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QUALITY PARAMETER CONTROL IN RED WINES FROM DIFFERENT WINE-GROWING CENTRES

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ABSTRACT

This paper presents the control of quality parameters in 12 red wines (Cabernet Sauvignon, Merlot, Pinot Noir, Fetească neagră) from three wine-growing centres in Oltenia: Oprișor, Segarcea and Banu Mărăcine-Breasta. Alcoholic strength, total and volatile acidity, glycerol, non-reducing dry extract and ash were determined, and the oenological indices for controlling naturalness were calculated. The wine-growing centre significantly influenced glycerol (10.01–12.59 g/L), volatile acidity and total acidity, while the variety significantly influenced non-reducing extract, ash and total acidity; Cabernet Sauvignon had the highest extract (31.24 g/L) and Pinot Noir the lowest. Volatile acidity was high at Oprișor, where Cabernet Sauvignon (1.10 g/L H_2SO_4) exceeds the legal limit. The oenological indices fell within the range of natural wines, with no indication of adulteration.

INTRODUCTION

The quality of red wines results from the interaction between variety, the soil and climate conditions of the growing area, and the winemaking technology applied. The concept of terroir brings together the influence of soil, climate and viticultural practices on the composition of the grapes and, consequently, on the typicity of the wine (Van Leeuwen & Seguin, 2006). In recent decades, the rise in mean temperatures during the growing season has led to a more intense accumulation of sugars in the grapes and to wines with higher alcoholic strength and lower acidity (Jones et al., 2005).

The physico-chemical composition of wine reflects both the raw material and the way in which alcoholic and malolactic fermentation are conducted. Ethyl alcohol, acidity, glycerol, dry extract and mineral substances define the structure, body and taste balance of red wines (Ribéreau-Gayon et al., 2006b; Jackson, 2008). Glycerol, the main by-product of alcoholic fermentation, contributes to the sensation of roundness and smoothness, and its concentration depends on the yeast strain, the fermentation temperature and the sanitary condition of the grapes (Scanes et al., 1998). Volatile acidity is, in turn, a sensitive indicator of fermentation quality and of the microbiological stability of the wine (Ribéreau-Gayon et al., 2006a).

Among the constituents of natural wines there are relatively constant correlations, expressed through the oenological indices for controlling naturalness: the glycerol/alcohol ratio, the ash/non-reducing extract ratio, the Gauthier sum, the Halphen ratio and the R ratio. These are used as preliminary tools for assessing compositional balance and for detecting possible adulteration, such as dilution or the addition of alcohol, glycerol or acids (Țârdea, 2007; Cotea et al., 2009). In addition, modern authenticity control methods are based on multivariate statistical analysis of compositional parameters (Arvanitoyannis et al., 1999).

The legal framework for the production and marketing of wines in Romania is established by the Law on Vine and Wine No. 164/2015 and by European regulations on authorised oenological practices, which impose maximum limits for certain parameters, including volatile acidity (Law 164/2015; Regulation (EU) 2019/934).

The aim of the paper was the comparative evaluation of the main quality parameters and oenological indices for red wines from four varieties, obtained in three wine-growing centres in Oltenia, in order to assess compositional balance, authenticity, and the influence of variety, growing area and technology on wine quality.

MATERIAL AND METHODS

The study material consisted of 12 samples of dry red wine, obtained from the varieties Cabernet Sauvignon, Merlot, Pinot Noir and Fetească neagră, originating from three wine-growing centres in Oltenia: Oprișor Winery (Mehedinți County), Segarcea Crown Estates (Dolj County) and Banu Mărăcine-Breasta Winery (7ARTS range, Dolj County). The wines from Oprișor Winery come from the 2024 harvest. At Segarcea Crown Estates, winemaking is monitored by IoT sensors and SCADA systems, which allow real-time tracking of temperature, density and fermentation progress.

The physico-chemical analyses were carried out according to the official methods of wine analysis (OIV 2023) and the methodology described in the specialist literature (Ough & Amerine, 1988; Țârdea, 2007). Alcoholic strength (% vol.) was determined by distilling the sample and measuring the density of the distillate; total acidity by titration with 0.1 N NaOH solution in the presence of bromothymol blue, and volatile acidity by steam distillation and titration of the distillate, both being expressed in g/L H_2SO_4. Glycerol (g/L) was determined by periodic acid oxidation, total dry extract by the densimetric method, and non-reducing dry extract was calculated by subtracting the reducing sugars from the total dry extract. Ash (g/L) was determined gravimetrically, by calcining the evaporation residue at 500–550 °C.

On the basis of the values determined, the oenological indices for controlling naturalness and compositional balance were calculated: the glycerol × 100 / alcohol ratio (alcohol expressed in g/L), the ash × 100 / non-reducing extract ratio, the Gauthier sum (the sum of alcoholic strength and fixed acidity), the Halphen ratio and the R ratio, according to the methodology presented by Țârdea (2007) and Cotea et al. (2009). The values obtained were compared between varieties and between wine-growing centres.

RESULTS AND DISCUSSION

The main compositional characteristics of the 12 wines analysed are presented in Table 1.

Table 1

Main compositional characteristics of the red wines analysed

Wine-growing centre	Variety	Alcohol (% vol.)	Total acidity (g/L H_2SO_4)	Volatile acidity (g/L H_2SO_4)	Glycerol (g/L)	Non-reducing extract (g/L)	Ash (g/L)
Oprișor	**Cabernet Sauvignon**	14.40	5.10	1.10	10.70	31.80	3.12
	Merlot	13.50	5.00	0.92	9.86	30.10	2.75
	Pinot Noir	13.10	4.75	0.85	9.23	28.10	2.40
	Fetească neagră	14.20	4.90	0.76	10.25	29.90	2.60
Segarcea	**Cabernet Sauvignon**	14.00	5.00	0.50	12.00	31.50	3.09
	Merlot	14.00	4.75	0.39	11.90	30.25	2.94
	Pinot Noir	14.00	4.20	0.40	10.85	28.90	2.25
	Fetească neagră	14.00	4.50	0.41	11.55	29.72	2.83
Banu Mărăcine-Breasta	**Cabernet Sauvignon**	14.50	4.85	0.55	12.65	30.43	2.85
	Merlot	14.00	4.55	0.46	12.24	29.35	2.70
	Pinot Noir	14.50	4.10	0.42	12.50	28.55	2.45
	Fetească neagră	15.50	4.60	0.65	12.95	29.64	2.83

Alcoholic strength ranged from 13.10 to 15.50 % vol. (mean 14.14 % vol.; CV 4.1 %). The means by centre increased from Oprișor (13.80 % vol.) to Segarcea (14.00 % vol.) and Breasta (14.63 % vol.), but the differences were not significant. At Segarcea all the wines had 14.00 % vol., which indicates standardisation of the technological process, supported by digital monitoring of fermentation, while at Breasta Fetească neagră reached 15.50 % vol., suggesting harvesting at overripeness.

Glycerol content was very significantly influenced by the wine-growing centre, with the means differing significantly among all three centres: Oprișor 10.01 g/L, Segarcea 11.58 g/L and Breasta 12.59 g/L, while the effect of variety was not significant. Glycerol correlated positively with alcoholic strength, which confirms the link between grape maturity, the intensity of alcoholic fermentation and glycerol formation (Scanes et al., 1998).

Total acidity (4.10–5.10 g/L H_2SO_4) was significantly influenced by both the wine-growing centre and the variety. The wines from Oprișor had a significantly higher total acidity (4.94 g/L H_2SO_4) than those from Segarcea (4.61 g/L H_2SO_4) and Breasta (4.53 g/L H_2SO_4). Among the varieties, Cabernet Sauvignon (4.98 g/L H_2SO_4) and Merlot (4.77 g/L H_2SO_4) differed significantly from Pinot Noir (4.35 g/L H_2SO_4), which had the lowest acidity in all centres.

Volatile acidity showed the greatest variability and depended very significantly on the wine-growing centre, but not on the variety. The mean at Oprișor (0.91 g/L H_2SO_4) was significantly higher than those at Segarcea (0.43 g/L H_2SO_4) and Breasta (0.52 g/L H_2SO_4), the difference between the latter two not being significant. The Cabernet Sauvignon wine from Oprișor (1.10 g/L H_2SO_4, equivalent

to approximately 22 meq/L) exceeds the maximum limit of 20 meq/L (0.98 g/L H_2SO_4) permitted for red wines (Regulation (EU) 2019/934), and Merlot (0.92 g/L H_2SO_4) approaches this limit, which calls for closer attention to fermentation control, high volatile acidity being associated with the activity of acetic and lactic bacteria (Ribéreau-Gayon et al. 2006a). The low and homogeneous values at Segarcea may be linked to the automated control of fermentation temperature.

Non-reducing dry extract (28.10–31.80 g/L) and ash (2.25–3.12 g/L) were significantly influenced by the variety, but not by the wine-growing centre. Cabernet Sauvignon had the highest extract (mean 31.24 g/L), significantly superior to the other varieties, while Pinot Noir had the lowest extract (28.52 g/L) and the lowest ash content (2.37 g/L). A strong positive correlation was established between extract and ash, and total acidity correlated positively with extract and ash. The consistency of the ranking of varieties across the three areas confirms the determining role of varietal characteristics in the extractive structure of the wine (Ribéreau-Gayon et al., 2006b).

The oenological indices for controlling the naturalness of the wines are presented in Table 3.

Table 3

Oenological indices for controlling the naturalness of the red wines analysed

Wine-growing centre	Variety	Glycerol × 100 / alcohol	Ash × 100 / non-red. extract	Gauthier sum	Halphen ratio	R ratio
Oprișor	**Cabernet Sauvignon**	9.25	9.81	19.05	0.35	4.50
	Merlot	8.55	9.13	18.50	0.38	4.48
	Pinot Noir	7.59	8.54	17.85	0.36	4.66
	Fetească neagră	9.03	8.69	19.01	0.34	4.74
Segarcea	**Cabernet Sauvignon**	10.58	9.80	19.00	0.35	4.00
	Merlot	10.49	8.89	18.75	0.33	4.16
	Pinot Noir	9.56	7.78	18.20	0.30	4.35
	Fetească neagră	10.18	9.52	18.50	0.32	4.23
Banu Mărăcine-Breasta	**Cabernet Sauvignon**	9.69	9.36	19.35	0.33	4.76
	Merlot	9.84	9.19	18.55	0.32	4.77
	Pinot Noir	9.57	10.86	18.60	0.28	5.07
	Fetească neagră	9.28	9.54	20.10	0.29	5.22

The glycerol × 100 / alcohol ratio had values between 7.59 and 10.58, characteristic of wines obtained by normal alcoholic fermentation, without added glycerol, with the highest values recorded at Segarcea (9.56–10.58), consistent with the high glycerol content. The ash × 100 / non-reducing extract ratio (7.78–10.86) had similar values in most samples (8.5–9.8), indicating an appropriate balance between the mineral and organic fractions of the extract and excluding dilution or the addition of extract (Țârdea, 2007).

The Gauthier sum (17.85–20.10) had maximum values for Fetească neagră (20.10) and Cabernet Sauvignon (19.35) from Breasta, consistent with the high alcoholic strength of these wines. The Halphen ratio (0.28–0.38) remained within the range characteristic of unadulterated wines, and the R ratio (4.00–5.22) indicated well-structured wines. Overall, the calculated indices did not reveal adulteration or major compositional imbalances, the results being consistent with data in the literature on Romanian red wines (Pomohaci et al., 2000; Cotea et al., 2009).

CONCLUSIONS

The red wines analysed from the three wine-growing centres in Oltenia showed high alcoholic strength (13.10–15.50 % vol.), substantial glycerol contents (9.23–12.95 g/L) and non-reducing dry extract (28.10–31.80 g/L), characteristic of full-bodied wines obtained from grapes of advanced maturity.

Analysis of variance showed that the variety significantly influenced non-reducing dry extract, ash and total acidity: Cabernet Sauvignon had the highest extract (31.24 g/L), while Pinot Noir had the lowest values of extract, ash and total acidity, confirming the robust profile of the former and the finesse of the latter.

The wine-growing centre, through the conditions of the area and the technology applied, significantly influenced glycerol, volatile acidity and total acidity: the wines from Breasta had the highest glycerol content (12.59 g/L), those from Segarcea the lowest volatile acidity (0.43 g/L H_2SO_4), an effect of the digitalised control of fermentation, and those from Oprișor the highest total and volatile acidity. The differences in alcoholic strength were not statistically significant.

The volatile acidity of the Cabernet Sauvignon wine from Oprișor (1.10 g/L H_2SO_4) exceeds the legal limit for red wines, and that of the Merlot wine from the same centre approaches this limit, which calls for additional measures to control fermentation and hygiene.

The oenological indices (glycerol/alcohol ratio, ash/extract ratio, Gauthier sum, Halphen ratio and R ratio) fell within the limits of natural wines, confirming the authenticity and compositional balance of the wines analysed.

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