Terroir of Fetească Neagră wines from Moldova

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Abstract. This study delves into the sensory intricacies of 20 Fetească Neagră (FN) wines originating from the 2019 and 2020 vintages. By conducting a comprehensive analysis, we explore the dynamic relationship between vintage, aroma, and taste attributes. Notably, discernible differences in aroma and taste profiles between the two years come to light. The descriptors of Forest fruit and oak aromas emerge as pivotal indicators of vintage variations, offering reliable tools for discerning aroma disparities. Significant taste differences, excluding bitter and alcohol, are evident in both vintages. Interestingly, descriptors including prune, cherry, black pepper, plant, smoke, bitter, and alcohol demonstrate consistent qualities across both years. These findings underscore their potential as stable markers in FN wines' sensory profiles. The study sheds light on the multifaceted influences, from oak treatment to natural factors, shaping wine's sensory characteristics. This research not only advances our understanding of sensory attributes but also aids producers in informed decision-making to achieve desired flavor profiles, preserving the distinct essence of FN wines across diverse vintages.

1 Introduction

Viticulture and winemaking are traditions deeply ingrained in Moldovan culture, and the wine industry holds significant importance in Moldova's social economy [1]. Moldovan wine is primarily intended for export. Amidst fierce competition in the international wine market, wine produced using Moldova's autochthonous grape varieties has emerged as a pivotal product, enhancing the competitiveness of Moldovan wine and the country's image.

Over the past decade, wines crafted from autochthonous Moldvoan-Romanian grape varieties have garnered increasing appreciation in both domestic and international wine markets. White varieties like Fetească Albă and Fetească Regală, along with red varieties such as Fetească Neagră and Rară Neagră, are making notable strides alongside other prestigious international grape varieties [2]. Notably, Fetească Neagră stands out as the most renowned red grape variety, sparking global discussions about Moldovan wine.

Terroir is a term of French origin widely employed in the realm of wine [3]. At present, a definitive consensus on the precise concept of terroir remains elusive. The International Organization of Vine and Wine (OIV) defines terroir as "a concept referring to a region where collective knowledge of the interplay between identifiable physical and biological practices

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develops, giving a distinctive character to products originating from that region" (International Organization of Vine and Wine 2010) [4].

Fetească Neagră finds its origins in the region along the Prut River and has been cultivated in the Moldova area for over 2000 years. This grape variety possesses the potential to yield high-quality wines, predominantly reds [5]. It is capable of producing red wines imbued with wild, purple cherry aromas, characterized by a concentrated berry flavor and a robust structure. As a local variety well-suited to Moldova's climatic conditions, Fetească Neagră aptly embodies the terroir of Moldovan wine and the authenticity of its production area. Presently, it is cultivated in three geographical protection production areas within Moldova and is employed in the production of both PGI and regular wines [6].

To capture the terroir nuances of Fetească Neagră (FN) wines in Moldova, a comprehensive tasting analysis was conducted on various commercial wine samples sourced from different PGI regions According to the guidelines provided by the OIV, it can be inferred that distinct terroir conditions, coupled with varying vineyard management techniques and diverse wine production processes, can significantly influence the composition and resultant sensory characteristics of the wine.

The selected samples were drawn from commercially available wines in the market, showcasing the diverse regions of Moldova (highlighting discrepancies in physical factors) and encompassing an array of wineries (displaying differences in biological practices). This assortment of sample origins offers a more comprehensive depiction of Moldova's FN terroir.

This study aims to define the sensory profiles of a curated collection of Fetească Neagră wines produced in 2019 and 2020 (henceforth referred to as FN wines), representing nearly all the wine production areas in Moldova. Furthermore, these findings are juxtaposed against the sensory profiles of Moldova's FN wines.

2 Materials and Method

A total of 20 Fetească Neagră (FN) wines were evaluated, comprising 10 wines from the 2019 vintage (designated as N1-N10) and 10 samples from the 2020 vintage (labeled as T1-T10), sourced from the same ten wineries as those in 2019. These wines originate from various wineries of different PGI regions within the Republic of Moldova.

The sensory profiling was conducted by two professional panels: a morning group consisting of 5 males and 7 females, and an afternoon group composed of 5 males and 7 females. The members of the morning group are winemakers from different Moldovan wineries, bringing their expertise in the production of the Fetească Neagră variety. The afternoon group is composed of professional sommeliers from Moldova.

All samples were prepared in accordance with the OIV review document on sensory analysis of wine (2015) [7]. Standard ISO glasses were utilized, and each glass contained 50-75 ml of wine, maintained at a temperature of 18-20°C.

The sensory profile used the characteristic confirmed by the ONVV, the description showed below table 1.

Table 1. Descriptors of characteristic sensory profile attributes

Olfactory description	Abbreviation	Gustatory description	Abbreviation	Persistence	Abbreviation
Forest fruit	O.F_fruit	Structure	G.Structure	Olfactory	Per.Gus
Cherry	O.Cherry	Body	G.Body	Gustatory	Per.Olf
Prune	O.Prune	Tannin	G.Tannin		

Violet	O.Violet	Bitter	G.Bitter		
Sweet spice	O.S_spice	Alcohol	G.Alcohol		
Black pepper	O.B_pepper	Oak	G.Oak		
Plant	O.Plant				
Dairy	O.Dairy				
Smoke	O.Smoke				
Oak	O.Oak				

The selected attributes were validated by providing the panel with appropriate reference standards. These attributes were evaluated twice in duplicate using unstructured scales ranging from 0 to 5, across two separate tasting sessions.

Quantitative sensory data were gathered through the utilization of Microsoft Office 365 software. The acquired quantitative sensory results, or sensory profiles, underwent analysis using ANOVA and Tukey's test (with a confidence level of 95%). This analysis considered factors such as wine type, assessor, and sensory session, along with their respective interactions. Principal Component Analysis (PCA) was performed using R version 4.03, when the $p<0.05$ the results regared as significant.

3 Results and Discussion

The panel successfully established sensory profiles for all 10 wines. To ascertain the sensory evaluation characteristics and distinctions between the two years, a PCA analysis was conducted. The outcomes of this analysis are presented in Figure 1.
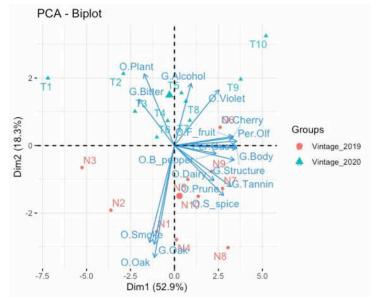

Fig. 1. PCA analysis of two vintages.

In Figure 1, the PCA illustrates the distribution of the wines. The first component accounts for 52.9% of the variance, while the second component explains 18.3%. Together, the PCA analysis captures a total of 71.2% it indicated that, the PCA analysis can explain most sensory characteristic.

The samples exhibit distinct differentiation based on their vintage, except for the T6 samples. Notably, significant variations in organoleptic properties emerge between the two vintages: the year 2020 displays more pronounced aromas of plant and violet, in the gustative aspect, the 2020 with more alcohol, whereas the year 2019 features stronger scents of aroma smoke and oak. Meanwhile, the taste of oak, tannin and sweet of spices also strong.

According to research by Yao Meiling et al.[8], the temperature in the growing season in 2020 is higher than that in 2019, resulting in higher alcohol content in the wines in 2020, reflecting the influence of natural factors on the terroir. In 2019, more oak taste reflects the influence of human factors (winemaking technology - the use of oak) on the terroir.

To illustrate the distinct attributes of the years 2019 and 2020, we have created radar charts depicting the two points nearest to the cluster center for each year. We have chosen eight key sensory characteristics for display on the radar charts.

For the T8 sample, a heightened intensity in G.alcohol is evident. Meanwhile, the T5 sample exhibits a notable prevalence of the O.Plant attribute. In the case of the N5 sample, distinct traits of G.Oak and G.Tannin are observable. Finally, the N10 sample showcases pronounced characteristics in O.Smoke, O.Oak, and O.S_spice.
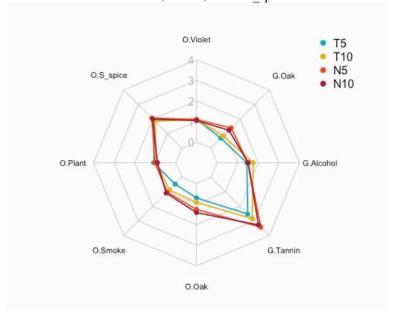

Fig. 2. Radar figure for two typical wines of each vintage

The ANOVA results are shown in Table 2. The factor wine resulted statistically significative (ANOVA and Tukey test, p = 95%)for all the 18 attributes.

Table 2. Formatting sections, subsections and sub-subsections.

2019									
O.F_fruit ***	N7[a]	N3[a]	N8[a]	N10[a]	N5[ab]	N9[ab]	N6[ab]	N2[ab]	N1[ab]	N4[b]

O.Oak***	N1^a	N9^a	N6^a	N8^a	N2^a	N4^a	N10^a	N3^a	N7^a	N5^b
G.Structure***	N3^a	N9^a	N7^a	N5^{ab}	N8^{abc}	N10^{abc}	N6^{abc}	N1^{abc}	N2^{bc}	N4^c
G.Body***	N3^a	N8^a	N7^{ab}	N10^{ab}	N9^{abc}	N5^{abc}	N6^{abc}	N1^{abc}	N2^{bc}	N4^c
G.Tannin***	N5^a	N7^a	N3^{ab}	N10^{ab}	N8^{abc}	N9^{abc}	N6^{abc}	N1^{abc}	N2^{bc}	N4^c
G.Oak***	N9^a	N6^a	N10^a	N4^a	N3^a	N1^a	N8^a	N2^a	N7^a	N5^b
Per.Gus***	N3^a	N5^a	N10^a	N9^a	N.8^a	N7^a	N1^{ab}	N6^{ab}	N2^b	N4^b
Per.Olf***	N3^a	N7^{ab}	N9^{ab}	N8^{abc}	N5^{abc}	N10^{abcd}	N1^{bcd}	N6^{bcd}	N2^{cd}	N4^d
2020										
O.F_fruit ***	T7^a	T3^a	T8^a	T10^a	T5^{ab}	T9^{ab}	T6^{ab}	T2^{ab}	T1^{ab}	T4^b
O.Violet*	T10^a	T4^{ab}	T9^{ab}	T2^{ab}	T8^{ab}	T5^{ab}	T6^{ab}	T1^{ab}	T3^b	T7^b
O.S_specie**	T9^a	T10^{ab}	T3^{abc}	T4^{abc}	T5^{abc}	T8^{abc}	T7^{abc}	T6^{abc}	T2^{bc}	T1^c
O.Dariy*	T10^a	T9^{ab}	T8^{ab}	T7^{ab}	T4^{ab}	T5^{ab}	T6^{ab}	T2^{ab}	T1^b	T3^b
O.Oak**	T3^a	T6^a	T4^{ab}	T8^{abc}	T1^{abc}	T2^{aTc}	T7^{abc}	T5^{abc}	T10^{bc}	T9^c
G.Structure***	T10^a	T9^{ab}	T8^{ab}	T7^{ab}	T5^{ab}	T6^{ab}	T3^{ab}	T4^{ab}	T2^b	T1^c
G.Body***	T10^a	T9^{ab}	T8^{ab}	T7^{ab}	T5^{ab}	T6^{ab}	T3^{ab}	T4^{ab}	T2^{ab}	T1^b
G.Tannin***	T9^a	T10^{ab}	T7^{ab}	T8^{ab}	T6^{ab}	T2^{ab}	T5^{ab}	T4^{bc}	T3^{bc}	T1^c
G.Oak***	T3^a	T4^a	T6^a	T7^{ab}	T1^{abc}	T8^{abc}	T2^{abc}	T5^{abc}	T9^{bc}	T10^c
Per.Gus***	T7^a	T3^a	T8^a	T10^a	T5^{ab}	T9^{ab}	T6^{ab}	T2^{ab}	T1^{ab}	T4^b
Per.Olf***	T10^a	T9^{ab}	T8^b	T7^{bc}	T4^{bc}	T6^{bc}	T5^{bc}	T3^{bc}	T2^{cd}	T1^d

*, **, *** significant at p<0.05, p < 0.01 and p < 0.001, respectively. Different letters indicate significant statistical differences with ANOVA and Tukey's test (p = 95%).

Table 2 reveals that out of the 18 descriptors in total, the characteristics showing significant differences in 2019 are primarily related to taste. Only Forest fruit and Oak exhibit noteworthy differences in aroma attributes, with Oak also displaying significant differences in taste. The aroma attributes attributed to forest fruit predominantly originate from grapes [9], while the sources of oak aroma and taste are more intricate. They stem mainly from the selection of diverse brewing methods and oak treatments, as outlined in the study [10].

In the year 2020, several prominent differences emerge both in aroma and taste. The pronounced divergence in the two aroma descriptors, Forest fruit and Oak, is more evident. Furthermore, besides Oak, Dairy – which indicates the fermentation by lactic acid bacteria [11] – also demonstrates a significant variance. This implies that, apart from oak treatment, slight differences in lactic acid bacteria fermentation treatment occurred in the winery during this year.

Additionally, this vintage exhibits substantial variation in aromas, particularly in the primary class aromas of O.Specie and Violet. This variability could potentially be attributed to diverse natural factors across various vineyards.

Both vintages exhibited distinctions in the descriptors of Forest fruit and oak aromas, thereby enabling the differentiation of aroma variations between the two years. In terms of taste, the two vintages demonstrated significant differences in four descriptors, excluding bitter and alcohol.

The analysis of the 20 samples unveiled that the two FN wine vintages, 2019 and 2020, did not display significant differences across eight descriptors: prune, cherry, black pepper, plant, smoke, bitter, and alcohol.

4 Conclusion

In conclusion, our comprehensive sensory analysis of 20 Fetească Neagră (FN) wines from the 2019 and 2020 vintages sheds light on the intricate interplay between vintage, aroma, and taste characteristics. The obtained results showcase discernible differentiations in aroma and taste profiles between the two years. Notably, the descriptors of Forest fruit and oak aromas emerge as key indicators of vintage disparities, offering a reliable means to distinguish aroma variations. In terms of taste, significant differences were observed in four descriptors, underscoring the nuanced variations that can arise within different vintages.

Interestingly, certain descriptors, such as prune, cherry, black pepper, plant, smoke, bitter, and alcohol, exhibited consistent qualities across both vintages, signifying their stability regardless of the specific year. These findings highlight the significance of such attributes as consistent markers in the FN wines' sensory profiles.

Our study also underscores the multifaceted nature of wine production, where factors like oak treatment, lactic acid bacteria fermentation, and natural influences play pivotal roles in shaping the sensory characteristics of the final product. These insights can contribute to informed decision-making in winemaking processes to achieve desired flavor profiles.

In essence, this research not only deepens our understanding of how different elements contribute to the sensory attributes of FN wines but also underscores the importance of considering these aspects in both viticulture and winemaking practices. As the wine industry continually evolves, such studies serve as valuable guides for producers seeking to maintain the integrity and distinctive character of their wines across varying vintages.

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