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Original Article

Genetic Study of Native Grapevine Varieties of Northern, Western and Central Greece with the Use of Ampelographic and Molecular Methods

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Abstract

The aim of this study was the identification and discrimination of 49 grapevine varieties that are cultivated in northern, western and central Greece with the use of the ampelographic description and the molecular method RAPD. The grapevine varieties were located in their cultivation centers and the studied samples were collected from productive vineyards of these regions. For the ampelographic description, 22 ampelographic characters were used following a list of descriptors developed by the International Organization of Vine and Wine (OIV), while for the molecular analysis 8 of the most polymorphic primers were used. The results showed that: (a) there is high degree of genetic heterogeneity among most of the varieties studied, (b) grapevine varieties 'Xinomavro' and 'Zalovitiko' exhibited identity with both methods used, therefore the latter constitutes a synonym/clone of the former, (c) high degree of genetic similarity was recorded between cv 'Stavroto' and 'Abelakiotiko', a result enhancing the view that they constitute biotypes/clones of an original/parent variety and originated through the accumulation of mutations, (d) a previous hypothesis is confirmed. This hypothesis states that in the vineyards of northern Greece, different varieties of *Vitis vinifera* L. as well as hybrids (direct producers) were imported. Names/synonyms were given to these imported varieties and hybrids related to their place of origin or the morphological traits of the grape/berries implying identity among them ('Mavroudi', 'Voulgariko', 'Voulgaroudia', 'Vapsa' etc.), while they are different varieties, (e) the combination of the ampelographic description and the molecular method RAPD is very effective in the identification and discrimination of grapevine cultivars.

Keywords: genetic diversity; grapevine cultivar; phenotyping; RAPD; *Vitis vinifera* L.

Abbreviations: PDO-Protected Designation of Origin; PGI-Protected Geographical Indication; RAPD - Random Amplified Polymorphic DNA

Introduction

More than 70 grapevine varieties are reported to be cultivated in central, western and northern Macedonia (Thessaly, Epirus, Macedonia, Thrace), of which a relatively large number of are considered to be indigenous (Ministry of Rural Development and Food, 2017). In the present work, 49 grapevine varieties from the above-mentioned regions were chosen to be studied, 36 of which for the first time. The studied samples were collected from productive vineyards of these regions, while the names of the varieties were maintained as found in the various cultivation centers. The 49 studied varieties can be divided in three groups, depending on their origin as well as on their viti-viniculture importance.

The first group consists of indigenous varieties that have been cultivated since many years in these viticultural regions and constitute the base of many PDO (Protected Designation of Origin) and PGI (Protected Geographical Indication) wines, such as 'Xinomavro', 'Limnio', 'Moschomavro', 'Stavroto', 'Abelakiotiko', 'Krassato', 'Vlachiko', 'Bekari', 'Priknadi' etc. (Ministry of Rural Development and Food, 2017).

The second group consists of varieties mainly of eastern origin, such as 'Karnachalades', 'Papas-kara', 'Sefka', 'Pamidi', 'Zoumiatiko', 'Keratsouda', as well as the various 'Mavroudia'. Grapevine varieties 'Karnachalades' and 'Papas-Kara' were cultivated in eastern Rumelia and because of the deep-colored skin of the berries, Greek viticulturists called them 'Bogia' and 'Bogialamas' (from the Turkish words *boya, boyama* = paint, color) (Hatziparaskevas, 1937/38; Stavrakakis, 2017).

The third group consists of varieties of unknown origin, such as 'Aleponoura', 'Alpitsa' etc. and some 'Asproudia' that are locally cultivated. Many of these varieties are either

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not included in the Greek National Catalogue of Grapevine Varieties ('Alpitsa', 'Kokkinouska', 'Nevro', 'Nigrikiotiko', 'Pach(i)pectsi', 'Piknassa', 'Vergiotiko') or they are hybrids (direct producers) that have been imported in northern Greece under various names ('Tzortzidika', 'Galliko', 'Vapsa', 'Vaftra', etc.). It is worth mentioning that some of these varieties are not preserved in the Ampelographic Collections of Greece, while in some cases, there are significant differences in the ampelographic characters between the varieties located and studied in productive vineyards and the one preserved in the ampelographic collections. For example, grapevine variety 'Alpitsa' which is cultivated in western Macedonia is white, contrary to the one in the Ampelographic Collection of NAGREF which is red, while opinions are divided when it comes to the typical sample of grapevine variety 'Krassato'.

'Xinomavro' is the noblest grapevine variety of the Macedonian vineyard and constitutes the base of PDO wines (Amynteo, Goumenissa, Naoussa, Rapsani) (Kourakou, 2017). In the present work, the representative biotype of grapevine variety 'Xinomavro' from the viticultural area of Naoussa was studied, compared to grapevine variety 'Zalovitiko' that exhibits similar ampelographic characters (Stavrakakis *et al*., 2018).

Red grapevine variety 'Limnio' (synonym 'Kalabaki') is considered one of the oldest of the vineyard of northern Greece, originating from the island of Limnos. It is believed to have been cultivated since the 5th century BCE, while it is mentioned by Polydefkis (2nd century CE) as Limnia grape. It participates in the production of PDO wine Slopes of Meliton (together with 'Cabernet Sauvignon', 'Cabernet Franc').

Grapevine variety 'Moschomavro' (also known as 'Moschogaltso') is considered to be of polyclonal nature, and it owes the first part of its name to the aromatic character of its must.

Grapevine varieties 'Stavroto' and 'Abelakiotiko' are considered to be closely related and/or synonyms (Ministry of Rural Development and Food, 2017). 'Stavroto' was cultivated mainly in the vineyards of the historic community Abelakia, and from there, one or more biotypes were transferred in the viticultural areas of Rapsani and as is usually the case, it took the name of the region of origin (*abelakiotiko* = the one coming from Abelakia). Respectively, grapevine variety 'Xinomavro' in the area of Rapsani was called '*Naoustiano*' (as the one originating from Naoussa, the first cultivation center of this variety). The name 'Stavroto' (from the Greek word *stavros* = cross) can be attributed to the shape of the grape, whose two first diversifications are significantly developed and give the shape of the cross (Krimbas, 1944; Stavrakakis *et al*., 2018).

Grapevine variety 'Krassato' is cultivated exclusively in the greater area of Rapsani and is co-macerated with grapevine varieties 'Xinomavro' and 'Stavroto' for the production of the PDO red wine Rapsani. The name *krassato* (= winy, wine-colored) is connected either with the fact that the variety is characterized as primarily appropriate for wine production or with the color of the skin of the berries that refers to the Homer's adjective of the sea (Alexiou, 1986; Lambert-Gòcs, 1990).

Grapevine varieties 'Pamidi' (synonyms 'Pamid', 'Plovdiska', 'Dorukata' etc.) and 'Sefka' (synonym 'Nicheftka') are of eastern origin; they have been cultivated for many years in Thrace and participate in the production of PGI wines (Vlachos, 1986). Grapevine variety 'Zoumiatiko' (synonyms 'Dimyat', 'Smederevka') is considered to originate from the Egyptian city Dimyat, to which it owes its name (Logothetis and Vlachos, 1966), while the Greek name derives from the Greek word *'ζουμίν'* and suggests the high must concentration of the berry (Stavrakakis, 2010).

Grapevine variety 'Debina' is cultivated exclusively in Epirus for the production of the PDO wine Zitsa, while grapevine variety 'Malagousia' - one of the most important varieties of the vineyard of southern Greece - was transferred and has been cultivated in recent years in various areas of northern Greece for the production of varietal wines.

Red grapevine variety 'Vlachiko' is cultivated mainly in Epirus and it most likely owes its name to the *Vlachous* (*vlachos* and *vlachikos*: raw, hardy) (Krimbas, 1949; Stavrakakis *et al*., 2018), and together with grapevine variety 'Bekari' they participate in the production of PGI wines Epirus, Ioannina, Metsovo, Meteora.

Grapevine variety 'Keratsouda' (synonym 'Tenedio', as it originated from the island of Tenedos) owes its name to the attractiveness of the grapes with the reddish berries (from the Greek idiomatic word *kyratsouda* or *keratsouda* = the young, beautiful lady, girl) (Stavrakakis *et al*., 2018). The rest of the varieties are cultivated in small surface areas and are of local interest.

The present work is part of a broader research project for the study and evaluation of Greek grapevine varieties, aiming to investigate the genetic diversity of grapevine varieties cultivated in central, western and northern Greece.

Materials and Methods

Plant material

Forty-nine (49) grapevine varieties (*Vitis vinifera* L.) were chosen for identification using the ampelographic description and the molecular method RAPD (Random Amplified Polymorphic DNA). The studied varieties, their special characters and the areas from where the samples were collected are presented in detail in Table 1.

Ampelographic and molecular methods

For the ampelographic description, twenty-two (22) ampelographic characters were used and measured on each grapevine cultivar, following a list of descriptors developed by the International Organization of Vine and Wine (OIV, 2009) including the preliminary minimal traits relative to shoot, mature leave, bunch etc. among others (Table 2). The ampelographic characters have proven to be quite effective in the discrimination of grapevine varieties, as shown in previous studies (Rusjan *et al*., 2015; Stavrakaki and Biniari 2016; Stavrakaki and Biniari 2017).

For the RAPD molecular analysis, from a total of sixteen (16) primers (random decamer oligonoucleotides) that were tested, eight (8) of the most polymorphic ones were chosen and used to amplify genomic DNA through the Polymerase Chain Reaction (PCR) in order to identify and discriminate the selected varieties (Table 3).

Table 1. Cultivars studied and sampling areas

a/a	Cultivar [a]	Berry color [b]	Use [c]	Sampling region [d]
1	Aleponoura	B	W	Thr (Soufli)
2	Aleponoura-1	N	W	wM (Pelekanos)
3	Alpitsa	B	W	wM (Velvendos)
4	Abelakiotiko	N	W	Th (Rapsani)
5	Aspro aromatiko	B	W	wM (Siatista)
6	Aspro myrodato	B	W	Thr (Soufli)
7	Aspro psilorrogo	B	W	Thr (Pentalofos)
8	Bekari	N	W	E (Zitsa)
9	Bogialamades	N	W	Thr (Soufli)
10	Debina	B	W	E (Zitsa)
11	Fokiano	Rs	W	Thr (Soufli)
12	Galliko	N	W	wM (Pelekanos)
13	Gountabi	N	W	E (Metsovo)
14	Karnachalades	N	W	Thr (Soufli)
15	Keratsouda	Rs	W/T	Thr (Soufli)
16	Kokkinouska	Rs	W/T	wM (Pelekanos)
17	Krassato	N	W	Th (Rapsani)
18	Limnio	N	W	cM (Chalkidiki)
19	Malagousia	B	W	cM (Chalkidiki)
20	Mavro aromatiko	N	W	Thr (Pentalofos)
21	Mavroudi	N	W	E (Metsovo)
22	Moschomavro-1	N	W	wM (Velvendos)
23	Moschomavro-2	N	W	wM (Siatista)
24	Negoska	N	W	cM (Goumenissa)
25	Nevro	N	W	wM (Pelekanos)
26	Nigrikiotiko-1	N	W	wM (Siatista)
27	Nigrikiotiko-2	N	W	wM (Siatista)
28	Ntopio Metsovou	N	W	E (Metsovo)
29	Pamidi	Rs	W	Thr (Soufli)
30	Papas-kara	N	W	Thr (Dikaia)
31	Pach(i)petsi	N	W	E (Metsovo)
32	Piknassa	B	W	E (Metsovo)
33	Priknadi	B	W	cM (Naoussa)
34	Salonikio	N	W	wM, cM
35	Sefka-1	N	W	Thr (Pentalofos)
36	Sefka-2	N	W	Thr (Soufli)
37	Sklithro	N	W	wM (Siatista)
38	Stavroto	N	W	Th (Rapsani)
39	Tzortzidika	N	W	E, Thr
40	Tsougiannides	B	W/T	Thr (Soufli)
41	Vapsa Naoussas	N	W	cM (Naoussa)
42	Vergiotiko	N	W/T	wM (Velvendos)
43	Vlachiko	N	W	E (Zitsa)
44	Voulgariko-1	N	W	wM (Pelekanos)
45	Voulgariko-2	N	W	wM (Siatista)
46	Voulgaroudia	N	W	Thr (Soufli)
47	Xinomavro	N	W	cM (Naoussa)
48	Zalovitiko	N	W	Th (Karditsa)
49	Zoumiatiko	B	W	cM (Serres)

a. Transliteration of the original Greek name of cultivar into Latin characters [as written in the National Catalogue]
b. N: black/red (Noir), Rs: pink (Rosé), B: white (Blanc) [as written in the OIV]
c. W: wine, T: table
d. E: Epirus, cM: Central Macedonia, wM: Western Macedonia, Th: Thessaly, Thr: Thrace

Table 2. Ampelographic characteristics, based on the OIV descriptors list (OIV, 2009)

Code	Ampelographic characteristic	Notes	Code	Ampelographic characteristic	Notes
001	Young shoot: opening of the shoot tip	1: closed, 3: half open, 5: fully open	004	Young shoot: density of prostrate hairs on tip	1: none or very low, 3: low, 5: medium, 7: high, 9: very high
016	Shoot: number of consecutive tendrils	1: 2 or less, 2: 3 or more	051	Young leaf: color of the upper side of blade (4th leaf)	1: green, 2: yellow, 3: bronze, 4: copper-reddish
053	Young leaf: density of prostrate hairs between main veins on lower side of blade (4th leaf)	1: none or very low, 3: low, 5: medium, 7: high, 9: very high	055	Young leaf: density of prostrate hairs on main veins on lower side of blade (4th leaf)	1: none or very low, 3: low, 5: medium, 7: high, 9: very high
067	Mature leaf: shape of blade	1: cordate, 2: wedge-shaped, 3: pentagonal, 4: circular, 5: kidney-shaped	068	Mature leaf: number of lobes	1: one (entire leaf), 2: three, 3: five: 4: seven, 5: more than seven
070	Mature leaf: area of anthocyanin coloration of main veins on upper side of blade	1: absent, 2: only at the petiolar point, 3: up to the 1st bifurcation, 4: up to the 2nd bifurcation, 5: beyond the 2nd bifurcation	075	Mature leaf: blistering of upper side of blade	1: absent or very weak 3: weak, 5: medium, 7: strong, 9: very strong
076	Mature leaf: shape of teeth	1: both sides concave, 2: both sides straight, 3: both sides convex, 5: one side concave, one side convex, 5: mixture between notes 2 & 3	079	Mature leaf: degree of opening / overlapping of petiole sinus	1: very wide open, 3: open, 5: closed, 7: overlapped, 9: strongly overlapped
080	Mature leaf: shape of base of petiole sinus	1: U-shaped, 2: brace-shaped, 3: V-shaped	081-2	Mature leaf: petiole sinus base limited by veins	1: not limited, 2: on one side, 3: on both sides
084	Mature leaf: density of prostrate hairs between the main veins on lower side of blade	1: none or very low, 3: low, 5: medium, 7: high, 9: very high	086	Mature leaf: density of prostrate hairs on main veins on lower side of blade	1: none or very low, 3: low, 5: medium, 7: high, 9: very high
087	Mature leaf: density of erect hairs on main veins on lower side of blade	1: none or very low, 3: low, 5: medium, 7: high, 9: very high	093	Mature leaf: length of petiole compared to length of middle vein	1: much shorter, 3: slightly shorter, 5: equal, 7: slightly longer, 9: much longer
208	Bunch: shape	1: cylindrical, 2: conical, 3: funnel shaped	223	Berry: shape	1: obloid, 2: globose, 3: broad ellipsoid, 4: narrow ellipsoid, 5: cylindric, 6: obtuse ovoid, 7: ovoid, 8: obovoid, 9: horn shaped, 10: finger shaped
225	Berry : color of skin	1: green yellow, 2: rose, 3: red, 4: grey, 5: dark red violet, 6: blue black	231	Berry: intensity of flesh anthocyanin coloration	1: none or very weak 3: weak, 5: medium, 7: strong, 9: very strong

As plant material, young and fully expanded leaves from the main shoots were used. In the vines from where the leaves were taken, the health of the vines was evaluated macroscopically, both during the vegetation period as well as during full maturation of the grapes, in order to locate and select healthy biotypes. From each vine, three samples were collected which were place in dried ice (-80 °C approximately) and were then stored in deep freeze (-80 °C).

Grapevine DNA was extracted from the young and fully expanded leaves followed by the same amplification conditions and gel electrophoresis preparation, as described in Stavrakakis *et al*. (1997).

Table 3. Primers used for RAPD molecular analysis

Primer Code	Sequence	Number of Amplified Fragments
1224	CAGGCCCTTC	17
1225	AGGTGACCGT	14
1226	CGCAGGATGG	14
1227	GTGTGCCCCA	11
OPM 01	GTTGGTGGCT	21
OPM 06	CTGGGCAACT	20
OPM 12	GGGACGTTGG	13
OPF 05	CCGAATTCCC	19

Data analysis

For the statistical analysis, relationships among the OIV descriptors (parameters) were studied using the statistical program JMP (JMP v. 10 statistical software, SAS Institute Inc., Cary, NC, USA). Principal Component (PC) analysis was used to evaluate the most important parameters that contributed to the biotype separation into different groups according to their morphological traits (OIV descriptors).

For the statistical analysis of the ampelographic and the molecular data, the method UPGMA was used with one dissimilarity/distance coefficient and one similarity coefficient, respectively. In order to present the morphological relationships between the cultivars, the DIST distance coefficient was used, as implemented in the NTSYS-pc package 2.1 developed by Rohlf (Exeter Software, New York, USA, 1993).

For the molecular analysis, the degree of genetic similarity (I) detected between each pair of cultivar studied was calculated using the Simple Matching (SM) coefficient (Sneath and Sokal, 1973) as implemented in the NTSYS-pc package 2.1.

Results and Discussion

OIV ampelographic descriptor evaluation

According to the PC analysis, which transforms the original data set (OIV descriptors) into a smaller set of uncorrelated new variables (Principal Components, where eigenvalue was bigger than 1), 9 components have been produced in a decline series of their importance, explaining 77.64% of the total variability among the different cultivars. All descriptors that are grouped in the same principal component have strong correlation between them.

Each component is strongly correlated with a set of the initial OIV descriptors, so their contribution to variability could be estimated.

The OIV descriptors strongly correlated with the 9 components are presented in Table 4 and Fig. 1. For example, and for the cultivars studied, the OIV descriptors 053 (Young leaf: density of prostrate hairs between main veins on lower side of blade (4th leaf)), 004 (Young shoot: density of prostrate hairs on tip), 084 (Mature leaf: density of prostrate hairs between the main veins on lower side of blade), 055 (Young leaf: density of prostrate hairs on main veins on lower side of blade (4th leaf)) contributed better to variability compared to OIV descriptors 223 (Berry: shape), 208 (Bunch: shape).

Cluster analysis separated the varieties in particular groups according to their morphological characteristics: the data from the ampelographic description with the 22 ampelographic descriptors of the varieties studied were used to create a distance matrix in order to generate a dendrogram (Fig. 2). As shown in Fig. 2, the grapevine varieties 'Xinomavro' and 'Zalovitiko' showed identity indicating that they are clones of one initial variety. The

Table 4. Evaluation of the OIV descriptors and their contribution to the variability of the varieties studied

Principal Components								
1	2	3	4	5	6	7	8	9
% Contribution to variability								
19.52	10.19	9.39	8.32	7.15	6.97	6.08	5.21	4.77
Eigenvalue								
4.09	2.14	1.97	1.74	1.50	1.46	1.27	1.09	1.00
Related OIV descriptors								
053	068	079	051	001	067	093	075	223
004	087	086	231	076		070		208
084		080		081-2				
055		225						

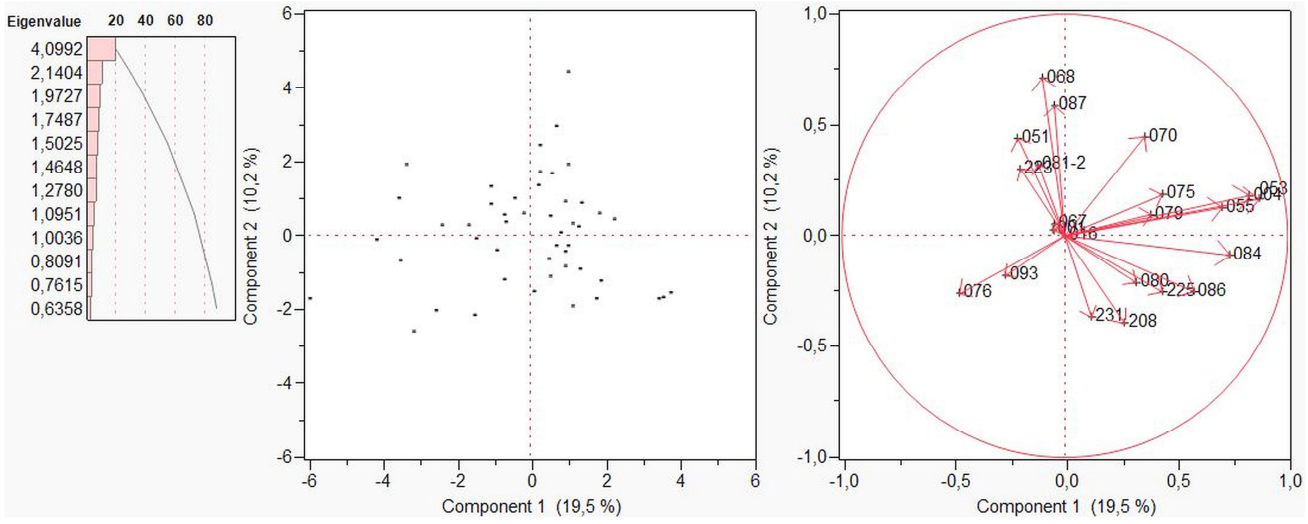

Fig. 1. Evaluation of the OIV descriptors and their contribution to the variability of the cultivars studied

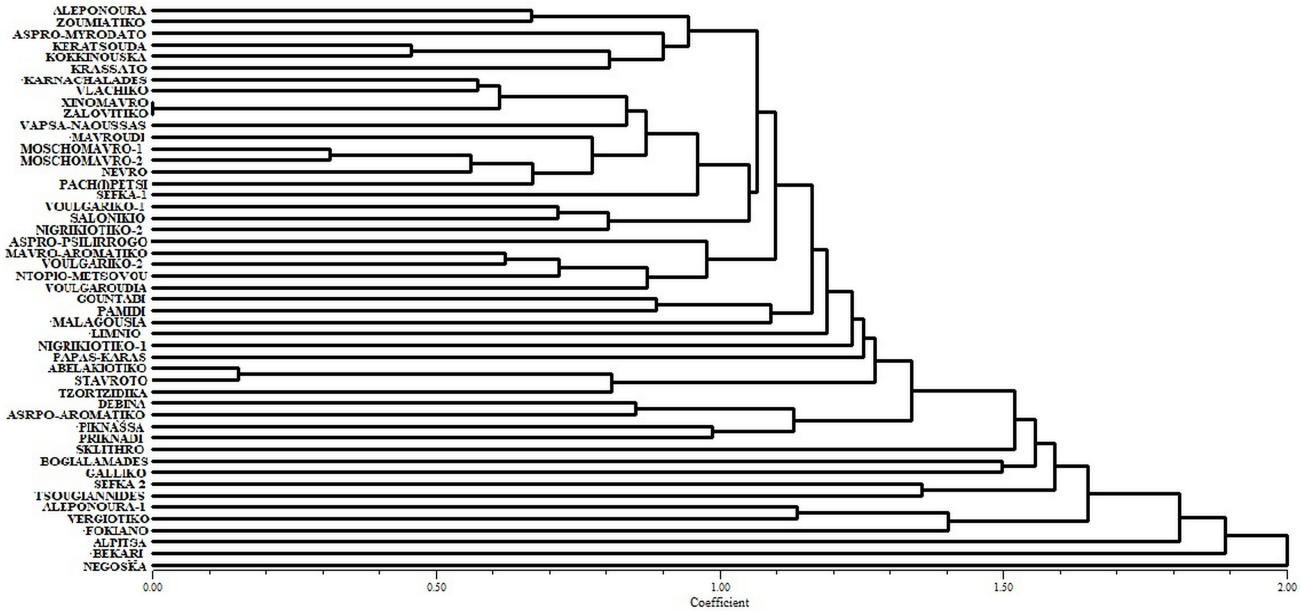

Fig. 2. Dendrogram based on ampelographic descriptors showing the relationship among samples studied (Dissimilarity Coefficient DIST, UPGMA)

very small distances between the cultivars 'Abelakiotiko' and 'Stavroto' (0.15) indicate that they are closely related cultivars which may have originated by the same parent cultivar through the accumulation of mutations. The same holds, but in a smaller degree, between the cultivars/biotypes 'Moschomavro-1', 'Moschomavro-2' (0.31) and 'Keratsouda', 'Kokkinouska' (0.46). On the contrary, grapevine varieties 'Voulgariko-1', 'Voulgariko-2' and 'Voulgaroudia' exhibited relatively large distance between them ranging from 0.92 to 1.01 for the first two, meaning that in spite of their common name, they are in fact different.

Finally, from the group of the varieties that were imported in the viticultural areas of northern Greece ('Galliko', 'Tzortzidika' [synonyms 'Isabella', 'Zabella'], 'Vapsa', 'Bogia' etc.), only 'Sefka-1', 'Sefka-2' and 'Vapsa Naoussas' are grouped in the same cluster of the dendrogram, but they are in fact different.

Molecular analysis

The results of the molecular analysis, as presented in the dendrogram generated (Fig. 3), confirmed the data of the ampelographic description for most of the studied grapevine varieties.

Particularly regarding grapevine varieties 'Xinomavro' and 'Zalovitiko' which showed identity for the 22 ampelographic characters used, they also exhibited identity with the eight primers used. Therefore, it can be said that these two varieties are one and the same, and that 'Zalovitiko' constitutes synonym/clone of the polyclonal grapevine variety 'Xinomavro'. These results are in disagreement with those of a previous study with the use of molecular method SSR, in which relatively low degree of genetic similarity was recorded between these varieties (Merkouropoulos *et al*., 2015), something that could be most likely attributed to the fact that different samples were analyzed. 'Zalovitiko' owes its name to the initial cultivation center, Trikomo Grevenon which used to be called Zalovo (*zalovitiko* = the one coming from Zalovo) (Krimbas, 1944).

The same applies for grapevine varieties 'Xinomavro' and 'Krassato'. In the present study, low degree of genetic similarity was determined between these varieties, placing these varieties in completely different clusters of the dendrogram, confirming the prevailing view that they are indeed different varieties (Kotinis, 1985; Spinthiropoulou, 2000; Nikolaou, 2012; Robinson *et al*., 2012; Stavrakakis *et al*., 2018). On the contrary, in a previous study with the use of molecular method SSR, it was suggested that these two varieties are closely related (Merkouropoulos *et al*., 2015).

High degree of genetic similarity was recorded, as expected, between grapevine cultivars 'Stavroto' and 'Abelakiotiko'. Therefore, they are biotypes/clones of an initial variety ('Stavroto') that originated through the phenomenon of mutation. Despite the differences in ampelographic characters among the biotypes/varieties 'Moschomavro-1' and 'Moschomavro-2', the high degree of genetic similarity (I=0.985) showed that they are biotypes/clones of an initial variety, confirming the polyclonal synthesis of Greek grapevine varieties (Loukas *et al*., 1983).

The low degree of genetic similarity as well as the differences in some ampelographic characters show that white grapevine variety 'Aleponoura' (Thr) does not constitute a color mutation of the red grapevine variety 'Aleponoura-1' (wM).

Despite the relatively high degree of genetic similarity, grapevine varieties 'Voulgariko-1', 'Voulgariko-2', 'Voulgaroudia', 'Mavro aromatiko' and 'Mavroudi', independently of their origin, are different. The same applies for grapevine varieties 'Sefka-1', 'Sefka-2' and 'Vapsa Naoussas', confirming the confusion that exists in the nomenclature of these varieties, while grapevine varieties 'Bogia', 'Galliko' and 'Tzortzidika' are also different. Moreover, the low degree of genetic similarity (I=0.767) among grapevine varieties 'Nigrigiotiko-1' and

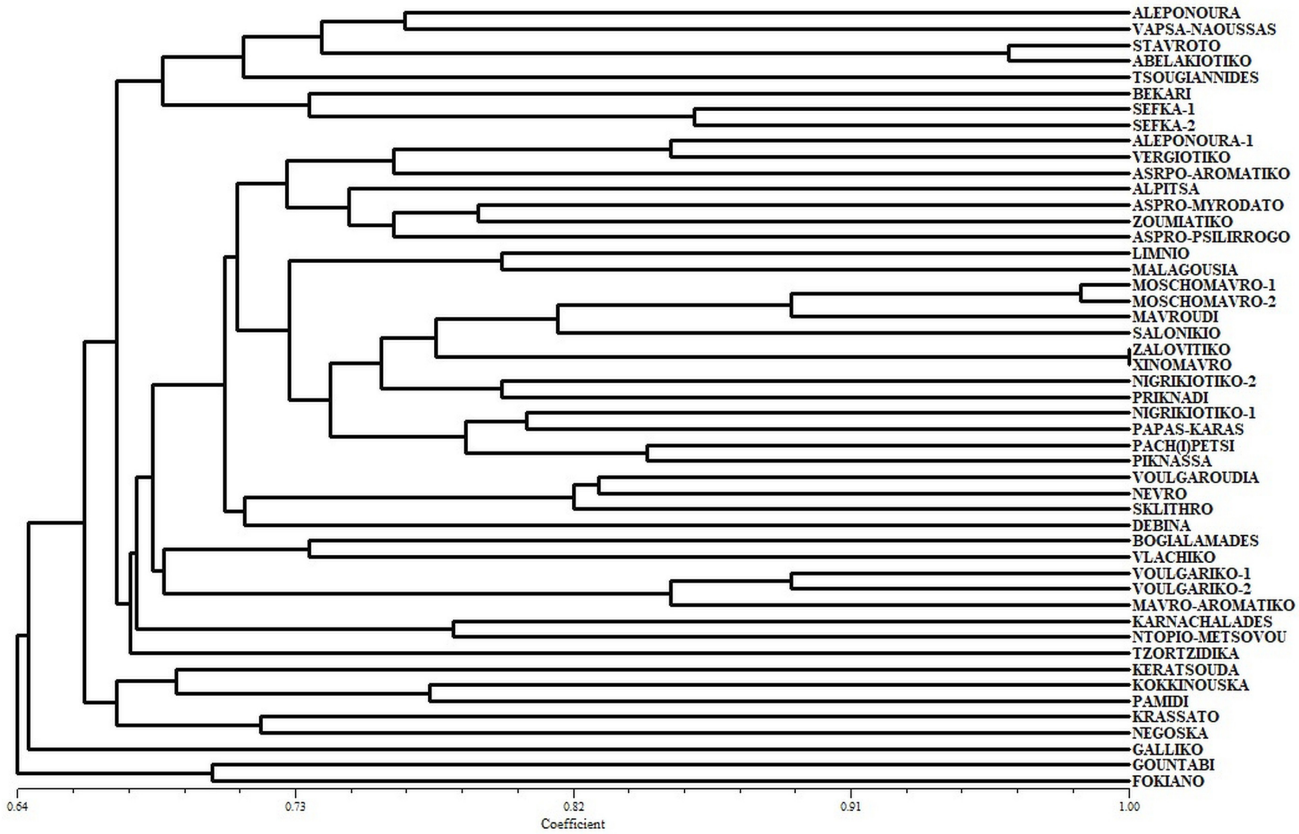

Fig. 3. Dendrogram based on RAPD amplification products showing the relationship among samples studied (Similarity Coefficient Simple Matching, UPGMA)

'Nigrigiotiko-2' confirms the data of the ampelographic description, that they are in fact different varieties that owe their name to the area of origin (Nigrita).

Despite their geographic location, grapevine varieties 'Bekari', 'Debina', 'Gountabi', 'Mavroudi', 'Ntopio Metsovou', 'Pach(i)petsi', 'Piknassa' and 'Vlachiko', which are cultivated in the viticultural area of Epirus, exhibited relatively low degree of genetic similarity, while grapevine varieities 'Karnachalas' (aka 'Karnachalades'), 'Papas-kara' and 'Nigrikiotiko-1', 'Nigrikiotiko-2' are located in the same cluster of the dendrogram, suggesting their possible common origin from eastern Thrace where the first two were mainly cultivated since the 19th century (Hatziparaskevas, 1937/38).

Grapevine variety 'Negoska' differs significantly compared to all other studied varieties and is located in a total different cluster of the dendrogram. It is considered as an indigenous variety of the Macedonian vineyard, with cultivation center being the greater area of Goumenissa (Logothetis, 1955) and participates in the production of PDO wine Goumenissa together with grapevine variety 'Xinomavro'.

Finally, despite the relatively high degree of genetic similarity in the ampelographic characters and characters of the grapes, grapevine varieties 'Pamidi' and 'Keratsouda' are in fact different.

Conclusions

The results of the present study confirm the genetic heterogeneity as well as the polyclonality of the studied grapevine varieties. At the same time, it is also established that the most efficient way for the identification and discrimination of grapevine varieties is the combination of the ampelographic description with the use of molecular methods.

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