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Relationship between grape berry size and oenological characteristics

Nistor Eleonora[1], Dobrei Alina[1], Simion Alda[1], Marcel Danci[1], Gabriel Ciorică[2], Dobrei Alin[1]

[1]University of Life Sciences "King Michael I" from Timișoara, Faculty of Engineering and Applied Technologies, Department of Horticulture, e-mail: nisnora@yahoo.com
[2]"Victor Babeș" University of Medicine and Pharmacy, Timișoara, Romania, email: gciorica@gmail.com

Abstract:

The composition and oenological characteristics of grape berries can be influenced by various factors, including their size. Therefore, several studies were conducted in the Mișca vineyards between 2019 and 2022, focusing on Merlot, Cabernet Sauvignon and Feteasca Neagră varieties. The studies were carried out considering the varieties, with Simple Guyot training system, and by cluster thinning (at a rate of 40%) or without thinning, during the veraison stage. Random selection of 25 vines from each variety, in each experimental plot was performed. Samples were collected on the harvest day, with maturity determined based on sugar content, titratable acidity and pH of the berry juice. Laboratory analyses included measurements of berry weight, sugar content, total acidity, pH and anthocyanins potential. Statistical analysis was employed to assess differences between means, while the Pearson correlation coefficient was used for further analysis. The results revealed differences between varieties regarding berry weight, sugar content and anthocyanin potential. Furthermore, the berry quality was influenced by the temperature and precipitation of each year. Although thinning of clusters did not significantly influence berry weight, it did affect anthocyanins and sugar content depending on the favourability of the growing season. The study highlighted the complex interaction among vineyard management practices, climatic conditions and grape variety in shaping the characteristics of grape berries.

• Introduction

Berry size significantly impacts wine quality, influencing flavor concentration, tannin structure, and overall balance. Smaller berries, with a higher skin-to-pulp ratio, contribute to deeper color, robust tannins, and higher acidity, enhancing aging potential and complexity. Larger berries may produce more approachable wines but with less complexity. Factors such as grape variety, terroir, and vineyard management practices affect berry size. Techniques like cluster thinning can produce smaller, high-quality berries by concentrating the vine's resources, leading to improved flavor, phenolic content, and disease resistance. The aim of this paper was to investigate the impact of berry size on the composition and oenological characteristics of grape berries, particularly focusing on Merlot, Cabernet Sauvignon, and Feteasca Neagră varieties grown in the Mișca vineyards between 2019 and 2022. By examining these factors comprehensively, the research aims to provide valuable insights into optimizing vineyard practices to enhance wine quality through the manipulation of berry size and cluster thinning techniques.

• Material and method

A study was conducted in the Mișca vineyard on Merlot, Cabernet Sauvignon, and Feteasca Neagră varieties from 2019 to 2022 to examine the influence of berry size on wine quality. The research involved a Simple Guyot training system with 40% cluster thinning at veraison. Berry weight and juice composition (sugars, acidity, pH, anthocyanins) were measured. Climatic conditions and vineyard management practices over the years were documented. Statistical analyses, including ANOVA and correlation, were performed using XLStat and Prism software. The study highlighted the impact of environmental factors and vineyard practices on grape quality attributes and wine production.

• Results and discussions

Table 1. Berry fresh weight, sugar, titratable acidity, pH and anthocyanins concentration in Cabernet Sauvignon, Merlot and Feteasca Neagră different sized berries influenced by variety, Simple Guyot training

Variety	Berry weight (g)	Sugar (°Brix)	Titratable acidity (g/l)	pH	Anthocyanins (mg/l)
2019					
Cabernet Sauvignon	1.64^{b}	21.71^{a}	4.61^{a}	3.41^{a}	184.94^{b}
Merlot	1.78^{a}	20.96^{b}	4.47^{a}	3.47^{a}	166.92^{c}
Feteasca Neagră	1.69^{a}	23.83^{a}	4.52^{a}	3.43^{a}	218.93^{a}
2020					
Cabernet Sauvignon	1.46^{c}	21.80^{b}	4.33^{b}	3.56^{a}	190.21^{b}
Merlot	1.53^{b}	22.13^{b}	4.56^{a}	3.32^{b}	152.23^{c}
Feteasca Neagră	1.71^{a}	24.52^{a}	4.48^{a}	3.51^{a}	201.18^{a}
2021					
Cabernet Sauvignon	1.64^{c}	22.34^{b}	4.72^{a}	3.68^{a}	194.73^{b}
Merlot	1.79^{b}	21.71^{c}	4.57^{a}	3.45^{b}	180.97^{c}
Feteasca Neagră	1.85^{a}	24.54^{a}	4.63^{a}	3.61^{a}	214.32^{a}
2022					
Cabernet Sauvignon	1.69^{b}	21.82^{b}	4.46^{a}	3.39^{b}	209.52^{b}
Merlot	1.58^{c}	20.55^{c}	4.32^{b}	3.36^{b}	190.83^{c}
Feteasca Neagră	1.76^{a}	24.10^{a}	4.51^{a}	3.52^{a}	221.56^{a}

Different lowercase letters in a row indicate significant differences ($p < 0.05$) between berry size classes.
Different uppercase letters in a column indicate significant differences ($p < 0.05$) between varieties

Cluster thinning did not produce significant differences in berry weight (Table 2), confirming the results of Mesić et al. [11] for Cabernet Sauvignon and Merlot grown in Slavonia, Croatia. Several authors report an increase in berry size after thinning, but this effect is interpreted as the result of compensation from the reduction of clusters [9;12]. Generally, this effect occurs when thinning is carried out at berry set, during a period of strong berry growth [2]. In the Feteasca Neagră variety, cluster thinning resulted in a significantly higher berry weight. Additionally, cluster thinning led to an increase in anthocyanin accumulation, a finding also noted by Wang et al. [23], for Cabernet Sauvignon.

Table 3. Pearson correlation among the variables (berry weight, sugar, titratable acidity, pH and anthocyanins) in the Cabernet sauvignon, Merlot and Feteasca Neagră varieties (2019-2022) influenced by cluster thinning

Variables	Berry Weight	Sugar	Titratable acidity	pH	Anthocyanins
Berry Weight	**1**	**0.917**	0.464	**0.685**	**0.801**
Sugar	**0.917**	**1**	0.515	**0.650**	**0.809**
Titratable acidity	0.464	0.515	**1**	**0.716**	0.123
pH	**0.685**	**0.650**	**0.716**	**1**	0.288
Anthocyanins	**0.801**	**0.809**	0.123	0.288	**1**

Values in bold are different from 0 with a significance level alpha=0.05

Sugar content and anthocyanin potential are also significantly higher in Feteasca Neagră variety and these characteristics are independent of berry size (Table 1). The climate conditions from 2019 to 2022 in Mișca, Arad County show variability that influences grapevine growing: warm temperatures in spring and summer with moderate to high rainfall generally supported grapevine growth, flowering, and fruit set. Warm and dry conditions in late summer and early autumn were ideal for ripening and harvesting. However, cold winters were stressful for dormant vines. High rainfall, particularly in spring and summer, increased the risk of fungal diseases, requiring effective management. Drier periods, especially in May 2022, were inadequate for vines without irrigation. The decrease in the quality component levels in 2022 may be due to the combined effect of very cool nights, with minimum temperatures on some nights in May reaching 2ºC and in July reaching 7ºC, which contributed to high stress.

Table 2. Berry fresh weight, sugar, titratable acidity, pH and anthocyanins concentration in Cabernet Sauvignon, Merlot and Feteasca Neagră influenced by cluster thinning (40%), Simple Guyot training

Variety	Berry weight (g)	Sugar (°Brix)	Titratable acidity (g/l)	pH	Anthocyanins (mg/l)
2019					
Cabernet Sauvignon	1.85^{b}	22.51^{a}	4.22^{b}	3.37^{a}	203.47^{b}
Merlot	1.81^{b}	20.90^{b}	4.37^{a}	3.40^{a}	196.28^{c}
Feteasca Neagră	1.99^{a}	23.66^{a}	4.31^{a}	3.39^{a}	221.34^{a}
2020					
Cabernet Sauvignon	1.90^{a}	23.19^{a}	4.29^{b}	3.51^{a}	219.16^{b}
Merlot	1.76^{b}	21.98^{b}	4.37^{a}	3.29^{b}	209.34^{c}
Feteasca Neagră	1.98^{a}	24.62^{a}	4.41^{a}	3.48^{a}	231.09^{a}
2021					
Cabernet Sauvignon	1.96^{b}	23.87^{a}	4.64^{a}	3.62^{a}	199.96^{c}
Merlot	1.83^{c}	22.99^{b}	4.49^{b}	3.41^{b}	201.33^{b}
Feteasca Neagră	2.02^{a}	24.63^{a}	4.58^{a}	3.57^{a}	224.12^{a}
2022					
Cabernet Sauvignon	1.89^{b}	23.18^{b}	4.38^{a}	3.37^{b}	214.08^{b}
Merlot	1.78^{c}	21.93^{c}	4.28^{b}	3.30^{c}	200.96^{c}
Feteasca Neagră	2.09^{a}	25.11^{a}	4.47^{a}	3.47^{a}	243.69^{a}

Different lowercase letters in a row indicate significant differences ($p < 0.05$) between berry size classes.
Different uppercase letters in a column indicate significant differences ($p < 0.05$) between varieties

The analysis of data from Table 4 influenced by the cluster thinning, show significant positive correlations between berry weight and other quality parameters, particularly sugar content (0.917) and anthocyanin concentration (0.801). Sugar content also shows strong positive correlations with anthocyanin concentration (0.809) and pH (0.650). Titratable acidity has strong positive correlations with pH (0.716), indicating a complex interaction affecting grape berry quality. These findings suggest that larger berries tend to have higher sugar levels and anthocyanin concentrations, which are important factors in grape and wine quality. Effective management of these parameters can optimise grape production and quality.

• Conclusions

From 2019 to 2022, Feteasca Neagră consistently exhibited the highest sugar content and anthocyanin levels, indicating its suitability for high-quality wine production in the region. Cabernet Sauvignon showed stable performance with a slight increase in anthocyanins in 2022. Merlot experienced a decrease in sugar content in 2022, potentially affecting wine quality. Despite variable climate conditions, grape varieties maintained quality components with annual variations. High anthocyanin levels in 2022, especially for Feteasca Neagră, suggested favorable conditions for color development. Cluster thinning (40%) positively impacted berry quality, enhancing berry weight, sugar content, and anthocyanin levels across all varieties, particularly benefiting Feteasca Neagră and Cabernet Sauvignon. The findings highlight the importance of managing sugar content to improve grape and wine quality.