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Determination of the spectrum of volatile chemical compounds in the berry juice of interspecific rhizogenic grapevine genotypes

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ABSTRACT

In this study, the aromatic compounds of some interspecific genotypes were analyzed for both white and red wines. The analysis of the aromatic spectrum of the interspecific rhizogenic vine genotype (*Vitis vinifera* L. x *Muscadinia rotundifolia* Michx.) 'Amethyst' genotype (blue-purple berry) was compared with red wine genotype 'Fetească neagră', 'Cabernet sauvignon' and Malbec'. The aromatic compounds are formed in the berries, and during the development and ripening of the berries, depending on the fluctuations of the climatic factors, they form the aroma specific to the grapevine genotype and, as a result of the processing, they form the bouquet of the derived product. Grapevine berries mostly contain the same aromatic chemical compounds, the specific aroma is only due to their different weight within the aromatic complex of each genotype. The results showed that the aromatic spectrum of the interspecific genotypes was as pronounced as that of the reference genotype.

Keywords*:* flavor, berry, chemical compound, genotype, rhizogen, grapevine.

INTRODUCTION

Climate change represents an unprecedented challenge facing human society, and the degree of impact of these changes will depend on the level of awareness of the trade-offs accepted and made at the global level. The real and opportunity costs will increase with future climate change, affecting the health and economic well-being of the population. Therefore, society's greatest challenge lies in the integration of environmental sustainability in the context of economic development. The development of society through the lens of the green economy provides for the restoration and maintenance of a sustainable, long-term balance between economic development and the integrity of the natural environment, in forms understood and accepted by society (Georgescu *et al*., 1991).

During the development and ripening of berries, depending on the fluctuations of climatic factors, the flavor characteristic of the grape genotype is formed, and as a result of processing the grapes, a bouquet of young wine is formed. Grape berries contain, for the most part, the same aromatic chemical compounds, however, the specific flavor is due not only to their different mass concentration but also to their ratios in the aromatic complex of each genotype. The specific shade of the flavor of the specific genotype and the accent of the aromas of the specific genotype depends to a greater extent on the transfer of hereditary traits from the parent pairs of crossing, the degree of ripening of the berries, the phytosanitary level of the plantations and the influence of the factors of the growing environment. The purpose of this research is the define and compare the analysis of aromatic compounds in berries of rhizogenic interspecific grape genotypes in comparison with intraspecific genotypes (Alexandrov, 2020[a]; Alexandrov *et al*.,2020[b]).

MATERIALS AND METHODS

The interspecific rhizogenic grapevine genotypes (*Vitis vinifera* L. x *Muscadinia rotundifolia* Michx.) approved in the Republic of Moldova served as the object of study: 'Amethyst' (blue-violet berry); 'Alexandrina', 'Augustina', 'Malena', 'Nistreana', 'Algumax', 'Sarmis' (green-yellow berry) (Alexandrov, 2020). From the *Vitis vinifera* L. group, the indigenous genotypes: 'Fetească albă' and 'Fetească neagră', 'Malbec' and 'Cabernet sauvignon'. Complex interspecific genotypes 'Rithon' and 'Legenda'. The Shimadzu GC analysis system and the GC/MS-QP2010 Plus mass spectrometer, equipped with the AOC-500 sample injection complex, were used to determine the volatile compounds with aromatic potential. For micro-extraction in the solid phase, Carboxen PDMS with dimensions of 100 μm was used, with which the volatile compounds were extracted in concentrations of 10 ppv and 10 ppm. Data analysis was performed using the Software GC/MS Solution system (Shimadzu), equipped with SCAN/SIM (FASST) (Methods of analysis in the field of winemaking, 2011; Țîrdea, 2007; Methodology for the description of grapevine cultivras, 1988).

RESULTS AND DISCUSSIONS

Aromatic compounds (odorant composition) accumulate in the berries, forming the aroma specific to the genotype. During the period of development and ripening of the berries, primary (varietal) aromas are formed, then secondary aromas are formed as a result of processing and alcoholic fermentation, and finally, as a result of keeping the derived product in wooden vessels (maturation) and then keeping it in glass vessels (aging) tertiary aromas are formed, and these, in turn, finalize the bouquet of the derived product.
The purity and accent of the aromas of a certain genotype depends on the degree of ripening of the berries, the phytosanitary level, and the climatic factors of the cultivation environment. However, the final aromatic bouquet depends on the initial volatile chemical compounds (Dobrei *et al*., 2021).
The results regarding the qualitative comparative analysis highlighted the increased concentration of cis-3-hexenal-1-ol (31.3+/-0.21 mg/dm^3 for the Amethyst cultivar, 66.9 +/-0.08 mg/dm^3 for Cabernet-sauvignon). An essential component of wines, which renders floral, basil or lavender nuances, is Linalool. According to the results, the amount of Linalool varied between 20.1+/-0.6 mg/dm^3 in the 'Fetească neagră' genotype and 42.0+/-0.11 mg/dm^3 in the 'Cabernet-sauvignon' genotype, which reproduces shades of basil or lavender.
The results revealed higher concentrations for the chemicals No - diendiol -1 (113.4+/-0.007 mg/dm^3 in berries of 'Amethyst' genotype lower 78.8 +/-0.03 mg/dm^3 in 'Malbec' genotype).
Similarly, Diethyil succionat varied between 550.3+/-0.029 mg/dm^3 in the 'Malbec' and 447.0+/-0.03 mg/dm^3 in the 'Amethyst' genotypes (Table 3).
From an organoleptic point of view, the dry red wine obtained from the grapes of the 'Amethyst' genotype is characterized by an increased intensity of astringency and extra vitality. In the young wine, nuances of the aromas of black berries are be felt.
Based on the results exposed to the odorant nuances, although the differences between the 5 genotypes for red wines are small, the aromatic spectrum shows that in all the grapevine genotypes analyzed, aromas with fruity nuances predominate (Tables 1, 2 and 3).
The results regarding the aromatic samples for the white wines showed that in all analyzed grapevine genotypes aromas with fruity nuances dominate. Analyzing the aromatic spectrum of the juice of the yellow-green berries of the grapevine genotypes

included in the study, it was found that the nuances of vegetable and floral aromas of the interspecific grapevine genotypes were more pronounced in the case of the 'Fetească albă', 'Riton' and 'Legenda' genotypes (Table 4. - 7.; fig. 1. and 2).

Table 1. The chemical compounds in blue-violet berries that form floral flavors

Flavor	Chemical compounds	Grapevine genotypes			
		'Ametist'	'Fetească neagră'	'Cabernet-sauvignon'	Malbec
Citrus – floral	Nerol	7,5±0,3	6,9±0,4	6,3±0,31	2,9±0,14
Basil – floral – levander	Linalool	21,4±0,14	20,1±0,8	4,2±0,11	3,8±0,09
Bergamot – floral – orange	Alpha - terpeniol	6,3±0,4	4,9±0,3	7,2±0,2	5,4±0,7
Floral	Trans - 8 - dihydrosilinalool	14,1±0,1	10,7±0,9	19,4±0,7	17,6±0,3
Floral – lily of the valley	Endiol	5,4±0,3	4,1±0,2	6,6±0,4	3,9±0,4
Floral – pelargonium – rose	Geraniol	9,6±0,9	8,8±0,4	11,7±0,09	7,8±0,9
Rose	Cis - 8 - dihydrosiralol	29,2±1,3	19,4±0,7	21,3±0,06	17±0,09
Rose – fruits	Citronellol	11,4±0,8	7,3±0,3	17,9±0,07	14,4±0,03
Viola – forest fruit	Beta - ionone	< 1,0±0,1	< 1,0±0,1	2,9±0,07	3,1±0,05
Floral – fruits	3-oxo-alpha-ionol	3,7±0,3	2,5±0,6	3,9±0,4	2,8±0,6
Rose – bee honey	Beta-damascenon e	2,9±0,2	1,1±0,1	2,2±0,3	1,7±0,7
Viola – fruits	Beta - ionone	1	1	2,3±0,2	0,9±0,8
Rose – bee honey – tabaco	Ethyl-phenyl-acetate	3,9±0,6	2,7±0,3	3,3±0,6	2,0±0,02
Carnation	Eugenol	2,3±0,2	1,9±0,1	4,9±0,7	2,4±0,9
Orange flowers - honey bees	Phenyl acetate - aldehyde	5,5±0,9	3,9±0,3	6,2±0,2	4,4±0,8

Table 2. The chemical compounds in blue-purple berries that form vegetable flavors

Flavor	Chemical compounds	Grapevine genotypes			
		'Ametist'	'Fetească neagră'	'Cabernet-sauvignon'	'Malbec'
Unripe fruits - herbs	Cis-3-hexene-1-ol	31,3±0,21	51,9±0,7	66,9±0,08	55,3±0,07
Camphor – woody	Actindiolo 1	< 1	< 1	< 1	< 1
Camphor – woody	Actindiolo 2	1,7±0,2	1,9±0,1	2,7±0,3	2,9±0,8
Camphor – eucalyptus	Vitispirin - 1	2,0±0,2	< 1,0±0,1	2,7±0,2	0,9±0,3
Camphor – eucalyptus	Vitispirin - 2	3,2±0,1	1,9±0,3	3,3±0,6	2,4±0,4
Woody – divin	Ethyl - lactate	1494±0,0039	1424±0,0021	1559±0,0043	1434,4±0,029
Birch tree	Ethyl - 3 - hydroxybutanoate	231±0,019	217±0,014	420,7±0,091	370,7±0,039
Peppermint	Methyl - salicytat	4,3±0,7	5,6±0,8	7,9±0,3	4,4±0,07
Green tea	Methyl - vanillin	28,7±0,12	35,6±0,18	49,3±0,06	33,0±0,06

Many factors are known to regulate the emission of aromas by fruits. Genotype influences flavor (Kongor et al., 2016). The final flavor profile is affected by environmental conditions such as climate, sunlight, soil, fruit ripening, harvesting time and post-harvest processes (Kongor *et al.,* 2016, 2017). Environmental stresses (eg temperature and drought) influences fruit metabolism and the content of aromatic compounds (Romero *et al*., 2021).

Table 3. The chemical compounds in the blue-purple berries that form fruity flavors

Flavor	Chemical compounds	Grapevine genotypes			
		'Ametist'	'Fetească neagră'	'Cabernet-sauvignon'	'Malbec'
Muscat	No - diendiol -1	113,4±0,007	79,3±0,09	83,8±0,07	71,8±0,03
Muscat	No - diendiol - 2	5,9±0,6	3,1±0,1	4,4±0,6	3,9±0,7
Fruits	Diehyil succionat	447±0,051	523±0,049	490,7±0,037	550,3±0,029
Coconut	Gamma - nanolactone	10,8±0,17	9,6±0,9	21,1±0,012	18,8±0,07
Peach	Gamma - butyrolactone	1139±0,029	1055±0,077	1017,2±0,0013	970,4±0,019
Banana	Ethyl-2-hydroxyvalerianate	5,5±0,3	6,6±0,7	7,9±0,6	5,4±0,8
Fruit - apple	Ethyl - hexanoate	159±0,011	143±0,05	219±0,013	198,2±0,039
Fruit – vine grapes	Ethul - decanoate	88,9±0,02	77,1±0,03	168±0,044	90,3±0,37
Kiwi - banana - pineapple	Ethyl - butanoate	107,3±0,031	91,4±0,04	99,3±0,03	87,8±0,21
Pear - apple - pineapple	Ethyl - acetate	9,0±0,3	7,8±0,2	17,7±0,09	12,0±0,07
Fruity – balsamic	Benzyl alcohol	417±0,031	431±0,034	569,4±0,029	467,1±0,072
Fruity - herbaceous – apple	Trans-3-hexen-1-ol	33,7±0,22	51,4±0,25	67,7+/-0,09	49,0±0,06
Bitter almond	Benzaldehyde	8,1±0,4	8,7±0,5	11,0±0,02	13,7±0,09
Vanilla	Vanillin	14,3±0,19	11,5±0,15	21,6±0,07	17,3±0,04

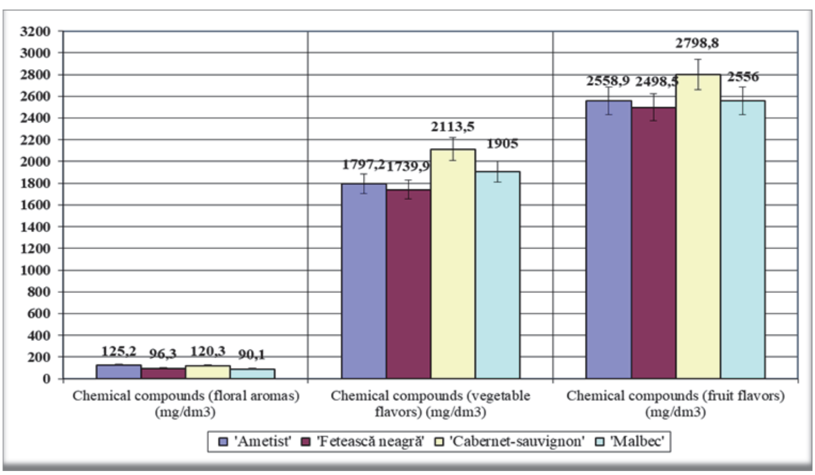

Figure. 1. Generalization and grouping of aromatic chemical compounds, blue-purple berry

Table 4. The chemical compounds in the yellow-green berries that form floral aromas

Flavor	Chemical compounds	Augusti na	Malena	Nistrean ă	Alexand rina	Alguma x	Sarmis	Feteasca Albă	Riton	Legenda
Orange flowers - bee honey	Phenyl - acetate - aldehyde	3,4	3, 1	4,0	3,9	2,9	3,3	4,1	4,4	5,7
Flowers – herbs	1-hexanal	1120	1188	1730	1449	1340	1517	1498	1537	1548
Rose – bee honey	B – phenyl – ethyl – acetate	141	179	149	192	129	163	407	498	551
Carnation	Eugenol	3,4	3,9	1,9	2,3	2,9	1,2	2,9	4,0	4,4
Rose – bees honey – tobacco	Ethyl - phenyl - acetate	3,7	3,0	2,7	3,2	2,9	2,0	3,7	4,0	4,7

Table 5. The chemical compounds in the yellow-green berries that form vegetable flavors

Flavor	Chemical compounds	Augustina	Malena	Nistreană	Alexandrina	Algumax	Sarmis	Feteasca albă	Riton	Legenda
Peppermint – spices	Metil – saliacetat	7,3	6,6	5,9	7,8	7,9	4,6	2,5	3,1	2,8
Woody – divin	Etil – lactat	2231	2114	2300	2278	2170	1949	2340	2248	2349
Green tea	Metil-vanilin	22,5	20,7	16,3	19,1	11,7	10,1	16,6	21,9	23,4

Table 6. The chemical compounds in the yellow-green berries that form fruit flavors

Flavor	Chemical compounds	Augustina	Malena	Nistreană	Alexandrina	Algumax	Sarmis	Feteasca albă	Riton	Legenda
Fruity–balsamic	Benzyl alcohol	43,5	37,4	39,2	40,0	41,4	50,2	56,2	59,3	60,3
Fruity-herbaceous-apple	Trans-3 hexaen-1-ol	50,3	54,2	61,4	59,2	61,1	66,9	51,3	49,3	50,4
Fruity – apple	Ethyl-hexanoate	149	123	151	133	147	130	155	163	169
Fruity–vine grapes	Ethyl – decanoate	70,7	63,9	77,7	69,9	557	50,5	60,3	69,8	72,7
Kiwi - banana - pineapple	Ethyl – butanoate	261	244	229	266	240	179	240	233	251
Pear - apple - pineapple	Ethyl - acetate	9,3	10,4	11,3	14,2	7,9	7,3	11,8	10,9	12,4
Bitter almond	Benzaldehyde	3,3	2,9	2,8	3,6	3,3	2,9	2,7	2,2	2,4
Strawberry	Furaneol	15,7	14,3	16,3	15,5	14,7	13,4	16,3	17,0	19,7
Vanillin	Vanillin	11,7	12,4	10,9	11,1	10,9	9,3	13,3	14,9	15,5

Table 7. The chemical compounds in the yellowish-green bath, which form specific aromas

Flavor	Chemical compounds	Augustina	Malena	Nistreană	Alexandrina	Algumax	Sarmis	Fetesaca albă	Riton	Legenda
Boiled potato	Methionol	1137	1049	1207	1216	1141	1316	1014	1037	1011
Bese	Etil – 3 hidroxibutonoat	148	113	140	188	193	201	258	266	249
Burnt	Furorurol	10,4	11,0	9,7	8,8	7,3	9,2	10,4	9,2	8,8
Pressed cheese	Hexanoic acid	1437	1520	1240	1340	1341	1144,9	1244	1349	1149
Pressed cheese	Octanoic acid	2349	2916	2130	3040	2411	2179	2140	2749	3020
Of smoke	Phenol	1,7	1,4	1,6	1,4	1,9	2,0	1,5	1,3	1,6

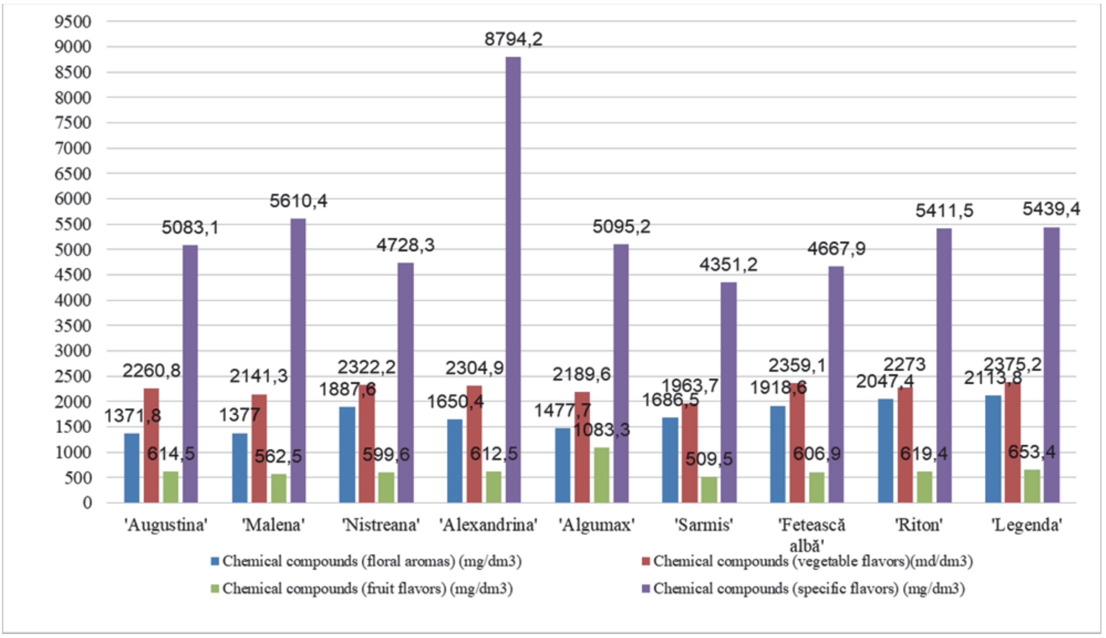

Figure 2. Generalization and grouping of aromatic chemical compounds, yellow-green berry

Based on the results shown in figure 2, we note that in the juice of the greenish-yellow berries, the chemical compounds that form genotype-specific aromas predominate, followed by the chemical compounds that form vegetal aromas.

CONCLUSIONS

Climatic changes impose the need to review the assortment and areas of vine cultivation.
The chemical analysis of the aromatic spectrum of the interspecific rhizogenic genotype 'Amethyst' allowed to establish the fact that little differs from the aromatic spectrum of grapevine genotype such as 'Cabernet-sauvignon', 'Fetească neagră' and 'Malbec'.
The interspecific rhizogenic genotypes of vines 'Amethyst', 'Alexandrina', 'Sarmis', 'Augustina', etc. can be used in the creation of organic vine plantations.

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