Scientific Papers. Series B, Horticulture. Vol. LXIX, No. 2, 2025
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

COMPARISON OF THE PHENOLIC COMPOSITION OF MAMAIA, BĂBEASCĂ NEAGRĂ AND PINOT NOIR BLACK GRAPES IN THE MURFATLAR WINE CENTER

Iulia-Cristina CIOBANU[1], Traian Ştefan COSMA[1], Victoria ARTEM[1], Arina Oana ANTOCE[2]

[1]Research Station for Viticulture and Oenology Murfatlar, 2 Calea Bucuresti, Murfatlar, Romania
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Horticulture, Department of Bioengineering of Horti-Viticultural Systems, 59 Mărăşti Blvd, District 1, 011464, Bucharest, Romania

Corresponding author email: arina.antoce@horticultura-bucuresti.ro

Abstract

Grape polyphenols are essential components that determine the quality and benefits of derived products, contribute to organoleptic characteristics (color, aroma, taste) and have remarkable antioxidant properties. The research aimed to compare black grape varieties from Murfatlar wine center to assess if their winemaking pomace is a good polyphenols source for food fortification. The varieties Mamaia, Băbeasca Neagră and Pinot Noir were especially selected, as they are not intensely coloured varieties and are usually not valorized for polyphenol extraction. During 2024 the grape ripening process was monitored and the must and the fresh, unfermented, pomace were analysed using the ITV method. The following parameters were determined: total polyphenol content, extractable anthocyanin concentration, total anthocyanin potential, total polyphenol index and antioxidant activity. The results indicated that Pinot Noir exhibited the highest values, with total polyphenols of 1022.3 mg GAE/L, 385.4 mg/L anthocyanins, and 36.2% antioxidant activity, followed by Băbeasca Neagră and Mamaia. These findings highlight the remarkable potential of Pinot Noir for pomace utilization, while also demonstrating the usability of the other varieties in enhancing the valorization of winemaking by-products.

Key words*: grape pomace, antioxidant activity, fortified foods, anthocyanins.*

INTRODUCTION

Grape polyphenols are essential bioactive compounds that play a pivotal role in defining both the quality and the health-promoting properties of grape-derived products (Zhou et al., 2022). These compounds significantly influence the organoleptic characteristics of grapes and their derived products, such as colour, aroma, and taste - attributes that are critical for consumer acceptance and market value (Lesschaeve et al., 2005; Gutiérrez-Escobar et al., 2021). In addition to their sensory contributions, grape polyphenols exhibit remarkable antioxidant properties, which are essential in mitigating oxidative stress and preventing the onset of various chronic diseases (Rudrapal et al., 2022). Their multifunctional role not only enhances the sensory appeal of grape-based beverages and foods (Kandylis et al., 2021) but also underscores their relevance in the development of nutraceuticals and functional food products (Caleja et al., 2017). As a result, grape polyphenols and their applications have become a prominent focus of research, aiming to maximize their potential through innovative processing and preservation techniques.

In recent years, the valorisation of winemaking by-products, particularly grape pomace, has received increasing attention due to its richness in bioactive compounds (Karastergiou et al., 2024; Wang et al., 2024), including polyphenols, anthocyanins, and other antioxidants. Grape pomace - composed of skins, seeds, and stems remaining after juice extraction - represents a significant, yet underutilized, resource in the food industry. Current research emphasizes that polyphenols extracted from grape pomace can be effectively used in food fortification (Sridhar et al., 2021), contributing to the creation of functional foods with enhanced health benefits (Eliopoulos et al., 2022). Furthermore, the extraction and

characterization of these compounds from various grape varieties provide valuable insights into their potential applications across multiple industries, including food, pharmaceutical, and cosmetic sectors.

In Romania, the Murfatlar wine centre is renowned for its viticultural tradition and diverse grape assortment. However, despite the significant production of red grape varieties, many of them remain insufficiently explored regarding their polyphenolic composition and potential uses beyond traditional winemaking. This study focuses on three black grape varieties cultivated in the Murfatlar wine centre: Mamaia, Băbească Neagră and Pinot Noir. These varieties were chosen because of their relatively low coloration compared to other intensely pigmented red cultivars, which often leads to their limited valorisation for polyphenol extraction.

The primary objective of this research is to compare the polyphenolic profiles of these selected grape varieties to assess their suitability for further applications, particularly in the context of winemaking by-product valorisation. The study evaluates key parameters, including total polyphenol content, extractable anthocyanin concentration, total anthocyanin potential, total polyphenol index, and antioxidant activity. Through this analysis, the research aims to provide a comprehensive evaluation of the potential of these grape varieties for food fortification and other functional uses.

Given the growing demand for sustainable and health-promoting ingredients in the food industry, this study intends to contribute valuable knowledge to the field of grape by-product utilization. The findings are expected to support the development of innovative strategies to enhance both the economic and nutritional value of winemaking residues, thereby encouraging a more sustainable and circular approach to viticulture and food production.

MATERIALS AND METHODS

For this study three red wine grape varieties were considered, which have not been the focus of previous research: the Mamaia variety, developed at the Murfatlar Research and Development Station, a Romanian-specific variety, Băbească Neagră, and an international variety, Pinot Noir.

For the first part of this study, focusing on grape sample analysis, grapes were collected weekly between August 22 and September 16, 2024. In order to determine the polyphenolic potential, the ITV method was applied. For the extraction 200 grape berries of each variety were crushed, and samples of 50 grams of the resulting mix were taken for analysis. The samples were treated with 85 ml of 0.1% HCl and 15 ml of 96% ethanol. After homogenization, the extraction was carried out at room temperature for one hour, with the sample being stirred every 15 minutes. Subsequently, the mixture was filtered, and the specific analyses were performed on the liquid fraction.

The determinations were performed spectrophotometrically at wavelengths of 280 and 520 nm, using a 1 cm optical path cuvette, against distilled water, with the Metertech SP-8001 spectrophotometer.

For the second part of the study, focusing on grape pomace analysis, the folowing procedure was used:

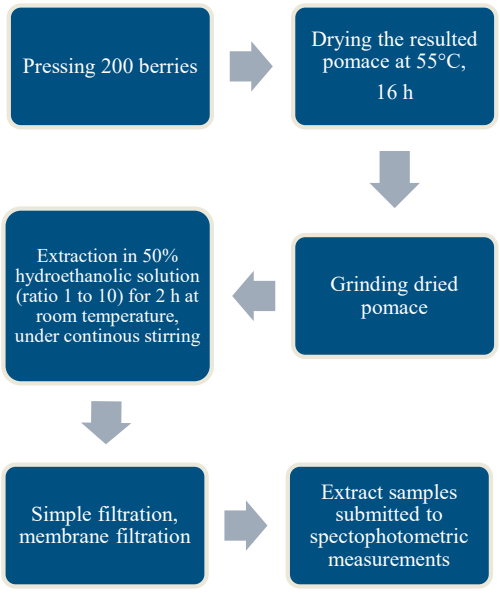

Figure 1. Technique for obtaining the pomace extracts analysed in the study

The obtained extracts subsequently underwent a series of spectrophotometric determinations, such as the total polyphenol index, anthocyanins, total polyphenols (Folin-Ciocalteu method, readings performed at 760 nm wavelenght), colour intensity, total anthocyanic potential and antioxidant activity (DPPH inhibition method, readings performed at 515 nm wavelenght). For the determination of total polyphenols and antioxidant activity, 1:10 dilutions of the extract were required. The results presented represent the average of three determinations. Standard errors were calculated and the means were compared for the 3 varieties by ANOVA and post-doc Tukey test $p<0.05$. For the statistical analysis the software Origin ver 9 was used.

RESULTS AND DISCUSSIONS

Determination of Phenolic Maturity Dynamics for Grapes

Phenolic maturity refers to the developmental stage of phenolic compounds present in grapes, primarily anthocyanins (pigments), proanthocyanidins (condensed tannins) and other relevant polyphenols, which directly influence grape quality. Figure 2 illustrates the dynamics of total polyphenol index evolution during the month before harvesting for the three grape varieties: Mamaia, Pinot Noir, and Băbească Neagră.

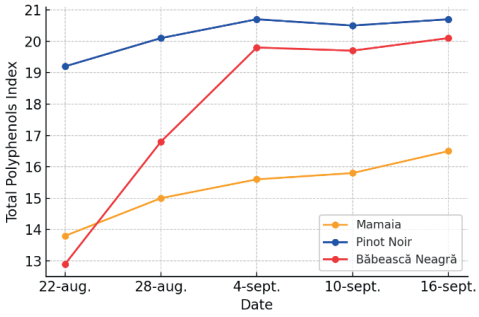

Figure 2. Total Polyphenols Index Dynamics for Grape Samples

The evolution of the Total Polyphenols Index for the three grape varieties shows distinct trends over the analysed period. Pinot Noir maintains the highest and most stable polyphenol content, ranging between 19.2 and 20.7, indicating an early and consistent accumulation pattern. Băbească Neagră shows a significant and steep increase, from 12.9 to 19.8 during the first two weeks of evaluation, followed by a steady phase in the last two weeks, in which there is a small progress from 19.8 to 20.1, suggesting a strong accumulation of polyphenols during ripening, reaching similar levels to Pinot Noir by mid-September. Mamaia has the lowest total polyphenols content but shows a gradual increase from 13.8 to 16.5, indicating a moderate accumulation capacity compared to the other two varieties.

The dynamics of anthocyanin accumulation (Figure 3) shows clear differences among the three grape varieties. Pinot Noir maintains the highest and most stable anthocyanin levels (92.4-95.1 mg/L), indicating early and steady accumulation. Băbească Neagră shows a significant and continuous increase during the entire month previous to harvesting, from 51 mg/L to 106.8 mg/L, suggesting a late and dynamic accumulation pattern. Mamaia has the slowest and most stable anthocyanin content evolution, with only a slight increase (53.7 to 59.3 mg/L), followed by a minor decrease.

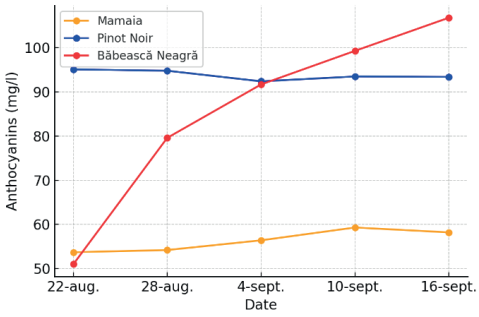

Figure 3. Dynamics of Anthocyanins Accumulations for Grape Samples

Of the three varieties, Pinot Noir is rich in anthocyanins and has a stable anthocyanin content in the month previous to harvest, consistent with the fact that it is a grape with early maturation. Băbească Neagră accumulates intensively over time in the month before harvesting, reaching higher concentrations of anthocyanins as compared to Pinot Noir. Of all studied varieties, Mamaia shows a lower anthocyanin synthesis potential,

progressing slowly during the month before harvesting and reaching a maximum of 60 mg/L.

The analysis of total polyphenols and anthocyanins accumulation dynamics shows distinct phenolic maturity patterns among the studied grape varieties. Pinot Noir is characterized by an early and consistent accumulation of both total polyphenols and the specific class of anthocyanins, maintaining high and stable levels throughout the ripening period. In contrast, Băbească Neagră shows a significant and continuous increase in both total polyphenols and anthocyanins, indicating a late but intense accumulation process that leads to high final concentrations. Meanwhile, Mamaia presents the lowest accumulation capacity for both measured parameters, with only moderate increases in polyphenols and minimal variation in anthocyanin content, suggesting a limited phenolic maturation potential compared to the other varieties.

Assessment of the polyphenolic profile of wine industry by-products (Grape Pomace extracts)

The extracts obtained from the grape pomace, resulted after winemaking following the methodology detailed in the 'Materials and Methods' section, were subjected to spectrophotometric analysis to evaluate their general polyphenolic composition and associated properties. For the assessment of total polyphenols and antioxidant activity, a 1:10 dilution of the extract was used to ensure the accuracy and reliability of the measurements.

The polyphenolic profile and antioxidant activity of the analysed grape pomace samples (Table 1) reveal significant differences in the content and distribution of bioactive compounds, highlighting their potential for revalorization as sources of natural antioxidants and phenolic extracts.

Among the studied samples, Pinot Noir pomace exhibited the highest concentrations for most analysed parameters, indicating its superior potential as a raw material for total phenols or for anthocyanin recovery. The Total Polyphenols Index (338.1) reflects a high content of extractable polyphenolic compounds, in direct relation with the total polyphenol quantity (1022.3 mg GAE/L), while the anthocyanin content (385.4 mg/L) also confirms the presence of significant amounts of bioactive molecules. Furthermore, the total anthocyanic potential (1156.2 mg/kg) demonstrates a considerable resource of anthocyanins that could be efficiently extracted and utilized in the production of functional ingredients. The antioxidant activity of 36.2% reinforces the potential of Pinot Noir pomace as a rich source of compounds with good radical scavenging properties, suitable for applications in the food, pharmaceutical, and cosmetic industries.

Băbească Neagră pomace presented intermediate values, suggesting a balanced phenolic composition with potential for exploitation. Although its Total Polyphenols Index (290.4) and total polyphenols (741.5 mg GAE/L) are somewhat lower than those of Pinot Noir, the anthocyanin content (237.0 mg/L) and total anthocyanic potential (711.0 mg/kg) indicate the presence of a substantial amount of pigments and antioxidant compounds that could be valorised. Additionally, the antioxidant activity of 32.8% confirms the presence of effective antioxidant molecules, supporting the use of Băbească Neagră pomace in the development of natural extracts for functional products.

Table 1. Polyphenolic Profile and Antioxidant Activity of the Pomace for the Studied Grape Varieties

Variety	Total Polyphenols Index (DO 280 nm)	Anthocyanins (mg/L)	Total Polyphenols (mg GAE/L)	Colour Intensity (IC 420+520+620)	Total Anthocyanic Potential (mg/kg)	Antioxidant Activity (%)
Mamaia	312.0 ± 2.9^{a}	137.9 ± 3.2^{a}	875.0 ± 5.5^{a}	4.62 ± 0.01^{a}	413.7 ± 9.6^{a}	22.2 ± 2.5^{a}
Pinot Noir	338.1 ± 3.4^{b}	385.6 ± 4.2^{b}	1022.3 ± 8.3^{b}	6.64 ± 0.02^{b}	1156.2 ± 11.7^{b}	36.2 ± 2.7^{b}
Băbească Neagră	290.4 ± 2.2^{c}	237.0 ± 3.7^{c}	741.5 ± 5.2^{c}	6.23 ± 0.01^{c}	711.0 ± 11.1^{c}	32.8 ± 2.8^{b}

Mean values of three independent determinations ± standard deviations. The comparison of means was done by ANOVA and post hoc Tukey test. Different letters represent significant differences at $p<0.05$.

Although Mamaia pomace exhibited lower contents of polyphenols, anthocyanins, and antioxidant activity compared to the other varieties, it nevertheless represents a valuable resource for revalorization. With a Total Polyphenols Index of 312.0 and a total polyphenols content of 875.0 mg GAE/L, Mamaia pomace still contains significant amounts of phenolic compounds. Although the anthocyanin concentration of 137.9 mg/L and total anthocyanic potential of 413.7 mg/kg of Mamaia variety are lower than those observed in Pinot Noir and Băbească Neagră, these levels may still support the extraction of natural pigments and bioactive compounds. Furthermore, while the Mamaia's antioxidant activity of 22.2% was the lowest among the studied samples, it still highlights the presence of compounds with functional properties, thus making Mamaia pomace a potential raw material for applications where moderate antioxidant activity is desirable, contributing to the sustainable valorisation of winery by-products.

CONCLUSIONS

The present study provides a comparative assessment of the polyphenolic composition and antioxidant activity of grape pomace derived from three black grape varieties cultivated in the Murfatlar wine centre: Mamaia, Băbească Neagră, and Pinot Noir. The results clearly demonstrate the richness and diversity of bioactive compounds present in these underutilized by-products, supporting their potential for revalorization in functional applications.

Among the analysed varieties, Pinot Noir pomace exhibited the highest levels of total polyphenols, anthocyanins, total anthocyanic potential and antioxidant activity, highlighting it as a promising raw material for the extraction of natural antioxidants and pigments. These findings underline Pinot Noir's exceptional potential for applications in the development of fortified foods, nutraceuticals, and cosmetic formulations aimed at enhancing health benefits and product functionality.

Băbească Neagră pomace presented intermediate values for all analysed parameters, demonstrating a well-balanced polyphenolic profile with considerable anthocyanin and antioxidant content. This variety can be considered a valuable source of natural compounds for industries seeking bioactive-rich ingredients, particularly for functional food fortification and antioxidant supplementation.

Although Mamaia pomace showed the lowest polyphenolic and antioxidant levels among the studied varieties, it nonetheless contains significant amounts of polyphenolic bioactive compounds, including anthocyanins. These results suggest that Mamaia pomace, despite its lower phenolic content, remains an important resource for revalorization. Its exploitation contributes to a sustainable approach to winery by-products, preventing waste and creating added value.

Overall, this research emphasizes the importance of varietal selection when considering grape pomace as a raw material for polyphenol recovery. The study demonstrates that even less intensely coloured varieties, traditionally not valorised for their phenolic content, can serve as important sources of bioactive compounds, supporting circular economy principles in viticulture. Future research should focus on optimizing extraction techniques and exploring specific applications of these compounds, contributing to a more sustainable and innovative use of grape pomace.

ACKNOWLEDGEMENTS

This research work was carried out under the guidance of INCDBH Ștefănești - Argeș and the support provided through the ADER 6.5.2 project, funded by the Ministry of Agriculture and Rural Development.

REFERENCES

Caleja, C., Ribeiro, A., Barreiro, M. F. (2017). Phenolic Compounds as Nutraceuticals or Functional Food Ingredients. *Current Pharmaceutical Design*, *23*(19), 2787-2806.

Eliopoulos, C., Markou, G., Langousi, I., Arapoglou, D. (2022). Reintegration of Food Industry By-Products: Potential Applications. *Foods*, *11*(22), 3743

Gutiérrez-Escobar, R., Aliaño-González, M. J., Cantos-Villar, E. (2021). Wine Polyphenol Content and Its Influence on Wine Quality and Properties: A Review. *Molecules, 26*(3), 718.

Kandylis, P., Dimitrellou, D., Moschakis, T. (2021). Recent applications of grapes and their derivatives in dairy products. *Trends in Food Science & Technology,* vol. 114, 696-711.

Karastergiou, A., Gancel, A-L., Jourdes, M., Teissedre P-L. (2024). Valorization of Grape Pomace: A Review of Phenolic Composition, Bioactivity, and Therapeutic Potential. *Antioxidants*, *13*(9), 1131.

Lesschaeve, I., Noble, A. C. (2005). Polyphenols: factors influencing their sensory properties and their effects on food and beverage preferences. *The American Journal of Clinical Nutrition*, *81*(1), 330S-335S.

Rudrapal, M., Khairnar, S. J., Khan, J., Bin Dukhyil, A, Ansari, M. A., Alomary, M. N., Alshabrmi, F. M., Palai, S., Kumar P. (2022). Dietary Polyphenols and Their Role in Oxidative Stress-Induced Human Diseases: Insights into Protective Effects, Antioxidant Potentials and Mechanism(s) of Action. *Frontiers in Pharmacology*, 14:13:806470.

Sridhar, K., Charles, A. L. (2021). Fortification using grape extract polyphenols – a review on functional food regulations. *International Journal of Food Science and Technology*, *56*(8), 3742–3751

Wang. C., You, Y., Huang, W., Zhan, J. (2024). The high-value and sustainable utilization of grape pomace: A review. *Food Chemistry: X*, vol. 24: 101845

Zhou, D., Jiahui, L., Xiong, R., Saimaiti, A., Huang, S., Wu, S., Yang, Z., Shang, A., Zhao, C., Gan, R., Hua-Bin, L. (2022). Bioactive Compounds, Health Benefits and Food Applications of Grape. *Foods*, *11*(18), 2755.