white wine fermentation within a range of 15–20 ºC and without aeration to conserve aromas in order to obtain fresher, fruitier wines, while some traditional European ones still prefer fermentation temperatures between 20 and 25 ºC [2], [5].
The aim of this study was to investigate the effect of temperature on the physicochemical parameters of white wines, of two winemaking strategies: Series 1, by controlling the temperature during the stages of the process and Series 2 by performing all the stages of the winemaking process at cellar temperature. Also, the results were compared with the maximum allowed values according to Romanian Legislation for wines.
Both series started from the same must obtained from indigenous Riesling grape variety. Riesling is a white aromatic grape variety which originated in the Rhine region of Germany, being Germany's most highly esteemed grape variety. His popularity throughout the world comes from his floral aroma, commonly reminiscent of roses, pronounced fruit flavors, as well as high acidity. Usually, it is used to make fresh, aromatic, well-aged wines, which can vary from dry, semi-sweet, sweet, and sparkling white wines [6].

2. MATERIAL AND METHODS

The white grapes used for this research were supplied by Pietroasa Development Research Center for Viticulture and Wine-making, located in Dealu Mare vineyard, Romania. The grapes, Riesling variety, were harvested in 2018 and transported to the laboratory for processing within 24 hours.

In order to obtain the must, the grapes were destemmed and crushed, and then goes to pressing where skins and seeds were eliminated. After pressing, the must was evaluated for the following parameters: sugar concentration, specific gravity, pH, and total acidity. Grape must was deposited in two stainless steel tanks, one tank with controlled and measured temperature (Series 1), and the other one with uncontrolled temperature (Series 2). For clarifying, the resulting must from both tanks was treated with Bentonite (1 g. per liter) and enzyme (Enozyme Arome white skin maceration, 4g. per 100 litres) were added. After 24 hours, the clarified must was transferred to the fermentation tanks and selected yeasts were added (Viniferm Saccharomyces cerevisiae Agrovin, Spain, 20g. per hectoliter).
The temperature of the first tank was set and maintained during the fermentation process to a maximum value of 15°C, while the temperature of the second tank reached a maximum of 22°C.
The alcoholic fermentation process was monitored by evaluating the following parameters: temperature, total acidity, alcohol content, specific gravity, pH, color density and hue. When alcoholic fermentation was finished, the wines were cold stabilized at 9°C (Series 1) and then the sulfur dioxide SO_2 was applied and filtration stage took place. The bottled wine was analyzed related to the following physicochemical parameters: total acidity, alcohol content, specific gravity, pH, color density and hue.

2.1. Physicochemical and analytical determinations

Total soluble solids were evaluated by refractometry, using an Abbe refractometer.
Density and specific gravity at 20°C was determined on the must sample for testing by areometry (hydrometry). The sample of 250 mL of was placed in the measuring cylinder and the hydrometer and thermometer were inserted. The apparent density is read on the stem of the hydrometer. The 20°C/20°C specific gravity is obtained by dividing the density at 20°C by 0.998203.
The pH of the samples was measured using a digital pH meter Consort C5010.
The total acidity (TA), expressed in equivalent of tartaric acid content (g/L), was measured using the Titratable Total Acidity Minititrator HI84102 from Hanna Instruments. The determination of total acids in wine is made according to a neutralization reaction that is the reaction between the acids found in wine and a base. This type of reaction forms the basis of titration methods of analyzing acids. At the end of the titration, the Total Titratable Acidity is displayed in g/L (Figure 1, a)).
The alcoholic strength by volume was determined using an Electronic Ebulliometer Bulteh 2000 that is designed for measurement of ethyl alcohol content percentage in wine. Electronic Ebulliometer provides easy, fast and accurate measurement, based on classic method and advanced electric technology. It enables automatic reading of boiling point and automatic alcohol contents calculation.
Spectrophotometric parameters
The color density (CD) for the white wine was calculated as the absorbance at 420 nm, and the color hue as the ratio of absorbance at 420 nm to absorbance at 520 nm, using the optical system of Hanna HI 83742 series colorimeters (Figure 1, b)).

a) b)

Figure 1: Instruments used for determination: a) minititrator, b) colorimeter

The HI 83742 is an auto-diagnostic portable microprocessor meter that has an advanced optical system based on a special tungsten lamp and a narrow band interference filter that allows most accurate and repeatable readings. Photometric chemical analysis is based on the possibility to develop an absorbing compound from a specific chemical reaction between sample and reagents. Given that the absorption of a compound strictly depends on the wavelength of the incident light beam, a narrow spectral bandwidth should be selected as well as a proper central wavelength to optimize measurements. The measurement process is carried out in two phases: first the meter is zeroed and then the actual measurement is performed. The color of wine was read after removal of suspended matter.

2. RESULTS AND DISCUSSIONS

The parameters of the initial must are shown in Table 1.

Table 1: Physicochemical parameters of the initial must

Sample	°Brix	Specific gravity	Sugar concentration [g/L]	pH	TA [g/L]
Must	26,75	1,114	298,01	3,3	6,75

At the end of alcoholic fermentation, we observed that the wine fermented at lower temperature had higher values for total soluble solids, specific gravity and pH (Table 2).

Table 2: Physicochemical parameters and chromatic characteristics at the end of fermentation

Sample	°Brix	Specific gravity	pH	TA [g /L]	Alcoholic concentration [% vol]	Color density	Color hue
Series 1	3,18	1,00725	3,32	5,7	13,29	0,345	2,29
Series 2	2,97	1,0051	3,28	5,5	13,37	0,368	3,14

There was also noted an effect of fermentation temperature on alcoholic concentration of Series 1. The values of total soluble solids, specific gravity and alcoholic concentration indicate that the fermentation process was slower in wine fermented under controlled temperature. Most of research also indicates that fermentation at temperatures below 15 °C proceed more slowly than at 25 to 30 °C [7].

Wine acidity was lower at higher fermentation temperatures. Acidity is important for producing a clean fresh taste and for favouring colour stability. It is also decisive for proper aging and protection from microbial spoilage [6]. Several studies have reported increased acidity with increasing fermentation temperatures [8] although other authors reported a decrease in titratable acidity as fermentation temperature increased over 22 °C [9].

The yellow color in wine comes from the present of tannins (polymers of flavonoid-procyanidins type, and non-flavonoid phenols) and can be read without dilution. The increase of the yellow-brown color in older wines is due to aging or oxidation.The color hue is the ratio between the yellow color concentrations over the red one, and is an indication about the degree of evolution.

The increase in absorbance resulting from increased temperature may have been the result of phenolic oxidation as phenolic compounds seem to increase in concentration in white wines consecutive with increasing fermentation temperatures [8], [9].

After bottling, total soluble solids content, specific gravity and pH displayed a similar trend with samples after alcoholic fermentation (Table 3).

Table 3: Physicochemical parameters and chromatic characteristics after bottling

Sample	°Brix	Specific gravity	pH	TA [g /L]	Alcoholic concentration [% vol.]	Colour density	Colour hue
Series 1	2,645	1,002	3,14	5,2	13,35	0,192	2,73
Series 2	2,605	1,0011	3,1	4,8	13,62	0,198	5,36

Moreover, increasing fermentation temperature slightly reduced total acidity and tended to increase ethanol, colour density and colour hue as seen in Figure 2 and Figure 3.

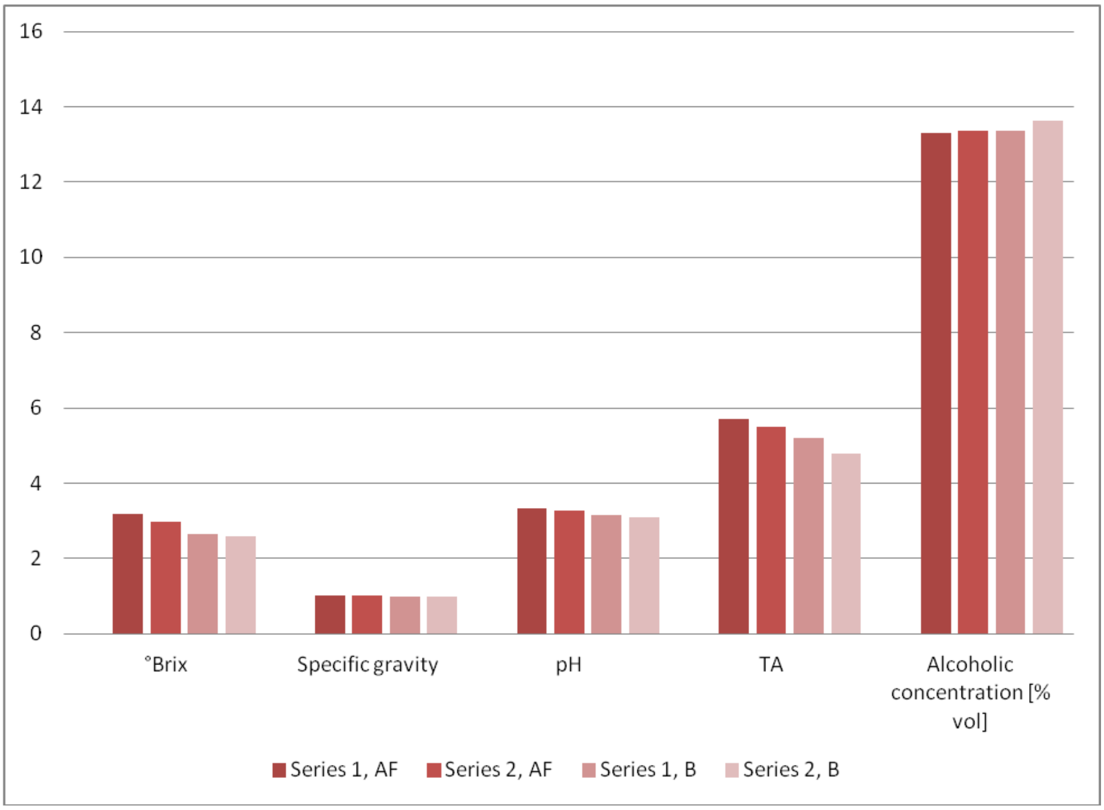

Figure 2: Evolution of the physicochemical parameters during vinification. AF alcoholic fermentation, B bottling.

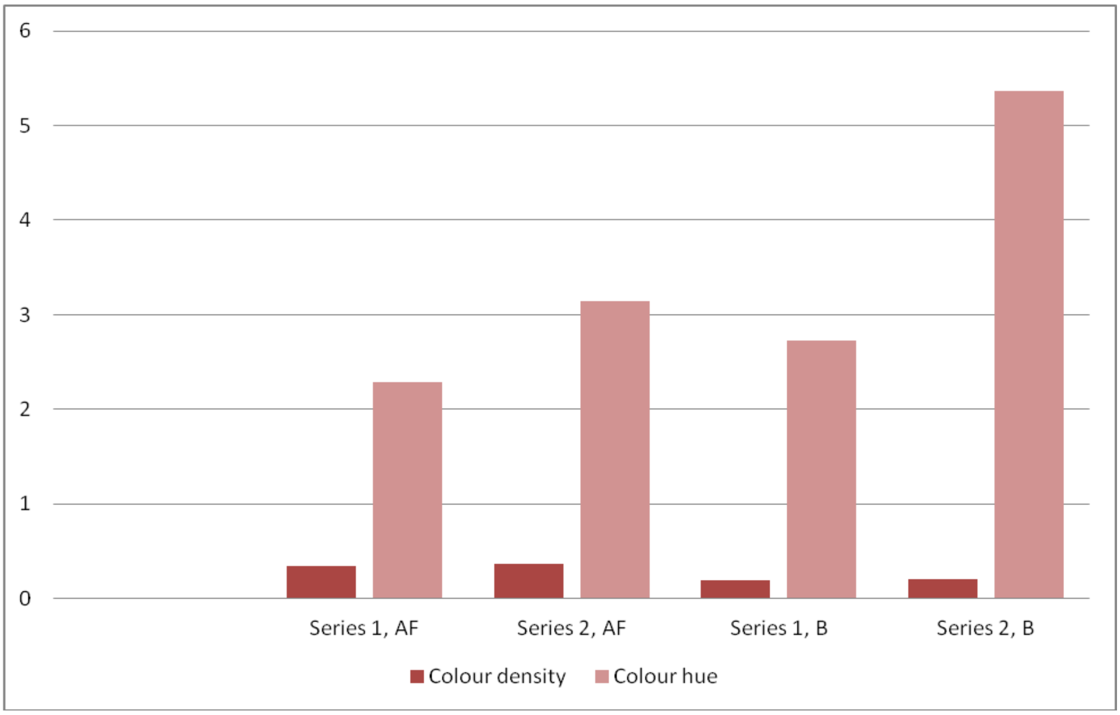

Figure 3: Evolution of color and hue during vinification. AF alcoholic fermentation, B bottling.

Authors noted that there are no precise recommendations for optimum acidity and pH values as the ideal parameters of a wine are dependent on the style and preferences of both the winemaker and consumer. Anyway, a range of between 3.1 and 3.4 is favoured for white wines. However, the acceptable range for total acidity in most wines is generally between 5.5 and 8.5 mg/litre and white wines are generally preferred at the higher end of the scale [3].

Moreover, both series were in accordance with Romanian legislation that indicates the value of 3,5 g/L as the minimum value of the tartaric acid and the value of 8,5 % vol. as the minimum value for alcoholic concentration [10].

3. CONCLUSIONS

Riesling wines fermented at different temperatures namely at maximum 15 °C and 22 °C respectively differ slightly in their physicochemical parameters after bottling. However, changes in color density and color hue resulted from increases in fermentation temperature. We observed that fermentation progressed faster as vinification temperature increased.
Both Series 1 and Series 2 were in accordance with Romanian legislation that indicates the minimum values for titratable acidity and alcoholic concentration.
Even the both series differ slightly in their physicochemical parameters, further research are required as the fermentation temperature influences also the sensory qualities and main organoleptic characters.

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