AMPELOGRAPHY OF 'MUŠKAT MOMJANSKI', THE MUSCAT ACCESSION CULTIVATED ON ISTRIAN PENINSULA

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The grapevine accession 'Muškat Momjanski' is traditionally cultivated on Istrian peninsula, it is well-known to consumers of Istrian wines and especially appreciated as highly aromatic, muscat-odour wine accession. To the extent of our knowledge, this is the first report where the accession 'Muškat Momjanski' is characterised phenotypically and its phenolic and aromatic fingerprints are compared to 'Muscat Blanc' ('Muškat bijeli', 'Muškat beli') and 'Moscato Giallo' ('Muškat žuti', 'Muškat rumeni'). The intent is to determine potential differences between the studied accessions, especially between 'Muscat Blanc' and 'Muškat Momjanski' which are, to this day, considered as synonyms. The study has revealed considerable differences between the studied accessions in morphological parameters, chemical composition, phenolic and terpene profiles of the grape and chemical composition of the wine. The accession 'Muškat Momjanski' has smaller berry size and weight, higher soluble solids, lower pH, higher phenolic and terpenic content than 'Muscat Blanc'. Considering genetic similarity, indicated differences suggest that the 'Muškat Momjanski' is a distinctive biotype of 'Muscat Blanc'.
Keywords: *Vitis vinifera*, Istria, 'Muscat Blanc', biotype, 'Moscato Giallo'

Ampelographie der auf der Halbinsel Istrien angebauten Muskat-Akzession 'Muškat Momjanski'. Die Weinreben-Akzession 'Muškat Momjanski' wird traditionell auf der Halbinsel Istrien angebaut, sie ist bei Konsumenten istrischer Weine sehr bekannt und wird vor allem für ihre hocharomatischen Weine mit Muskat-Aroma geschätzt. Dies ist die erste phänotypische Charakterisierung dieser Akzession und ebenso der erste Vergleich ihrer phenolischen und aromatischen Charakteristiken mit denen von 'Muscat Blanc' ('Muškat bijeli', 'Muškat beli') und 'Moscato Giallo' ('Muškat žuti', 'Muškat rumeni'). Das Ziel der Studie besteht darin, mögliche Unterschiede zwischen den untersuchten Akzessionen, insbesondere zwischen 'Muscat Blanc' und 'Muškat Momjanski', die bis heute als Synonyme betrachtet werden, zu bestimmen. Die Studie zeigte erhebliche Unterschiede zwischen den untersuchten Akzessionen hinsichtlich morphologischer Parameter, chemischer Zusammensetzung, Phenol- und Terpenprofile der Traube wie auch der chemischen Zusammensetzung der Weine. Die Akzession 'Muškat Momjanski' hat eine kleinere Beerengröße und ein geringeres Beerengewicht, höhere Gehalte an löslichen Feststoffen, einen niedrigeren pH-Wert und höhere Phenol- und Terpengehalte als 'Muscat Blanc'. Unter Berücksichtigung der genetischen Ähnlichkeit deuten die festgestellten Unterschiede darauf hin, dass 'Muškat Momjanski' ein unverwechselbarer Biotyp von 'Muscat Blanc' ist.
Schlagwörter: *Vitis vinifera*, Istrien, 'Muscat Blanc', Biotyp, 'Moscato Giallo'

The Istrian peninsula is a traditional winegrowing area, shared by three countries (Croatia, Slovenia and Italy) where many local grapevine accessions are recorded (Vertovec, 1844; Libutti, 1913; Škvarč et al., 2015). The white varieties 'Muscat Blanc' (MB) and 'Moscato giallo' (MG) are most common muscat accessions in vineyards of the Istrian peninsula. The accession 'Muškat Momjanski' ('Muscat of Momjan') is traditionally cultivated on the hills under the little village of Momjan, located in central Istria. Despite the fact, that 'Muškat Momjanski' has been known for many decades and is particularly appreciated as odouriferous muscat accession in Istria (Libutti, 1913), till today there are no detailed studies regarding its morphological properties, chemical constitution and aromatic profile.
The aim of this study was for the first time – to determine differences and similarities between 'Muscat Blanc', 'Muškat Momjanski' and 'Moscato Giallo' through observing morphological characteristics and grape and wine chemical composition, which are still insufficiently studied under unified conditions.

MATERIALS AND METHODS

EXPERIMENTAL VINEYARD AND PLANT MATERIAL

The preliminary study was conducted on eight-year-old vines of the muscat family traditionally cultivated on Istrian peninsula, 'Muscat Blanc' (MB), 'Muškat Momjanski' (MM) and 'Mu scato Giallo' (MG) vines were grown under uniform conditions. Plant material was acquired from the collection vineyard of the Institute of Tourism and Agriculture Poreč. The vineyard is located on the west coast of the Istrian peninsula (45°13'20.3"N, 13°36'06.3"E) on "terra rossa" soil, thus representing typical climatic conditions and soil characteristics for the mentioned muscat accessions grown in Istria.

SAMPLING

For phyllometric measurements, ten mature leave samples per accession were sampled at berries pea-size (BBCH 75) according to Lorenz et al. (1994), scanned and herbarized at the Institute of Agriculture and Tourism Poreč.
The grapes of the studied accessions were sampled five times during ripening in intervals of approximately ten days between each sampling. Approximately 0.5 kg of sound berries per accession were sampled at different parts of grape clusters growing on various parts/sides of the canopy. In order to obtain a representative sample, berries were sampled with care to prevent berry damage and were immediately frozen at a temperature of -80 °C until further analysis.

PHYLLOMETRIC MEASUREMENTS

For phyllometric measurements, scanned leaves were analysed using the analysis program AnalySIS (Soft Imagining System GmbH, Münster, Germany). The 32 morphometrical parameters were measured on ten representative mature leaves for each accession according to Galet (1988), Pelengič and Rusjan (2010) and Oiv (2013). The characteristics that could be measured on the left and the right side of the main nerve (L1) are given as the average of both measurements, with standard error.

GRAPE AND WINE COMPOSITION

The berry height and width were measured with 20 randomly selected berries per sampling and accession. After calculation of the ratio between width and height, which was in all cases 0.99 to 1.00, berry size was calculated and given as average of berry height and width with standard error.
For each accession, four repetitions of 100 berries were crushed in plastic bags to separate skins and juice. Grape juice was used for measuring soluble solids content, pH, titratable and total acidity. The content of soluble solids was quantified using digital refractometer (ATAGO PAL87S, Tokyo, Japan) and expressed in Brix scale. For titratable acids 0.1 M NaOH were added to samples of berry juice and wine with a semiautomatic titrator till pH reached 7.0 and for total acidity till pH reached 8.2.
Skins were carefully separated from the rest of the pulp and prepared for the extraction of phenolics according to Slatnar et al. (2010) with some modification. Total phenolics (TPC) were measured spectrophotometrically, individual phenolic compounds were determined using HPLC (Thermo Scientific, San José, USA) under conditions described by Mikulič-Petkovšek et al. (2015).

TERPENE COMPOUND DETERMINATION IN GRAPE

Determination of volatile terpene compounds in grape and wines was performed at the Agricultural Institute in Nova Gorica. The solid-phase microextraction method described by Prosen et al.(2010) was used for the analysis. Determination of terpene compounds was conducted on samples from the last three samplings (III, IV, V). Compounds were tentatively identified on the basis of their retention times and mass spectra using the searchable EI-MS spectra library (NIST02).

For quantification of terpene compounds, the calibration curve was obtained using the standard procedure following the above described methods. The quantification calculation using linalool calibration curve was applied to terpene compounds with highest abundance.

VINIFICATION

Three individual vinifications per accession were conducted under the same conditions at the Institute of Agriculture and Tourism Poreč. The Harvest was carried out on September, 15th, 2014. Approximately 25 kg of sound bunches per accession were manually harvested and vinified under uniform conditions. Destemming, crushing and pressing of the grapes were performed at the same day as harvesting. During destemming and crushing 1.5 g of potassium metabisulphite dissolved in 100 ml distilled water was continually added. During pressing, the pectolytic enzymes (SihazymTM Claro, Langenlonsheim, Germany) were added in concentration of 2 g/hl. The must was gathered in 5 litre glass bottles for fermentation in three repetitions for each accession. After settling at 10 °C for 48 h, the grape juice was separated from the precipitate, 30 g/hl of *Saccharomyces cerevisiae* yeast (Ruler® Cultivar, Treviso, Italy) and 25 g/hl of fermentation activator (V Activ Premium®, Verona, Italy) were added. All of the oenological agents were added according to manufacturer instructions. The fermentation was conducted under controlled temperature (17 ± 2 °C). The fermentation lasted for 11 days for MG, 12 days for MB and 14 days for MM. After fermentation, the wine was decanted and 10 g/hl potassium metabisulphite was added. The wine was not subjected to filtration and fining in order to preserve volatile compounds.

STATISTICAL ANALYSIS

The one-way Anova and Duncan test, with confidence level $p = 0.05$, were applied to discriminate acquired data. Data is presented as mean value ± standard error. Statistical processing was carried out by using R commander package for programme R v. 3.1.0. (Rcmdr (64 bit), Version 3.1.3; R Formation for Statistical Computing, Auckland, New Zealand).

RESULTS AND DISCUSSION

PHYLLOMETRIC MEASUREMENTS

According to Pelengič and Rusjan (2010), phyllometry is a valuable asset to ampelographic methods and might be used to discriminate grapevine varieties and biotypes. From 32 phyllometric measurements (Fig. 1), the significant difference between all three accessions was observed in four OIV descriptors (Oiv, 2013); length of nerves (L3, L4, L5) and distance from petiole insertion to lower sinuses (OI). Results of phyllometric measurements suggested a high similarity between the accessions MB and MM. Phyllometric measurements also showed that the MG accession is the most distinctive in comparison to MM and MB. The graphic reconstruction of the leaves showed more conspicuous upper right and both lower sinuses of accession MM in comparison to the leaf of MB (circular lines on Fig. 1). The depth of sinuses is in direct correlation with length and angle between sinuses. This trait can be used for fast visual distinction between these two accessions.

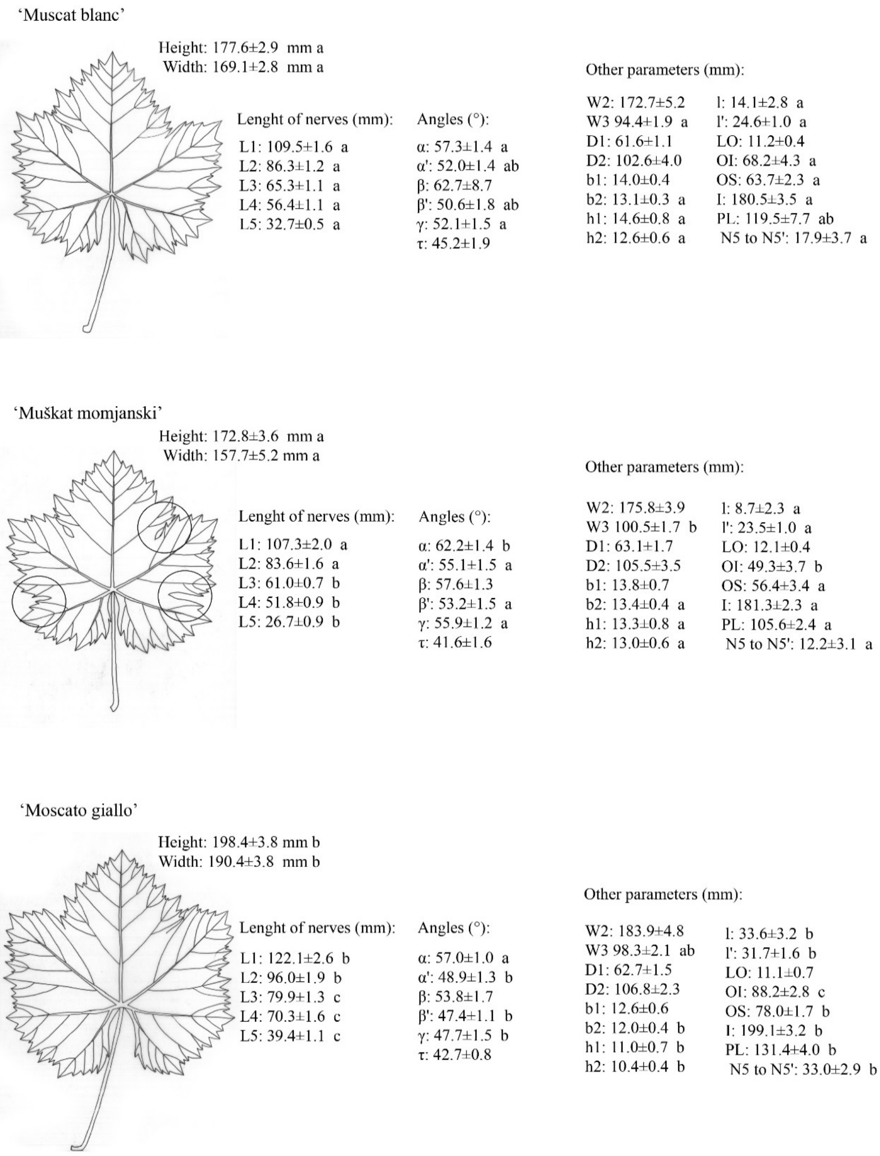

Figure 1. Thirty-two morphometrical parameters measured on mature leaves of accessions MB, MM and MG. Comparison was made regarding accessions, parameters sharing same letters or no letters are not significantly different by Duncan test (p ≤ 0.05). Circular lines emphasize the morphological distinctiveness between MM and other analysed varieties.

Table 1: Morphological measurements and chemical compounds quantification of three muscat accessions cultivated on Istrian peninsula (MB = 'Muscat Blanc', MM = 'Muškat Momjanski', MG = 'Moscato Giallo'). Comparison was made regarding biotypes, separately for every date of sampling and measured parameter. Means sharing same letters or no letters, are not significantly different by Duncan test at p = 0.05. Samplings: 11th Aug (I), 20th Aug (II), 29th Aug (III), 9th Sep (IV), 15th Sep (V); GAE = gallic acid equivalents

Accessions	I	II	III	IV	V
			Berry size (mm)		
MB	16.4 ± 0.3 b	15.9 ± 0.3 b	16.0 ± 0.3 b	14.9 ± 0.3 b	16.1 ± 0.3 b
MM	14.0 ± 0.4 a	13.7 ± 0.3 a	15.0 ± 0.3 a	13.5 ± 0.3 a	15.0 ± 0.4 a
MG	16.6 ± 0.2 b	15.9 ± 0.3 b	17.8 ± 0.3 c	16.8 ± 0.4 c	16.8 ± 0.3 b
			Weight of 100 berries (g)		
MB	276.0 ± 6.11 b	304.4 ± 9.0 b	273.5 ± 8.3 b	235.5 ± 8.4 a	290.6 ± 8.06 b
MM	230.3 ± 18.7 a	211.7 ± 7.8 a	230.3 ± 5.7 a	224.0 ± 3.7 a	237.9 ± 5.93 a
MG	270.8 ± 6.3 b	314.2 ± 9.4 b	327.2 ± 6.8 c	323.9 ± 2.7 b	345.3 ± 17.4 c
			Soluble solids (°Bx)		
MB	13.1 ± 0.4 a	15.9 ± 0.3 b	15.9 ± 0.3 a	17.00 ± 0.3 a	18.9 ± 0.3 a
MM	13.7 ± 0.4 a	15.2 ± 0.1 b	18.7 ± 0.2 b	19.15 ± 0.1 c	21.4 ± 0.2 b
MG	11.4 ± 0.1 b	13.9 ± 0.1 a	17.2 ± 0.1 c	18.40 ± 0.0 b	18.3 ± 0.9 a
			pH		
MB	2,98 ± 0,02 b	3,14 ± 0,03 ab	3,05 ± 0,02 a	3,32 ± 0,01 a	3,47 ± 0,05 b
MM	2,95 ± 0,03 b	3,10 ± 0,03 a	3,08 ± 0,02 a	3,38 ± 0,01 a	3,32 ± 0,02 a
MG	2,88 ± 0,01 a	3,19 ± 0,01 b	3,29 ± 0,02 b	3,73 ± 0,01 b	3,53 ± 0,02 b
			Titratable acids (g/l)		
MB	19.4 ± 1.5 a	15.6 ± 0.9 a	11.4 ± 0.5	12.1 ± 0.3 c	11.3 ± 1.0
MM	17.0 ± 0.8 a	12.5 ± 0.5 a	12.8 ± 1.2	10.2 ± 0.2 b	12.3 ± 0.7
MG	27.6 ± 1.7 b	22.5 ± 1.4 b	12.8 ± 0.4	7.6 ± 0.3 a	12.7 ± 1.2
			Total acid content (g/l)		
MB	20.0 ± 1.5 a	16.2 ± 0.9 a	11.8 ± 0.5	12.6 ± 0.4 c	11.8 ± 1.0
MM	17.5 ± 0.9 a	13.0 ± 0.5 a	13.4 ± 1.2	10.8 ± 0.3 b	12.9 ± 0.7
MG	28.7 ± 1.7 b	23.4 ± 1.6 b	13.4 ± 0.4	8.0 ± 0.3 a	13.4 ± 1.3

MORPHOLOGY MEASUREMENTS

In the last sampling, accession MM significantly differed from MB and MG in berry size, weight, soluble solids and pH (Table 1). According to acquired data, MM had smallest berry size (15.0 ± 0.4 mm), lowest weight of 100 berries (237.9 ± 5.93 g), greatest content of soluble solids (21.4 ± 0.2 °Bx) and the lowest pH value (3.32 ± 0.02). There were no significant differences in titratable acidity and total acidity between the studied accessions at harvest date, whereas all three accessions had significantly different average weights of 100 berries.

PHENOLIC PROFILE

In the examined accessions, we identified 14 phenolic compounds and the most abundant group of phenolics is the group of flavonols. Differences in contents of quercetin-3-galactoside mainly, but also in concentrations of rutin (quercetin rhamnoside) and kaempferol-3-glucoronide in white muscat grape accessions indicate diverse biosynthetic pathways and can be used to distinguish between group of accessions (Degu et al., 2015). From the mentioned phenolics we identified quercetin-3-galactoside and rutin. A significantly higher content of quercetin-3-galactoside was recorded in the accession MM in comparison to MB and MG, whereas no difference between the accessions was found with rutin contents (Table 2).

Most differences in phenolic contents between the studied accessions were recorded at sampling IV. According to these and previous results of morphological parameters, it is evident that 9th of September was the date of technological maturity. Our results showed high divergence in the phenol profiles of MB and MM and similarity of MB and MG. In future differential studies of muscat accessions, the use of more specific molecular methods combined with metabolic profile would be of great importance for establishing the dissimilitude between accessions.

Table 2: Total and individual phenolic composition of grapes of the muscat accession MB ('Muscat Blanc'), MM ('Muškat Momjanski') and MG ('Moscato Giallo'). Percentage is given with regard to the total phenolic content (TPC) and group of phenolic compounds (PG). Comparison was made regarding biotypes, separately for every date of sampling and measured parameter. Means sharing same letters or no letters, are not significantly different by Duncan test at $p = 0.05$. Samplings: 11th Aug (I), 20th Aug (II), 29th Aug (III), 9th Sep (IV), 15th Sep (V); GAE = gallic acid equivalents

Phenolics	I			II			III		
	MB	MM	MG	MB	MM	MG	MB	MM	MG
Caftaric acid (mg/kg)	3.0 ± 0.6 a	6.8 ± 2.0 a	16.4 ± 4.1 b	4.6 ± 1.2 a	6.7 ± 0.3 ab	10.7 ± 2.9 b	8.8 ± 1.9	4.4 ± 0.2	8.6 ± 2.7
cis Coutaric acid (mg/kg)	4.1 ± 1.1 a	22.3 ± 9.0 a	113.2 ± 29.7 b	15.6 ± 5.8 a	23.2 ± 3.3 a	65.3 ± 16.6 b	48.3 ± 7.5 a	17.6 ± 1.1 a	67.3 ± 26.9 a
Procyanidin dimer (mg/kg)	6.3 ± 1.9 a	42.1 ± 15.1 a	212.9 ± 62.6 b	23.3 ± 10.0 a	49.0 ± 2.1 a	125.5 ± 27.1 b	116.3 ± 22.1	61.2 ± 5.4	151.6 ± 60.8
Catechin (mg/kg)	3.1 ± 0.9 b	7.5 ± 1.9 b	1.4 ± 0.3 a	2.1 ± 0.6 a	3.0 ± 0.1 ab	4.9 ± 1.2 b	4.0 ± 0.9 b	2.0 ± 0.1 a	3.9 ± 1.2 ab
Q-3-rutinoside (mg/kg)	23.3 ± 4.9	31.3 ± 9.2	19.6 ± 1.0	26.5 ± 0.6 a	52.8 ± 5.4 b	30.6 ± 6.9 a	22.9 ± 4.7	19.1 ± 1.5	26.8 ± 8.4
Q-3-galactoside (mg/kg)	12.8 ± 2.6	12.9 ± 5.1	9.1 ± 0.7	23.3 ± 2.0	23.2 ± 23.3	22.6 ± 11.6	13.6 ± 17.4	19.2 ± 8.5	24.2 ± 29.8
Q-3-glucoside (mg/kg)	50.1 ± 9.9	48.6 ± 20.8	41.5 ± 4.0	95.8 ± 3.0	84.0 ± 94.5	97.4 ± 46.7	54.3 ± 69.3	80.6 ± 33.5	100.8 ± 12.9
Q-3-glucuronide (mg/kg)	104.1 ± 14.6	135.3 ± 33.9	80.1 ± 5.0	110.9 ± 6.0	161.0 ± 120.3	112.8 ± 106.5	82.9 ± 78.1	65.3 ± 82.3	96.4 ± 66.3
Q-3-xyloside (mg/kg)	3.8 ± 1.1 b	3.3 ± 1.2 b	2.3 ± 0.1 a	3.8 ± 5.0 a	7.1 ± 5.0 b	4.9 ± 3.2 ab	2.5 ± 2.2	2.1 ± 2.2	4.2 ± 2.7
Q rhamnoside (mg/kg)	17.2 ± 3.6	12.1 ± 6.2	14.2 ± 1.9	36.4 ± 10.0	26.2 ± 32.6	32.2 ± 14.5	15.0 ± 20.0	19.0 ± 11.1	35.7 ± 42.8
Kaempferol (mg/kg)	4.6 ± 0.6	6.0 ± 1.5	3.5 ± 0.2	4.9 ± 7.0	7.1 ± 5.3	5.0 ± 4.7	3.7 ± 3.5	2.9 ± 3.6	4.3 ± 2.9
K-3-glucoside (mg/kg)	7.9 ± 3.3	3.5 ± 0.8	3.3 ± 0.2	24.3 ± 8.0	12.3 ± 18.5	17.7 ± 4.9	2.8 ± 10.3	5.1 ± 6.0	19.8 ± 24.9
K-3-rutinoside (mg/kg)	0.3 ± 0.1	0.6 ± 0.2	2.1 ± 0.1	0.8 ± 4.0 a	0.7 ± 1.8 a	3.3 ± 1.0 b	1.0 ± 1.0	0.7 ± 0.1	2.6 ± 1.6
IR glucoside (mg/kg)	16.1 ± 3.4	11.3 ± 5.8	13.3 ± 1.8	34.0 ± 9.0	24.5 ± 30.5	30.1 ± 13.5	14.1 ± 18.7	17.7 ± 10.4	33.3 ± 40.0
Total phenol. (g GAE/kg)	1.51 ± 0.37 a	1.98 ± 0.57 a	5.61 ± 0.65 b	3.30 ± 0.29 a	2.39 ± 0.18 a	6.18 ± 0.44 b	3.50 ± 0.07 b	1.39 ± 0.22 a	4.27 ± 0.67 b

Phenolics	IV			V			% TPC			% PG		
	MB	MM	MG	MB	MM	MG	MB	MM	MG	MB	MM	MG
Caftaric acid (mg/kg)	3.4 ± 0.4 a	9.8 ± 1.8 b	7.9 ± 2.7 ab	4.1 ± 1.2	5.1 ± 0.9	7.2 ± 2.3	26.6	21.7	14.9	0.2	0.3	0.2
cis Coutaric acid (mg/kg)	9.4 ± 1.1 a	35.3 ± 6.5 ab	45.0 ± 15.6 b	13.3 ± 4.4 a	19.7 ± 4.3 a	51.6 ± 15.1 b	73.6	78.3	85.1	0.7	1.1	1.1
Procyanidin dimer (mg/kg)	31.8 ± 5.3 a	116.9 ± 18.4 b	102.8 ± 33.3 b	43.3 ± 10.5 a	77.9 ± 11.1 ab	126.9 ± 33.9 b	95.4	96.3	96.6	2.3	3.5	2.6
Catechin (mg/kg)	1.6 ± 0.2 a	4.5 ± 0.8 b	3.6 ± 1.3 ab	1.9 ± 0.4	2.3 ± 1.1	3.3 ± 0.6	4.8	3.7	3.4	0.1	0.1	0.1
Q-3-rutinoside (mg/kg)	12.1 ± 1.5 a	43.0 ± 10.6 b	10.7 ± 4.0 a	18.9 ± 2.5	31.4 ± 10.1	20.2 ± 6.9	7.3	10.0	6.6	0.9	1.3	0.3
Q-3-galactoside (mg/kg)	10.6 ± 2.2 a	32.5 ± 6.6 b	12.7 ± 3.2 a	26.5 ± 6.5	29.6 ± 3.9	33.3 ± 8.1	6.4	7.5	7.9	0.8	1.0	0.3
Q-3-glucoside (mg/kg)	43.4 ± 9.3 a	127.1 ± 24.2 b	52.4 ± 14.3 a	112.0 ± 27.9	117.8 ± 15.7	138.8 ± 33.2	26.2	29.5	32.5	3.2	3.8	1.3
Q-3-glucuronide (mg/kg)	49.9 ± 3.7 a	140.6 ± 31.1 b	39.0 ± 14.2 a	57.9 ± 9.6	86.0 ± 31.0	55.0 ± 16.6	30.2	32.6	24.2	3.6	4.2	1.0
Q-3-xyloside (mg/kg)	1.0 ± 0.2 a	4.1 ± 1.2 b	1.0 ± 0.4 a	2.1 ± 0.4	3.4 ± 0.6	2.7 ± 1.0	0.6	1.0	0.6	0.1	0.1	0.0
Q rhamnoside (mg/kg)	17.6 ± 5.0	29.8 ± 6.6	17.6 ± 5.7	44.2 ± 15.3	30.6 ± 3.3	53.7 ± 13.7	10.6	6.9	10.9	1.3	0.9	0.4
Kaempferol (mg/kg)	2.2 ± 0.2 a	6.2 ± 1.4 b	1.7 ± 0.6 a	2.6 ± 0.4	3.8 ± 1.0	2.4 ± 0.7	1.3	1.4	1.1	0.2	0.2	0.0
K-3-glucoside (mg/kg)	11.8 ± 2.4	18.5 ± 6.7	8.1 ± 4.4	22.3 ± 9.6	20.9 ± 4.1	31.4 ± 8.1	7.1	4.3	5.0	0.9	0.6	0.2
K-3-rutinoside (mg/kg)	0.2 ± 0.0 a	1.2 ± 0.2 b	1.6 ± 0.4 b	0.7 ± 0.2 a	1.0 ± 0.8 a	3.3 ± 0.7 b	0.1	0.3	1.0	0.0	0.0	0.0
IR glucoside (mg/kg)	16.4 ± 4.7	27.8 ± 6.2	16.5 ± 5.3	41.3 ± 14.3	28.6 ± 3.1	50.2 ± 12.8	9.9	6.5	10.2	1.2	0.8	0.4
Total phenol. (g GAE/kg)	1.37 ± 0.38	3.31 ± 0.74	3.99 ± 0.94	1.86 ± 0.17	1.46 ± 0.14	2.81 ± 0.71			Σ	15.4	18.0	8.0

TERPENIC PROFILE

Accession MG showed the highest content of total terpenic compounds compared to MB and MM, where at the last sampling, the content of linalool (3089.7 ± 56.0 µg/kg), geraniol (253.4 ± 27.0 µg/kg), β pinen (341.0 ± 38.6 µg/kg) and limonen (137.2 ± 16.8 µg/kg) were even a fewfold higher in comparison to contents measured in MB and MM. The only exception is nerol, the content of which in MG (87.4±15.2 µg/kg) was the lowest of the studied accessions (Table 3).

CHEMICAL PROPERTIES OF WINE

Significant differences in alcohol content, pH, malic acid and tartaric acid content were observed between wines of all three accessions. Highest sugar content and lowest pH of grapes, highest alcohol content (10.4 ± 0.1 %vol.) and lowest pH (3.1 ± 0.0) were measured in the wine of MM. MG had the highest pH and the highest content of malic acid (4.33 ± 0.0 g/l), but the lowest content of tartaric acid (1.97 ± 0.1 g/l)in wine. The lowest content of malic acid was observed in wine of MB (2.87 ± 0.1 g/l), while MM had the highest content of tartaric acid (3.37 ± 0.2 g/l). There were no significant differences between accessions in total extract, volatile acids, lactic acid and phenolic content (Table 4).

CONCLUSION

This preliminary study revealed considerable morphological and chemical differences among studied accessions of muscats, but also the need for a further, more detailed examination of phyllometric parameters, morphological and chemical composition under diverse climatic conditions. We suggest the use of additional phyllometric parameters, especially ratios between measured parameters, which are considered more stable within varieties. Since studied accessions achieve technological maturity at different times, it is necessary to use techniques to

Table 3: Content of most abundant terpenes in grapes of 'Muscat Blanc' (MB), 'Muškat Momjanski' (MM) and 'Moscato Giallo' (MG); Comparison was made regarding biotypes, separately for every date of sampling and measured parameter. Means sharing same letters or no letters, are not significantly different by Duncan test at p = 0.05

	Aug. 29	Sept. 9	Sept. 15
	β-Pinene (µg/kg)		
MB	102.3 ± 4.4 a	87.4 ± 11.1 a	102.0 ± 14.4 a
MM	101.2 ± 3.9 a	125.8 ± 7.4 b	179.3 ± 16.5 a
MG	258.8 ± 2.0 b	236.2 ± 13.4 c	341.0 ± 38.6 b
	D-Limonen (µg/kg)		
MB	48.1 ± 2.1 a	41.7 ± 3.9 b	58.7 ± 5.9 a
MM	50.4 ± 1.7 a	66.4 ± 2.0 a	89.5 ± 6.9 a
MG	104.2 ± 1.9 b	99.8 ± 0.3 c	137.2 ± 16.8 b
	Ocimen (µg/kg)		
MB	70.0 ± 4.4 a	71.6 ± 8.1 a	89.2 ± 12.0 a
MM	77.4 ± 4.0 a	75.7 ± 3.8 a	142.8 ± 2.2 ab
MG	155.9 ± 3.5 b	174.4 ± 20.3 b	190.6 ± 43.9 b
	Linalool (µg/kg)		
MB	749.5 ± 12.2 a	562.0 ± 16.7 a	928.7 ± 60.1 a
MM	1063.2 ± 26.2 b	1093.4 ± 30.5 b	1352.8 ± 32.7 b
MG	2700.8 ± 25.0 c	2258.7 ± 157.4 c	3089.7 ± 56.0 c
	Nerol (µg/kg)		
MB	158.4 ± 17.4 b	148.4 ± 10.9 a	110.0 ± 12.1 a
MM	93.6 ± 2.8 a	221.8 ± 6.4 b	160.4 ± 5.6 b
MG	59.4 ± 3.2 a	159.4 ± 29.4 ab	87.4 ± 15.2 a
	Geraniol (µg/kg)		
MB	186.1 ± 18.2 b	144.2 ± 6.4 a	138.2 ± 17.0 a
MM	131.6 ± 7.5 a	198.7 ± 14.5 ab	170.9 ± 7.2 a
MG	155.1 ± 11.4 ab	265.3 ± 44.6 b	253.4 ± 27.0 b

equalize grape berries ripeness among accessions prior to measurements in order to form accurate phenolic and terpenic profiles and acquire correct morphological parameters of the studied accessions. The ampelographic study of the variety 'Muškat Momjanski' contributes to the knowledge of the "family" of varieties denominated muscat, and suggests that further detailed studies should not focus only on genetics, but also on morphological and biochemical characteristics, which distinguish 'Muškat Momjanski' from the group of 'Muscat Blanc'.

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Table 4: Chemical properties of wine made from the studied accessions MB, MM and MG. Comparison was made regarding biotypes, separately for every date of sampling and measured parameter. Means sharing same letters or no letters, are not signifycantly different by Duncan test at p = 0.05. (MB = 'Muscat Blanc', MM = 'Muškat Momjanski', MG = 'Moscato Giallo', GAE = gallic acid equivalents)

	Alcohol (%vol.)	Total extract (g/l)	Sugar free extract (g/l)	Reduced sugar (g/l)	Total acidity (g/l)	pH
MB	10.2 ± 0.1 b	19.4 ± 0.3	19.4 ± 0.3 ab	1.0 ± 0.1 a	7.4 ± 0.1 b	3.2 ± 0.0 b
MM	10.4 ± 0.1 c	20.2 ± 0.7	20.1 ± 0.7 a	1.0 ± 0.1 a	8.9 ± 0.1 b	3.1 ± 0.0 a
MG	9.2 ± 0.0 a	20.9 ± 0.2	20.9 ± 0.2 b	0.6 ± 0.0 b	7.3+0.0 a	3.4 ± 0.0 c
	Volatile acids (g/l)	Malic acid (g/l)	Citric acid (g/l)	Lactic acid (g/l)	Tartaric acid (g/l)	Phenolic content (g GAE/l)
MB	0.15 ± 0.0	2.87 ± 0.1 a	0.28 ± 0.0 b	0.20 ± 0.0	2.70 ± 0.0 b	0.15 ± 0.06
MM	0.18 ± 0.0	3.07 ± 0.0 b	0.27 ± 0.0 b	0.20 ± 0.1	3.37 ± 0.2 c	0.16 ± 0.01
MG	0.16 ± 0.0	4.33 ± 0.0 c	0.32 ± 0.0 a	0.10 ± 0.0	1.97 ± 0.1 a	0.13 ± 0.01

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