Available on IVES Conference Series vine & wine

DOI : https://doi.org/10.58233/KygMxe8t

The potential of new selection and indigenous grape varieties for sparkling wine production

Boris Morari[1], Nicolae Taran[1], Olga Soldatenco[1], Ana Soltan[1], Pavel Glavan[1], Vasile Sandu[1]

[1] PI National Institute for Applied Research in Agriculture and Veterinary Medicine, Republic of Moldova.

Abstract. In the context of climate change, it is essential to provide producers with alternatives based on local grape varieties capable of meeting modern quality and sustainability requirements. In this regard, researchers in the Republic of Moldova aim to study and promote the potential of indigenous and new selection grape varieties for high-quality sparkling wine production.

The study was conducted during the 2020-2023 period. Its objective was to assess the oenological potential of indigenous and new selection grape varieties for sparkling wines production with advanced foaming and perlage properties. The research focused on new selection grape varieties Viorica, Floricica, Riton, Legenda, and the indigenous grape variety Plavaie.

Using these grape varieties, experimental wine blends were produced under microvinification conditions. The foaming indices of the base wines were determined using the Mosalux system, while the composition of aromatic compounds was analyzed using the GC-MS method on a Shimadzu system. The experimental batches of blended wines from local grape varieties were fermented with selected Saccharomyces strains from the institute's collection. The secondary fermentation was carried out in the bottle, and after nine months of maturation, the sparkling wines were subjected to physicochemical analyses.

The analysis of foaming indices demonstrated that sparkling wines produced from new selection varieties Viorica and Floricica exhibited high foaming capacity. Additionally, blends incorporating wines obtained from the indigenous variety Plavaie showed foaming indices 10-20% higher, which positively influenced the perlage and foaming properties of the final sparkling wines.

The addition of wine from the indigenous Plavaie variety in blends with Viorica and Floricica improved the volatile aromatic profile and complexity of the sparkling wines. The increase in certain aromatic components contributed to enhancing the olfactory profile and organoleptic perception of wines.

This study demonstrated the potential of using wines from new selection varieties Viorica, Floricica, Riton, and Legenda in combination with the indigenous variety Plavaie in the context of climate change and rising average temperatures. Plavaie-based wine is distinguished by its neutral aroma, fresh taste, and advanced foaming potential, making it a valuable blending partner due to its high titratable acidity and lower alcohol content.

Thus, the study confirms the perspective of producing white sparkling wines based on new selection varieties Viorica and Floricica, along with Plavaie wine in blends, contributing to the diversification and increased competitiveness of Moldovan sparkling wines on international markets.

1. Introduction

In the current context of viticulture, there is a growing need to valorize both indigenous and newly selected grape varieties in the development of sparkling wines. Beyond adaptation to climate change [12], these varieties offer the potential to individualize local wine styles by contributing unique aromatic profiles, improved technological suitability, and enhanced sustainability [1010].

This research, conducted between 2020 and 2023, focused on the oenological evaluation of several Moldovan grape varieties for sparkling wine production, both in single-varietal vinification and in blends. The primary objective was to assess the performance of these varieties under realistic production conditions, considering their aromatic composition, organoleptic characteristics, and technological behavior during the sparkling process—

specifically through instrumental determinations of foaming parameters.

Experimental batches of sparkling wines were produced based on the enological potential of each selected grape variety. Among them, Viorica was chosen for its intense aroma with characteristic notes of basil and flowers, contributing to a complex and attractive aromatic profile in sparkling wines. Floricica stood out for its fine floral aroma and delicate structure, enhancing elegance in blends. Riton, a high-yielding and disease-resistant variety, exhibited a neutral aromatic profile with subtle melon notes. Legenda displayed a distinctive aromatic expression dominated by rose blossom, suitable for creating sparkling wines with pronounced personality [1, 9].

In addition, the indigenous Moldovan grape variety Plavaie proved to be a valuable blending partner due to its high natural acidity and moderate sugar accumulation. In the context of global warming, which accelerates sugar accumulation in grapes, Plavaie offers technological benefits by contributing freshness, lower alcohol levels, and improved foaming stability [1].

The study aims to highlight the oenological value of these grape varieties in sparkling wine production, with an emphasis on the authenticity, adaptability, and identity of the local grape material.

2. Materials and Methods

2.1. Grape Material and Vineyard Conditions

The study was conducted during the 2020–2023 period at the National Institute for Applied Research in Agriculture and Veterinary Medicine, Republic of Moldova. Grapes were harvested from an experimental vineyard located on the southern slope of the Codru region, in the southern area of Chișinău municipality. The following grape varieties were used: Viorica, Floricica, Riton, Legenda (newly selected), and Plavaie (indigenous). Grapes were harvested at technological maturity based on sugar content, titratable acidity, and pH.

2.2. Climatic Conditions

The 2020 and 2021 growing seasons in the Codru winegrowing region of the Republic of Moldova were marked by notable climatic contrasts that influenced the ripening dynamics and quality of grape material used for sparkling wine production. In 2020, the season was relatively cool and balanced, with moderate temperatures and well-distributed precipitation, which favored gradual sugar accumulation and preservation of titratable acidity. The sum of active temperatures (≥10 °C) recorded for 2020 was approximately 3007 °C, indicating a temperate growing season that supported the development of aromatic profiles and structural acidity in grapes [3].

In contrast, the 2021 vintage was characterized by above-average air temperatures, earlier onset of véraison, and limited rainfall during ripening, conditions that led to a more accelerated accumulation of sugars and a slight decrease in titratable acidity. The sum of active temperatures for 2021 reached 3416 °C, exceeding the multiyear average for the region, and reflecting the warmer and drier nature of the season. These climatic conditions highlighted the technological importance of high-acidity, low-sugar grape varieties such as Plavaie, which contributed to balancing freshness and maintaining foam stability in the final sparkling wine blends [4].

2.3. Vinification of Base Wines

All grapes were processed under microvinification conditions. For the aromatic varieties (Viorica, Floricica, Legenda), the must underwent a 4-hour skin contact maceration with enzymatic treatment (Zimopec PML at 0.3 mL/hL), followed by gentle pressing (up to 50 dal/t) and static clarification with Trenolin Opti DF (0.3 g/hL). For the neutral varieties (Riton and Plavaie), no maceration was applied.

The clarified musts were fermented with active dry yeast Oenoferm Freddo (2–3 g/hL) at 12–14 °C, with the addition of fermentation nutrients: Ecobiol Pied de Cuve (1–2 g/hL) and Actibiol (0.2–0.3 g/hL). After fermentation, the wines were racked, cold-stabilized, and stored at 11–12 °C prior to use in sparkling wine production [6].

2.4. Physicochemical and Aroma Analysis

Base wines from the 2020 and 2021 harvests were analyzed for the following parameters:

General physicochemical parameters: alcohol content, residual sugar, titratable and volatile acidity, pH, total and free SO_2, glycerol, and dry extract were determined according to OIV official methods [5, 8].

Organic acids: The content of tartaric, malic, citric, succinic, lactic, and oxalic acids was determined using the capillary electrophoresis system "Kapel" [11].

Conductivity and total soluble salts: Measurements were performed using a Mettler Toledo MC 226 conductometer [5, 7].

Volatile compounds: Volatile aroma compounds were extracted using diethyl ether. Quantification was performed by the internal standard method using n-pentanol. Extracts were analyzed on a Shimadzu GC-MS QP2010S system in SCAN mode, using a capillary column Rtx-5MS (30 m × 0.25 mm, 0.25 μm film thickness). Compound identification was carried out by matching the mass spectra with the NIST08.LIB spectral library, selecting the most intense ion fragments for each compound [2].

2.5. Tirage Blend Design

Based on the results of physicochemical and foaming analysis, six experimental tirage blends were created in

2021 to evaluate the enological behavior of each variety and their combinations:

All tirage blends were bottled in 0,75 L sparkling bottles and inoculated with Saccharomyces cerevisiae strain No. 81 from the institute's collection. The secondary fermentation was conducted in bottles according to the traditional method, followed by a 9-month aging on lees in the underground cellar at 12–13 °C [6].

2.6. Foaming and Sensory Evaluation

Foaming parameters (maximum foam height, foam stability height, and collapse time) were measured using the Mosalux system at 20 °C, with a CO_2 flow of 7 L/h and 10-minute analysis time.

Sensory evaluation of both base and sparkling wines was conducted by the Tasting Commission of INCAAMV.

3. Results and Discussion

3.1. General Oenological Characteristics of Base Wines (2020–2021)

The general oenological parameters of the experimental base wines obtained from the 2020 and 2021 harvests are presented in Table 1. These parameters provide an essential foundation for assessing the technological suitability of the wines for secondary fermentation and sparkling wine production.

Table 1 illustrates differences in pH, ethanol concentration, residual sugars, titratable and volatile acidity, and free/total sulfur dioxide content across the five studied varieties.

Table 1. General physicochemical parameters of white wines from local grape variety's (h.y. 2020–2021).

Variety	*Vintage*	*pH*	*Alcohol (% vol.)*	*Residual Sugar (g/dm³)*	*Titratable Acidity (g/dm³)*	*Volatile Acidity (g/dm³)*	*Total/Free SO_2 (mg/dm³)*
Riton	2020	3,05	12,7	3,4	6,8	0,53	150/50
	2021	3,31	12,4	3,4	8,5	0,59	105/23
Floricica	2020	3,00	12,2	7,4	7,4	0,60	157/44
	2021	3,11	13,1	4,1	8,8	0,59	109/29
Legenda	2020	3,02	11,1	2,0	6,1	0,60	154/38
	2021	3,27	12,7	0,5	8,2	0,46	100/32
Viorica	2020	3,07	12,7	4,0	6,9	0,46	129/45
	2021	3,19	11,4	0,4	8,6	0,46	132/37
Plavaie	2021	3,10	9,9	0,4	9,0	0,46	115/29

Standard analytical error: pH ±0.02; Alcohol ±0.1% vol.; Residual sugars ±0.2 g/dm³; Titratable acids ±0.1 g/dm³; Volatile acids ±0.02 g/dm³; SO_2 (total/free) ±5 mg/dm³.

Wines from Viorica and Floricica grape variety displayed favorable profiles in both vintages, with balanced alcohol concentrations (11.4–13.1% vol.), low residual sugar (0.4–4.1 g/dm³), and consistently high titratable acidity (6.9–8.8 g/dm³), indicating their potential as primary varietals in sparkling wine blends. Wines from Plavaie grape variety, evaluated only in 2021, was distinguished by the lowest alcohol content (9.9% vol.) and the highest titratable acidity (9.0 g/dm³), suggesting its value as a blending component for adjusting structural freshness and maintaining balance in cuvées.

Wines from Riton and Legenda grape variety showed greater variability between vintages, with Riton reaching a higher pH value of 3.31 and Legenda displaying notable differences in sugar content and acidity across the two years. These fluctuations may reflect differences in harvest maturity and climatic conditions and suggest a more limited application as standalone base wines.

Across all samples, volatile acidity ranged from 0.46 to 0.60 g/dm³, within acceptable limits. Total and free sulfur dioxide levels were maintained within the typical ranges for sparkling wine base production, ensuring adequate protection from oxidative degradation. The pH values, spanning from 3.00 to 3.31, support good microbial stability, though slightly elevated values in wines from Riton and Legenda grape variety may reduce foam persistence and freshness in bottle-fermented sparkling wines.

To further evaluate the freshness potential and structural acidity of the base wines, the concentration of major organic acids was determined. For a more comprehensive varietal assessment, six key acids—tartaric, malic, citric, succinic, lactic, and oxalic—were identified and quantified. The results are presented in Table 2

Table 2. Concentration of organic acids in white wines from local grape variety's (h.y. 2020–2021).

Grape Variety	Year	Tartaric acid, g/dm³	Malic acid, g/dm³	Citric acid, g/dm³	Succinic acid, g/dm³	Lactic acid, g/dm³	Oxalic acid, g/dm³
Viorica	2020	4.24	1.33	0.36	0.80	0.21	0.42
	2021	4.06	2.82	0.30	0.52	0.19	0.22
Floricica	2020	5.45	0.91	0.19	0.71	0.27	0.38
	2021	3.95	2.26	0.10	0.72	0.13	0.24
Riton	2020	4.60	1.02	0.25	0.92	0.22	0.56
	2021	2.92	3.21	0.28	0.78	0.13	0.19
Legenda	2020	3.79	0.51	0.12	0.86	0.22	0.38
	2021	4.50	2.30	0.26	0.60	0.20	0.18
Plavaie	2021	3.90	3.71	0.18	0.39	0.10	0.17

Standard analytical error: ±0.05 g/dm³ for each acid.

The data show that tartaric acid was the dominant acid in all samples, with the highest levels in wines from Floricica (2020) and Riton (2020) grape variety, suggesting strong structural support. In contrast, wines from Legenda and Plavaie grape variety had lower tartaric values.

Malic acid content varied significantly between vintages, being higher in 2021, especially in wines from

Plavaie (3.71 g/dm³) and Viorica (2.82 g/dm³) grape variety, which enhances freshness and acidity. Succinic acid remained stable across all varieties, while citric and oxalic acids were present in small but consistent amounts. Low lactic acid values confirmed the absence of malolactic fermentation.

Overall, wines from the 2021 harvest, particularly those from Plavaie and Viorica grape variety, showed higher freshness potential due to elevated malic and total acid content. This highlights their suitability for sparkling wine production.

The concentrations of glycerol and non-reducing extract are critical indicators of the textural and structural quality of base wines. Glycerol contributes to the body and mouthfeel, while the non-reducing extract reflects the wine's dry matter content, influencing persistence and foam stability in sparkling wine production. Figure 1 presents the comparative values of these parameters across the 2020 and 2021 vintages for the studied varieties.

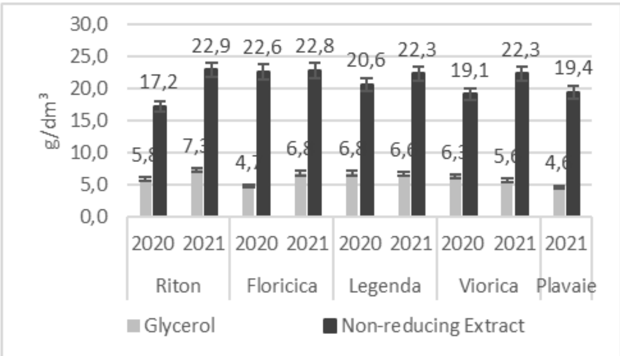

Figure 1. Glycerol and Non-Reducing Extract Concentrations in white wines from local grape variety's (h.y. 2020–2021).

Across the two vintages, wines from Riton and Floricica grape variety showed the most pronounced increases in glycerol content, reaching 7.3 and 6.8 g/dm³ in 2021, respectively, suggesting a more active or prolonged fermentation. Legenda exhibited consistent glycerol levels (~6.6–6.8 g/dm³), indicating varietal stability.

In terms of non-reducing extract, all wines recorded values above 19 g/dm³, with the highest concentrations found in Floricica and Viorica (22.8 and 22.3 g/dm³ in 2021), enhancing body and potential foam stability. Plavaie, evaluated only in 2021, had the lowest levels of both glycerol (4.6 g/dm³) and extract (19.4 g/dm³), supporting its role as a freshness-enhancing partner rather than a structure-contributing base.

These results confirm the suitability of Floricica and Riton for use in sparkling wine bases requiring texture and richness, while Plavaie's modest extract composition may reinforce its balancing function in blends.

Electrical conductivity and total soluble salts are important physicochemical indicators reflecting the mineral composition and ionic strength of wines. These parameters influence not only the stability and aging potential of sparkling wines but also their gustatory perception—particularly mouthfeel and minerality.

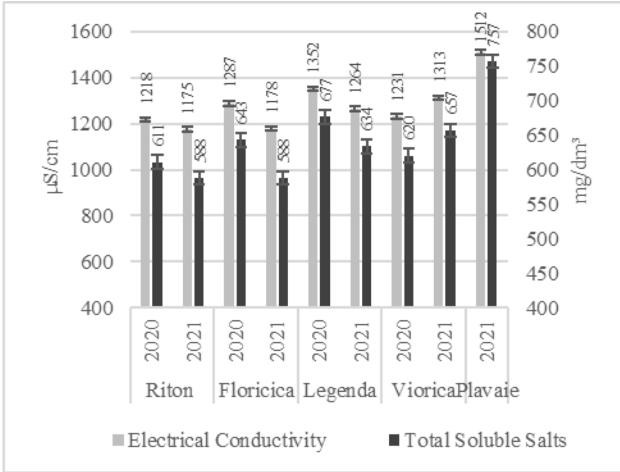

Figure 2. Electrical Conductivity and Total Soluble Salts in white wines from local grape variety's (h.y. 2020–2021).

Legenda and Floricica wines from 2020 showed the highest electrical conductivity values (1352 and 1287 μS/cm, respectively), indicating a rich ionic profile which can enhance wine mouthfeel and contribute to a more expressive texture. However, a moderate decrease in conductivity was observed in 2021 for most varieties, likely due to climatic conditions affecting nutrient uptake.

Wines from Plavaie grape varaety, analyzed only for 2021, registered the highest values of both electrical conductivity (1512 μS/cm) and total soluble salts (757 mg/dm³), which supports its classification as a structurally stabilizing variety, despite its low alcohol level. These findings reinforce its value in blends for improving mineral balance and potential foam stability.

In contrast, wines from Riton grape variety showed the lowest levels of salts and conductivity, which—combined with its higher pH and lower acidity—may indicate a comparatively lower structural complexity for sparkling wine production.

Foaming properties of white wines obtained from the studied local grape varieties were determined using the Mosalux system. The results, which reflect the wines' capacity to generate and stabilize foam, are presented in Figure 3.

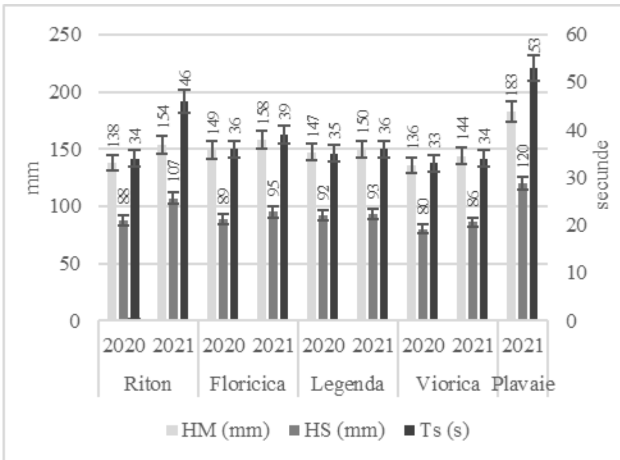

Figure 3. Foaming Properties of white wines from local grape variety's (h.y. 2020–2021).

According to the obtained results, among all samples, wines from Plavaie grape variety (2021) exhibited the most advanced foaming behavior, with a maximum foam height of 183 mm, foam stability height of 120 mm, and the longest foam stability time (53 seconds). These outstanding parameters justify its use as a blending partner to enhance foam persistence and structure in sparkling wine production.

Wines from Floricica grape variety showed the most consistently high foaming values among the new selection varieties, particularly in 2021, where they reached 158 mm in maximum foam height and 39 seconds of stability time, indicating strong potential as a primary varietal for sparkling wine production.

Wines from Viorica grape variety presented moderate foaming performance, with slightly lower values across both vintages, though still within the range suitable for sparkling wine bases.

Wines from Legenda and Riton grape varieties, while showing acceptable results in 2021, exhibited less consistent foaming indices across vintages. For instance, wines from Riton grape variety recorded an increase in foam height from 138 mm in 2020 to 154 mm in 2021, yet overall performance remained behind that of Floricica and Plavaie.

Overall, these results highlight the synergistic role of wines from Plavaie grape variety in improving foam characteristics when blended with aromatic varieties from new selections, especially under warmer climatic conditions that may compromise acidity and protein-related foam stability.

To complement the physicochemical and foaming evaluations, a sensory analysis of the base wines obtained from the 2020 and 2021 harvests was conducted. This assessment aimed to determine the varietal expression, aromatic typicity, and overall harmony of each wine, as these attributes are critical for defining the aromatic complexity and balance of the future sparkling wines.

The wines were evaluated by the trained tasting panel using the 100-point scoring system. Results are presented in Tabel 3.

Table 3. Sensory Evaluation of white wines from local grape variety's (h.y. 2020-2021).

Grape Variety	2020 Description	2020 Score	2021 Description	2021 Score
Riton	Pale green color, clean typical aroma with melon nuance; taste: clean, full, fresh, slightly acidic.	79.2	Pale green color, clean, complex, floral aroma with melon notes; taste: clean, fresh, floral.	80.2
Floricica	Pale green color, clean aroma with tropical and basil nuances; taste: clean, fresh, full.	79.7	Pale green color, clean, complex, fine, tropical aroma; taste: full, clean, harmonious, aromatic.	81.4
Legenda	Pale yellow color, neutral aroma with yeast notes; taste: fresh, simple, acidic, watery.	78.3	Pale green color, clean, floral aroma with rose nuance; taste: clean, balanced, full, harmonious.	80.6
Viorica	Pale green color, clean floral aroma with basil nuance; taste: clean, full, extractive.	80.6	Pale green color, clean, intense floral aroma with basil; taste: clean, fresh, slightly acidic.	80.5
Plavaie	—	—	Pale green color, clean, typical floral aroma; taste: clean, acidic, low extract.	80.4

Scores are presented on a 100-point scale. Standard error of sensory panel evaluations: ±1.0 point.

The sensory data presented in Table 3 show relatively consistent results across the two vintages. Viorica and Floricica stood out for their complex aromatic profiles and harmonious taste, with scores exceeding 80 points in both years. Floricica, in particular, improved its aromatic complexity in 2021, reflecting favorable climatic conditions and higher extract concentration.

Riton, while showing a clean and fresh profile, was slightly behind in overall intensity and balance, scoring 79.2 in 2020 and 80.2 in 2021. Legenda showed a notable increase in quality from 2020 to 2021, where the wine shifted from a neutral and dilute profile to a more expressive, rose-scented character.

The inclusion of Plavaie in the 2021 tasting confirmed its enological value as a varietal with clean, typical floral notes and a fresh, crisp taste, although its light body may limit its use as a standalone base wine.

Overall, the results reinforce the superior sensory potential of Viorica and Floricica, while highlighting the utility of Plavaie as a freshness-enhancing blending partner.

3.2. Optimization of Blends for Sparkling Wine Production from local grape variety's (h.y 2021)

Based on the analytical and sensory evaluation of the base wines produced in 2021, it was concluded that the grape variety Legenda had a comparatively lower suitability for sparkling wine production. Its higher pH values, reduced foam stability, and less expressive sensory profile justified its exclusion from further blending experiments.

In laboratory conditions, were formulated 12 experimental blends using wines from the newly selected grape varieties Floricica, Viorica, and Riton, each combined with the indigenous grape variety Plavaie, which served as a blending partner. The results of these evaluations are summarized in Table 4.

Table 4. Sensory Scores and Foaming Indices of Experimental Blends Based on wines from local grape varaety (h.y. 2021)

№	Blend Composition	Ratio (%)	Sensory Score	Max Foam Height (mm)	Foam Stability Height (mm)	Foam destruction Time (s)
1	Floricica + Plavaie	50:50	79.8	197	48	28
2	Floricica + Plavaie	60:40	80.1	162	38	26
3	**Floricica + Plavaie**	**70:30**	**81.0**	**195**	**45**	**27**
4	Floricica + Plavaie	80:20	81.0	162	36	25
5	Viorica + Plavaie	50:50	79.6	145	46	25
6	Viorica + Plavaie	60:40	79.6	140	46	26
7	**Viorica + Plavaie**	**70:30**	**79.8**	**138**	**47**	**26**
8	Viorica + Plavaie	80:20	80.3	107	43	26
9	**Riton + Plavaie**	**50:50**	**79.4**	**162**	**44**	**25**
10	Riton + Plavaie	60:40	80.1	160	50	42
11	Riton + Plavaie	70:30	79.7	162	47	27
12	Riton + Plavaie	80:20	79.5	162	49	28

Standard error of sensory panel evaluations: ±1.0 point. standard deviation for: (HM): ±2.5 mm, (HS): ±1.8 mm, (TS): ±1.6 sec.

The data presented in Table 4 provide a detailed overview of the sensory and foaming characteristics of experimental blends composed of newly selected grape varieties (Floricica, Viorica, Riton) and the indigenous Plavaie (harvest year 2021).

Blends based on Floricica displayed consistently favorable results. The 70:30 Floricica:Plavaie combination obtained the highest sensory score (81.0 points) and a high maximum foam height (195 mm), with good foam stability (45 mm, 27 s). This ratio ensured an expressive floral profile with enhanced structural freshness and foaming capacity.

Viorica-based blends, particularly at the 70:30 ratio, reached 79.8 points and demonstrated solid foaming behavior (138 mm maximum foam height, 47 mm stability), confirming the variety's suitability when balanced with Plavaie to moderate acidity and enhance texture.

Riton + Plavaie blends demonstrated a notable improvement in foaming properties, especially at the 50:50 ratio, which resulted in the highest maximum height (162 mm) and excellent foam stability (44 mm, 25 s). Although the 60:40 blend recorded a slightly higher sensory score (80.1 points), the 50:50 blend proved to be the most effective in enhancing the foaming performance of Riton-based wines. This suggests that Plavaie plays a crucial technological role as a blending partner to compensate for Riton's lower natural acidity and to improve its suitability for sparkling wine production.

Overall, the inclusion of Plavaie significantly contributed to the modulation of both acidity and foam behavior across all blends. Based on the data, the optimal blending ratios were determined as 70:30 for Floricica + Plavaie, 70:30 for Viorica + Plavaie, and 50:50 for Riton + Plavaie, specifically for improving foam formation and stability.

Based on the results obtained from the evaluation of base wines and experimental blends, six tirage blends were designed in 2022 using wines from the 2021 harvest. The objective was to validate, under real conditions, the oenological suitability of new selection varieties (Floricica, Viorica, Riton, Legenda) and the indigenous variety Plavaie for bottle-fermented sparkling wine production.

Three blends were formulated with Plavaie as a blending partner, selected due to its high acidity and moderate alcohol content, to enhance structural freshness and improve foaming properties:

- Tirage Blend №1: Floricica (70%) + Plavaie (30%): With Ethanol concetration: 11.40% vol. and sugar content: 21.1 g/dm³.
- Tirage Blend №2: Viorica (70%) + Plavaie (30%) With ethanol concentration: 10.90% vol. and sugar content: 20.8 g/dm³.
- Tirage Blend №3: Riton (50%) + Plavaie (50%): With ethanol concentration: 11.21% vol. and sugar content: 21.5 g/dm³.

Although the Legenda variety was excluded from the earlier blending optimization due to its lower base wine potential, was created complementary blend (№4)— Legenda (50%) + Plavaie (50%), with ethanol concentration: 11.01% vol. and sugar content: 21.0 g/dm³— to complete the experimental series.

Additionally, two monovarietal tirage blends were assembled:

- Tirage Blend №5: Floricica (100%) – to assess its full varietal potential.
  With ethanol concentration: 12.70% vol. and sugar content: 22.0 g/dm³.
- Tirage Blend №6: Viorica (100%):

With ethanol concentration: 11.20% vol. and sugar content: 20.9 g/dm³ – to evaluate the standalone performance of this aromatic cultivar.

All tirage blends were bottled in 75 cl bottles and inoculated with yeast strain №81 from the INCAAMV Collection of Oenological Microorganisms. The secondary fermentation was carried out at 10–12 °C in the institute's underground cellar.

Physicochemical indices of the tirage blends confirmed their suitability for sparkling wine production, with alcohol levels ranging from 10.9% to 12.8% vol., titratable acidity between 7.5–7.7 g/dm³, and pH values from 3.05 to 3.28. Volatile acidity and sulfur dioxide levels remained within acceptable oenological limits.

3.3. Evaluation of sparkling wines produced from the new selection grape varieties Viorica, Floricica, Legenda, Riton and the indigenous grape variety Plavaie after secondary fermentation.

After secondary fermentation and 9 months of maturation, the sparkling wines were analyzed to assess changes in alcohol content, acidity, sugar consumption, and CO_2 pressure (Table 5). The increase in alcohol content by 1.2–1.5% vol confirms complete secondary fermentation. A noticeable pressure increase (520–580 kPa) was also recorded across all samples, indicating proper carbonation and yeast activity.

Table 5. Physicochemical parameters of sparkling wines based on wines from local grape varaety after 9 months of maturation in bottle (h.y. 2021)

Blend №	Alcohol (% vol)	Residual sugars (g/dm³)	Titratable acidity (g/dm³)	Volatile acidity (g/dm³)	pH	Pressure (kPa)
№ 1	12.7	1.2	7.5	0.58	3.21	520
№ 2	12.2	1.2	7.4	0.54	3.25	540
№ 3	12.4	0.8	7.6	0.59	3.26	530
№ 4	12.3	1.0	7.6	0.60	3.20	570
№ 5	13.7	1.3	7.5	0.59	3.22	580
№ 6	12.5	1.1	7.4	0.54	3.24	570

Standard errors: ±0.1% vol (alcohol), ±0.1 g/dm³ (sugars and titratable acidity), ±0.01 g/dm³ (volatile acidity), ±0.01 (pH), ±10 kPa (pressure).

Analysis of data from Table 5 reveals that the residual sugar concentration decreased significantly from 20.8–22.0 g/dm³ prior to secondary fermentation to 0.8–1.3 g/dm³ in the final sparkling wines, confirming that the secondary fermentation was successfully completed. As a result of this fermentation, internal bottle pressure increased to values ranging from 520 to 580 kPa, and the ethanol concentration rose by approximately 1.0–1.5% vol, depending on the composition of the tirage blends.

The titratable acidity showed a slight decrease of 0.1 g/dm³ in blends No. 1 and No. 2, 0.2 g/dm³ in blends No. 5 and No. 6, and remained unchanged in blends No. 3 and No. 4. No significant changes were observed in pH values or volatile acidity, indicating the overall chemical stability of the wines and the controlled nature of the fermentation process.

For the determination of foaming indices, the sparkling wines were first degassed and then analyzed using the Mosalux installation under controlled conditions. The results are presented in Figure 4.

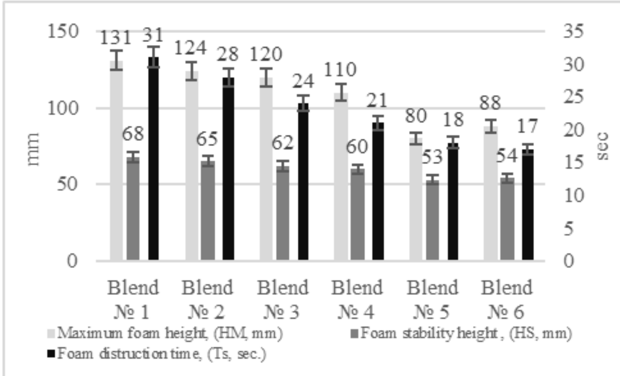

Figure 4. Foaming properties of sparkling wines based on wines from local grape varaety after 9 months of maturation in bottle.

Presented data, highlight significant differences in the foaming capacity of the six sparkling wine samples. The blends containing the local variety Plavaie showed clearly improved foaming performance compared to their respective monovarietal (control) counterparts.

Sparkling Wine №1 (Floricica 70% + Plavaie 30%) exhibited the highest overall foaming performance, with a maximum foam height (HM) of 131 mm, foam stability height (HS) of 68 mm, and foam stability time (Ts) of 31 seconds. This represents a notable increase compared to the control wine based solely on Floricica (№5), where HM reached only 80 mm and Ts was 18 seconds.

Similarly, Sparkling Wine №2 (Viorica 70% + Plavaie 30%) achieved better results (HM: 124 mm; Ts: 28 s) compared to the Viorica control sample (№6), which registered lower values (HM: 88 mm; Ts: 17 s).

The inclusion of Plavaie also improved the foaming performance in Sparkling Wine №3 (Riton 50% + Plavaie 50%), which surpassed the performance of monovarietal Riton base wines observed during previous screening phases. Conversely, Sparkling Wine №4 (Legenda 50% + Plavaie 50%) displayed the lowest enhancement among the blends, though it still surpassed the control wines in HM and HS.

Overall, the results emphasize the positive contribution of the Plavaie variety as a blending partner for improving foam structure and stability in traditional method sparkling wines, especially when used with aromatic or neutral new selection varieties.

To characterize the aromatic potential of the sparkling wines obtained from new selection grape varieties and the indigenous variety Plavaie, volatile compounds were extracted using diethyl ether and quantified by GC-MS with n-pentanol as an internal standard. The main identified compounds include higher alcohols (isopropanol, n-propanol, isobutanol, isoamyl alcohol), ethyl acetate, methyl alcohol, and acetaldehyde. The results are presented in Table 3.

Table 5. Volatile compound content and sensory evaluation of sparkling wines based on wines from local grape varaety after 9 months of maturation in bottle (h.y. 2021)

Blend	№ 1	№ 2	№ 3	№ 4	№ 5	№ 6
Isopropanol	6.2	2.8	10.2	2.8	4.4	2.5
2-Butanol	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1
n-Propanol	20.0	19.6	15.3	16.9	18.5	20.6
Isobutanol	30.6	27.3	29.3	26.0	30.6	29.4
n-Butanol	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1
Isoamyl alcohol	191.6	168.1	198.1	196.7	230.2	123.5
Methyl alcohol	28.8	27.8	38.6	23.8	33.0	28.8
Acetaldehyde	82.9	92.4	84.1	106.3	83.3	97.8
Ethyl acetate	57.1	45.0	61.7	62.4	64.5	50.4
Sensory score *(100 pt)*	**82.3**	**82.5**	**81.6**	**81.2**	**80.9**	**81.6**

Standard errors: ±0.2 mg/dm³ for major volatile alcohols (isopropanol, n-propanol, isobutanol, isoamyl alcohol, methyl alcohol, acetaldehyde, ethyl acetate), ±0.05 mg/dm³ for 2-butanol and n-butanol (below quantification threshold), ±1,0 points for sensory evaluation score.

The data presented in Table 6 reveal that the sparkling wines, after 9 months of maturation, exhibit generally low concentrations of isopropanol, ranging from 2.5 to 4.4 mg/dm³ in most samples. An exception was noted in Blend №1 (Floricica 70% + Plavaie 30%), where isopropanol reached 6.2 mg/dm³, and in Blend №3 (Riton 50% + Plavaie 50%), where the highest concentration of 10.2 mg/dm³ was recorded.

The 2-butanol content in all samples remained below the detection threshold of the analytical method (<0.1 mg/dm³), indicating its negligible contribution to the volatile profile. Wines produced from Floricica as a monovarietal (Blend №5) and in Blend №1 presented the highest levels of n-propanol, isobutanol, and ethyl acetate, suggesting a more pronounced aromatic intensity and complexity. These samples also had relatively lower concentrations of methyl alcohol and acetaldehyde, indicating a clean and well-managed fermentation process.

Blends №2 and №6 (based on Viorica) were characterized by slightly higher concentrations of n-propanol and acetaldehyde, with lower levels of isobutanol, isoamyl alcohol, and the lowest ethyl acetate and methyl alcohol content among all analyzed sparkling wines. This supports the varietal typicity of Viorica, which is defined by fresh floral and basilic aromas, and confirms its controlled fermentation behavior.

Sparkling wine from Blend №3 (Riton + Plavaie) had the lowest n-propanol concentration (15.3 mg/dm³) but exhibited the highest levels of methyl alcohol (38.6 mg/dm³) and isoamyl alcohol (198.1 mg/dm³), reflecting a more vigorous fermentation and potentially higher fermentation by-product formation. Despite this, the wine maintained clean aromatic characteristics and a balanced structure.

Blend №4 (Legenda + Plavaie) was distinguished by the highest concentration of acetaldehyde (106.3 mg/dm³), along with elevated values of isoamyl alcohol and ethyl acetate, while having the lowest methyl alcohol concentration (23.8 mg/dm³). Although showing improved foam indices, its volatile profile suggests a simpler and less refined aromatic composition compared to other blends.

Importantly, n-butanol remained below 0.1 mg/dm³ in all samples, confirming that its impact on the aroma was negligible and consistent across the wines.

The sensory evaluation showed that Blend №1 and Blend №2 received the highest scores—82.3 and 82.5 points, respectively—surpassing the monovarietal sparkling wines made solely from Floricica and Viorica (scores of 80.9 and 81.6). These two blends were appreciated for their long-lasting perlage, expressive and clean floral aromas, and harmonious, well-structured taste profiles with excellent CO_2 integration.

Blend №3 (Riton + Plavaie) was described as having a pale straw color, intense mousse, subtle floral notes, and a clean, fresh taste with good CO_2 integration, achieving a score of 81.6 points. Although not the highest scoring wine, its balance and aromatic clarity confirmed the improvement brought by blending Riton with Plavaie.

Blend №4 (Legenda + Plavaie) received the lowest score among the blends (81.2), though still within the high-quality range. It was noted for its pale straw color, moderate mousse, clean but simple aroma with faint rose notes, and a fresh, straightforward taste with well-integrated CO_2.

4. General Conclusions

The main objective of this study was to evaluate, during the 2020–2023 period, the potential of several grape varieties—newly selected (Viorica, Floricica, Riton, and Legenda) and the indigenous Plavaie—for the production of white sparkling wines by the traditional method.

The research was carried out at the Scientific-Practical Institute of Horticulture and Food Technologies (currently INCAAMV), within the framework of the State Project 20.80009.5107.05, and finalized in 2024 under the Institutional Program 200101, which focuses on the development of local grape varieties and modern winemaking technologies.

The results showed that wines obtained from Viorica and Floricica stand out through their aromatic richness, freshness, and good foaming capacity, making them suitable as base wines for sparkling production. The indigenous variety Plavaie, due to its high natural acidity, moderate alcohol content, and very good foam formation, proved to be an excellent blending partner.

Blending Plavaie with Floricica, Viorica, or Riton improved the sensory qualities and foaming indices of both the base wines and the final sparkling wines. The best results were obtained in blends with 70–50% of the new varieties and 30–50% Plavaie, which recorded higher organoleptic scores and improved stability of foam after secondary fermentation.

As a result of these findings, the experimental blends based on Floricica + Plavaie, Viorica + Plavaie and Riton + Plavaie were patented. These blends represent promising technological solutions for the production of high-quality sparkling wines with local identity and enhanced competitiveness on international markets.

5. References

1. N. Taran, *Soiuri de struguri de selectie noua si autohtone in vinificatie*, Print Caro, Chisinau (2022), pag. **9-16**.
2. E. Scorbanov, N. Taran, I. Ponomariova, N. Degteari, P. Rinda, E. Efremov, *Complexul aromatic al vinurilor albe seci din soiuri de struguri de selectie noua prin metoda GC-MS*, Institutul Stiintifico-Practic de Horticultura si Tehnologii Alimentare, Chisinau (2023), pp. **34–37**.
3. Serviciul Hidrometeorologic de Stat al Republicii Moldova, *Conditiile meteorologice ale anului agricol 2020*, www.meteo.md (accessed May 2025)
4. Serviciul Hidrometeorologic de Stat al Republicii Moldova, *Conditiile meteorologice ale anului agricol 2021*, www.meteo.md (accessed May 2025)
5. Organisation Internationale de la Vigne et du Vin (OIV), *Compendium of International Methods of Wine and Must Analysis*, OIV, Paris (2021)
6. Organisation Internationale de la Vigne et du Vin (OIV), *International Code of Oenological Practices*, OIV, Paris (2022)
7. C. Tardea, *Chimia si analiza vinului*, Ion Ionescu de la Brad, Iasi (2007), pag. **1055–1061**.
8. V. Gherjicova, et al., *Metodi tekhnokhimicheskogo kontrolya v vinodelii*, Tavrida, Simferopol (2002), pag. **91–93**
9. *Catalogul soiurilor de plante ale Republicii Moldova*. Chişinău: Lumina, 2018, p. **132**.
10. E. Rusu, B. et al. *Crearea identitaţii vinurilor moldovenesti prin promovarea soiurilor noi de selectie.* International conference, „Realizari inovative in domeniul vitivinicol”, 18-19 sept., Chisinau, (2008), p. **165-166.**
11. I. Coteț, N. Taran, E. Scorbanov, *Determinarea acidului malic, lactic și succinic în vinuri prin metoda electroforezei capilare*, *Buletinul AȘM. Științe biologice, chimice și agricole*, **3**, **135–140** (2019)
12. Taran N., Ponomariova I., Morari B., Nemteanu S. *Studiul potentialului tehnologic al soiurilor de struguri de selectie noua in contextul schimbarilor climatice in Republica Moldova*, Pomicultura, Viticultura si Vinificatia, 1 [**87**], **42–48** (2022)