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TECHNOLOGICAL POTENTIAL OF ANCESTRAL ROMANIAN GRAPEVINE VARIETIES AND PROSPECTS FOR THEIR REINTRODUCTION INTO CULTIVATION

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ABSTRACT

This paper presents the evaluation of the technological potential of old indigenous grapevine varieties, in the context of wine market globalization and climate change. Conducted between 2020-2024 in the Valea Călugărească viticultural center (Dealu Mare vineyard), the study focused on five traditional varieties: Băşicată, Gordin, Gordin gurguiat, Negru vîrtos and Vulpea. The results were compared with historical data from 1945 – 1956, when these varieties produced low-alcohol, low-acidity wines with limited character. The impact of climatic conditions during the analyzed period, marked by high heliothermal values and water stress, led to increased sugar levels in grapes. Based on the findings, two white wine varieties (Gordin and Gordin gurguiat) and one red wine variety (Negru vîrtos) were identified as having high-performance grape quality characteristics.

INTRODUCTION

Global viticulture is being reshaped by climate change, sustainability requirements and consumer demand for wines with regional identity (Duchêne et al., 2010). In this context, traditional grape varieties play a critical role by enhancing biodiversity, production resilience and adaptation to new pedoclimatic and market conditions (Keller, 2015).

European biodiversity policies support the revival of local cultivars. In Romania, many ancestral varieties were replaced by more productive ones, despite preserving valuable genetic and oenological traits (Dejeu, 2010; Popa et al., 2019). Their reintroduction is now gaining traction, aligned with growing interest in authentic wines from well-defined terroirs (OIV, 2023), offering competitive advantages for high-quality DOC (Controlled Designation of Origin) wines (Teodorescu & Mihăescu, 2014).

These varieties show good adaptability to climatic stress, lower phytosanitary input needs and potential for wines with distinctive aromatic and phenolic profiles (Ribéreau-Gayon et al., 2021). The white grape varieties Băşicată, Gordin and Gordin gurguiat are appreciated for freshness and acidity (Popescu & Avram, 2020), while the red grape varieties Negru vîrtos and Vulpea stand out through high polyphenol and anthocyanin content, suitable for structured wines (Matei & Ilie, 2018).

Scientific validation of these varieties requires the analysis of key physicochemical parameters: yield, sugar and acidity balance, phenolic profile and alcoholic strength, to ensure their suitability for modern and climate-resilient viticulture.

MATERIAL AND METHODS

The study was conducted between 2020-2024 in the ecopedoclimatic conditions of the Valea Călugărească viticultural center and compared with historical data (1945-1956) to assess the impact of climate change on the technological potential of five grape varieties: Băşicată (B), Gordin (G), Gordin gurguiat (GG) for white wines and Negru vîrtos (NV), Vulpea (V) for red wines. Climatic parameters analyzed included: air temperature, precipitation, solar radiation and relative humidity.

The experimental plot features reddish-brown soil with a loam-clay texture, weakly acidic pH (6.1), good humus content (2.2%) and optimal levels of N, P and K. Assessments were conducted at technological maturity, at the same phenological stage for all varieties, evaluating both yield and grape quality.

The following analyses were performed: sugar content (refractometry, OIV 2021a), total acidity (NaOH titration, OIV 2021b), gluco-acidimetric index (sugar/total acidity ratio), total polyphenols (Folin-Ciocâlteu method, OIV 2021) and anthocyanins (spectrophotometry at 520 nm).

Data were statistically processed using ANOVA and Tukey tests for significance, PCA for multivariate differentiation, Pearson correlations to explore variable relationships and linear regression to identify factors influencing yield and quality.

RESULTS AND DISCUSSIONS

Climatic trends observed between 2020 and 2024 reveal an increase in thermal regime, with annual average temperatures ranging from 11.8°C (2021) to 13.8°C (2024) and vegetation period temperatures exceeding the 1945-1956 baseline by up to +3.0°C. Rainfall during the vegetation period showed a general decreasing trend, with deficits reaching 11.1 mm in 2022, except for 2021, which recorded a surplus of 15.3 mm. The Valea Călugărească viticultural center is classified in the IS1 rainfall variability class, indicating moderate drought conditions, often associated with elevated summer temperatures and berry wilting during ripening.Grape yield per vine varied significantly among varieties, with a general decline observed in 2020-2024 compared to 1945-1956: from 3.978 to 3.684 kg/vine in Băşicată (B), 3.664 to 3.315 kg/vine in Gordin (G) and 6.449 to 5.899 kg/vine in Gordin gurguiat (GG) (Table 1).

Table 1

The grape production (kg/vine) of the analyzed varieties in the period 1945-1956 and 2020-2024

Grape varieties /Year	B	G	GG	NV	V
1945-1956	3.978	3.664	6.449	2.890	4.472
2020	3.838	3.562	6.223	2.786	4.418
2021	3.880	3.389	6.041	2.762	4.300
2022	3.776	3.299	5.891	2.565	4.199
2023	3.469	3.203	5.802	2.535	4.058
2024	3.460	3.120	5.539	2.467	3.941

Regression analysis revealed a strong negative correlation between grape yield and sugar content, with determination coefficients of $R^2 = 0.9899$ for Gordin and $R^2 = 0.9645$ for Gordin gurguiat (Figure 1). These results indicate that 98.99 % and 96.45 % of the variability in sugar content can be explained by variations in yield. This finding indicates that yield increases lead to reduced levels of quality-associated compounds, including sugars, as resources are divided among more berries.

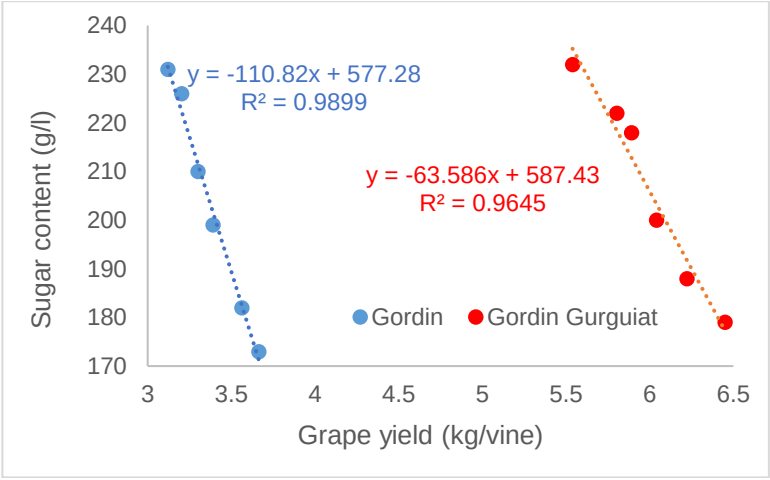

Figure 1. Regression analysis between grape yield and sugar content for Gordin and Gordin gurguiat grapevines

Between 2020 and 2024, sugar content in musts increased annually by an average of 9.5 g/l/year in Băşicată, 12.3 g/l/year in Gordin and 11.0 g/l/year in Gordin gurguiat. Among red varieties, increases were 7.5 g/l/year in Negru vîrtos and 10.3 g/l/year in Vulpea. These trends correlate positively with rising temperatures and negatively with declining yields, (Table 2).

Table 2

The sugar content (g/l) of the analyzed varieties in the period 1945-1956 and 2020-2024

Grape varieties/Year	B	G	GG	NV	V
1945-1956	147	173	179	186	176
2020	162	182	188	205	198
2021	160	199	200	212	198
2022	172	210*	218*	219*	215*
2023	176	226***	222***	233***	236***
2024	200	231***	232***	235***	239***
Average	170	204	207	215	210

$p < 0.05$ (*significant difference); $p < 0.01$ (**very significant difference); $p < 0.001$ (***extremely significant difference)

Also Băşicată had the lowest alcoholic strength (11.8% vol.), compared with Gordin and Gordin gurguiat (13.6% vol. both), whereas Vulpea (14.1% vol.) slightly exceeded Negru vîrtos (13.8% vol.)

Under these climatic conditions, total acidity (expressed as tartaric acid) showed significant variation compared to 1945-1956, with values detailed in Table 3, acidity declined annually by 0.25-0.40 g/l/year depending on the variety, while coefficients of variation remained below 10%, indicating stability in acidity levels.

Table 3

The total acidity (g/l) of the analyzed varieties in the period 2020-2024 compared to the period 1945-1956

Grape varieties/Year	B	G	GG	NV	V
1945-1956	6.8	5.5	8.7***	8.3**	8.3**
2020	6.5	5.1	8.6***	7.9**	8.2**
2021	6.2	4.9	8.0**	7.8**	7.9**
2022	6.1	4.5	7.6	7.4	7.5
2023	6.1	4.2	7.9	6.7	6.9
2024	5.4	4.1	7.0	6.3	6.6
Average	6.2	4.7	8.0	7.4	7.6

$p < 0.01$ (**very significant difference); $p < 0.001$ (***extremely significant difference)

Climate changes in the vineyard have led to an increase in sugar accumulation in the grapes, accompanied by a significant reduction in total acidity. Consequently, the gluco-acidimetric index reached an average value of 27.7, ranging from 21.6 (1945-1956) to 37.0 (2024) in the Băşicată variety. For the Gordin variety, the index recorded maximum values of 56.3 (2024) and minimum values of 31.5 (1945-1956). In the case of the red wine varieties Negru vîrtos and Vulpea, the average index values were 29.5 and 28.2 respectively, corresponding to optimal conditions for producing typical and high-quality wines (Table 4).

Table 4

The gluco-acidimetric index (g/l) of the analyzed varieties in the period 2020-2024 compared to the period 1945-1956

Grape varieties/Year	B	G	GG	NV	V
1945-1956	21.6	31.5	20.6	22.4	21.2
2020	24.9	35.7	21.9	25.9	24.1
2021	25.8	40.6	25.0	27.2	25.1
2022	28.2	46.7	28.7	29.6	28.7
2023	28.9	53.8	28.1	34.8	34.2
2024	37.0	56.3	33.1	37.3	36.2
Average	27.7	44.1	26.2	29.5	28.2

Polyphenols are key compounds influencing wine color, flavor, texture and health benefits. While present in both red and white wines, they are significantly more concentrated in red wines and are critical to oenological processes and sensory quality. The data obtained indicate that the red wine varieties Negru vîrtos and Vulpea exhibit the highest total polyphenol contents, reflecting substantial tannic potential (Table 5). The difference between these two varieties is statistically significant: Negru vîrtos shows an average polyphenol concentration of 3215 mg/l, ranging from a minimum of 2586 mg/l (1945-1956) to a maximum of 4217 mg/l (2024). In contrast, Vulpea averages 1618 mg/l, reaching a maximum of 2364 mg/l in 2024.

Table 5

The total polyphenols (mg/l) of the analyzed varieties in the period 2020-2024 compared to the period 1945-1956

Grape varieties/Year	B	G	GG	NV	V
1945-1956	219	398	395	2586	1026
2020	247	406	415	2851	1048
2021	288	429	458	2941	1369
2022	343	452	462	3199	1562
2023	437	459	491	3494***	2341**
2024	452	490	502	4217***	2364**
Average	331	439	454	3215	1618

$p < 0.01$ (**very significant difference); $p < 0.001$ (***extremely significant difference)

The white grape varieties Băşicată, Gordin and Gordin gurguiat exhibited lower polyphenol levels as is typical for white grape varieties. Specifically, Băşicată showed an average polyphenol content of 331 mg/l, ranging from 219 mg/l (1945-1956) to 452 mg/l (2024), while Gordin averaged 439 mg/l.

For the Negru vîrtos variety, values increased from 606 mg/l (1945-1956) to 967 mg/l (2020-2024), resulting in an absolute increase of 361 mg/l. In the case of the Vulpea variety, a more pronounced increase was observed, from 180 mg/l to 640 mg/l, with a difference of 460 mg/l. Comparatively, the average value for Negru vîrtos variety is 91.8 % higher than that of Vulpea variety (786.5 vs. 410), reflecting a quantitative dominance of the Negru vîrtos variety across both periods, despite its slower growth rate (Table 6).

Table 6

The total anthocyanins (mg/l) of the analyzed varieties in the period 2020-2024 compared to the period 1945-1956

Grape varieties/Year	NV	V
1945-1956	606	180
2020-2024	967	640
Average	786.5	410

The Negru vîrtos variety was distinctly characterized by high levels of polyphenols, anthocyanins and alcohol content, while Vulpea occupied a more central position, indicating its status as a balanced red wine variety. The Gordin variety demonstrated superior productive potential, reflected by high sugar content and alcohol strength. According to the PCA scores, the Gordin variety is considered a very well-balanced white wine variety (Table 7).

Table 7

Characterization of varieties according to the scores obtained

Grape varieties	Score	Characterization
Gordin gurguiat	1.43	→ productive and balanced variety
Negru vîrtos	-1.19	→ qualitative variety (high content of polyphenols and anthocyanins), low production
Vulpea	0.27	→ balanced variety, with high alcohol potential
Gordin	-0.56	→ variety with smooth acidity, balanced
Băşicată	0.24	→ variety with low sugar content and low alcohol potential

CONCLUSIONS

Rising temperatures and reduced rainfall during 2020-2024 led to a significant decrease in grape yield across all studied varieties, accompanied by increased sugar content and decreased acidity, impacting the sugar-acid balance of the must.

The red varieties Negru vîrtos and Vulpea stood out with high polyphenol and anthocyanin levels, indicating superior quality potential, while Gordin gurguiat was the most productive and balanced white variety. Gordin proved to be a balanced variety. Băşicată showed a comparatively lower sugar and alcohol profile.

These results confirm the adaptability of these traditional varieties to changing climatic conditions, supporting sustainable viticulture and the production of wines with distinctive regional character.

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