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GENETIC DIVERSITY OF GREEK GRAPEVINES

Abstract: The Greek viticulture represents one of the oldest viticulture in the world and although it is small in size, it is rich in history and in grapevine varieties, varieties that are characterized by significant genetic diversity. The identification and discrimination of Greek grapevine cultivars is a rather difficult and complicated task because of: (a) the large number of Greek grapevine cultivars, most of which constitute single or multiple hybrids, (b) the polyclonal nature of grapevine cultivars, (c) mutations, (d) the large number of synonyms and homonyms and their grouping under a generic name (e. g. Asproudia, Mavroudia).

At the same time, and over the past few decades, the wine companies focus on minor traditional Greek grapevine cultivars. The polyclonal synthesis and the significant number of synonyms of these varieties make the selection of the representative samples difficult, even in ampelographic collections. For the discrimination of Greek grapevine varieties, the following methods have been widely used: (a) the ampelographic description, (b) the enzyme polymorphisms which are detected electrophoretically and (c) the molecular methods.

Many research studies have been made for the investigation of the genetic relationships of the synonyms, the homonyms, the types and variations of grapevine cultivar Roditis, the varieties of the group Fileria and recently the varieties of the group Mavroudia both between them and with the "Vine of Pafsanias", after the name of the Greek traveler and geographer of the second century BCE, a very old vine which has all the typical characteristics of the *Vitis vinifera* spp. *sylvestris* Gmel.

When it comes to studying old, polyclonal and geographically very dispersed grapevine cultivars, the discrimination and identification tools play an indispensable role in order to solve problems related to transliteration, the substitution of local or regional names with the original cultivar names, the presence of variants within cultivars and the many synonyms and homonyms, as is the case in the Greek vineyard. The ampelographic description, especially when it takes place for consecutive years and when a

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great number of descriptors is used, in combination with the use of molecular methods, can constitute such reliable tools for the detection of the genetic diversity and discrimination of Greek grapevine cultivars, clones and biotypes.

Key words: *Greek grapevine varieties, traditional, characterization, ampelographic description*

REVIEW

The Greek viticulture is characterized, despite its relatively small size, by varietal richness and by a land area of cultivation that is relatively large (approx. 110000 ha, of which 70000 ha yield wine grapes). The grapevine cultivation in Greece begins from ancient times. Since the Early Minoan IIB period, ca. 2200 B. C., the cultivation of the vine and the art of winemaking had reached a high level, while at the same time the first “retsina”, a resinated wine, was produced [12]. Indeed, during the Protopalatial period, there were several grape wine varieties in Phaestos which were carefully selected and vastly different from those found throughout the rest of Greece and Cyprus [9].

The long-time vine cultivation, the great geographical dispersion and the genetic heterogeneity of the grapevine created this great variability among grapevine varieties. The Ampelography of Viala and Vermorel (1909) included 2,400 names, types and variations of grapevine varieties. More than 200 varieties are reported and described in the ampelography of Krimbas [4].

In Greece, there are more than 700 reported varieties of which 280 are included in the National Catalogue of Grapevine Varieties (Ministry of Rural Development and Food, 2015). The large number of synonyms and homonyms as well as the grouping of many varieties under the generic name ‘Mavroudia’ and ‘Asproudia’ are among the reasons that make the identification and discrimination of Greek grapevine varieties a difficult task [16].

For the discrimination of Greek grapevine varieties, the following methods have been widely used: (a) the ampelographic description [4–6, 10, 25, 19], (b) the enzyme polymorphisms which are detected electrophoretically [23, 24] and (c) the molecular methods [20, 7, 13, 15]. Similar research studies have been made for the investigation of the genetic relationships of the synonyms, the homonyms, the types and variations of grapevine cultivar Roditis [21], the varieties of the group Fileria [22].

The extremely heterogeneous group under the generic name ‘Mavroudia’ cultivated in Greece has been the object of many research studies. There have been studies which focused on the identification and the discrimination of grapevine varieties of the Mavroudia group both between them and with the “Vine of Pafsania”, after the name of the Greek traveler and geographer of the second century A. D., a very old vine which has all the typical characteristics

of the *Vitis vinifera* spp. *sylvestris* Gmel. [8, 1]. Recently, twenty-one Greek grapevine cultivars belonging to this group were chosen for identification using the ampelographic description and the molecular method AFLP [17].

'Mavroudi' (meaning blackish) also known as 'Mavro' (meaning black) is a generic name that was given to several almost distinct varieties all over Greece which all constitute the group of 'Mavroudia'. In fact, in Greece, there is not one specific variety with the name 'Mavroudi'. The word 'Mavroudi' is often followed by a specific characteristic of the berry ('Mavroudi chondrorago', 'Mavroudi psilorago'), of the must ('Mavrostifo') or the name of the region of origin ('Mavroudi Nemeas', 'Mavroudi' or 'Mavro Arachovis' etc.). Due to this conventional criterion of the color of the skin, many Greek black/red wine grapevine cultivars are included in this large group, and at least until the end of 1970 the most famous among them being 'Ag-iorgitiko' (aka 'Mavroudi Nemeas', 'Mavro Nemeas'), 'Xinomavro' (aka 'Mavro Naoussas', 'Popolka') and 'Mavrodafni'.

In general, and despite the high degree of genetic similarity between certain pairs of the studied cultivars, the group of 'Mavroudia' was characterized as being heterogeneous. From the studied cultivars, 'Kountoura mavri', 'Mavro Spetson' and 'Pappoudes' showed very high degree of genetic similarity, sustaining the hypothesis that the last two are clones of the first. Grapevine cultivar 'Pappoudes' was for the first time ampelographically described and identified as being closely related to 'Kountoura mavri'. High degree of genetic similarity was observed between cultivars 'Gaidouricha' and 'Ag-iomavritiko', suggesting that they probably originated from the same parent variety through the accumulation of mutations. This may also be true for cultivars 'Mavrokorakas' and 'Kartsiotis'. Also, the results from the statistical analysis showed that 'Mavro Arachovis', 'Mavroudi Voulgarias' and 'Voulgaroudes', despite the relatively high genetic similarity between them, are different [17].

The variety 'Kountoura mavri' according to Krimbas is a clone or synonym of grapevine variety 'Mandilaria' and the name 'Kountoura' derives from the Turkish word "kundura" [a woman's slipper], due to the shape where the vines have after their winter pruning [18]. It is mentioned also as 'Koundoura' by Viala and Vermorel (1909).

Regarding 'Pappoudes', it is a grapevine cultivar that is being cultivated in multi-varietal vineyards in various viticultural areas. The name derives from the Greek word pappous = grandfather, showing that the variety has been known for a long time.

Concerning Mavro Spetson, Krimbas described the variety 'Mavroudi' and noted that the variety is also known as 'Mavro' in Spetses, Argolida), 'Mavraki' (Achaia) and 'Karvouniaris' (Messinia). Later, Krimbas [5,6] describes

varieties 'Chondromavroudi', 'Karvouniaris', 'Mavraki' and 'Mavrostifo' as being different.

The cultivars 'Mavroudi Voulgarias' and 'Voulgaroudes' are different cultivars. There are in different branches in the dendrogram.

The same for the cultivars 'Mavro Arachovis' and 'Mavroudi Voulgarias', confirm the results of previous studies with the use of molecular method SSR [3].

At the same time, grapevine cultivar 'Karvouniaris', which is one of the most well-known and widespread 'Mavroudia' of Peloponnese, showed relatively high degree of genetic similarity with 'Voulgaroudes' ($I=0.85$) and 'Mavro Kolliniatiko' ($I=0.83$).

'Agiomavritiko' and 'Gaidouricha' are very old wine cultivars of the Ionian Islands (Corfu, Lefkada) and today they are cultivated sporadically in different regions (Thessaly).

The high degree of genetic similarity particularly between the pair 'Gaidouricha' — 'Agiomavritiko' ($I=0.90$) shows that they most likely originated from the same parent variety through the accumulation of mutations.

Grapevine cultivar 'Agiomavritiko', certainly of polyclonal nature, most likely owes its name to its origin from Lefkada, which was called Agia Mavra during the 14th century.

Grapevine cultivar 'Gaidouricha' has been described by Krimbas [4] and it is mentioned as 'Gaidourica' [14], 'Gaidourica', 'Guadurea' [2] and 'Gaidouria noir', 'Gaidourica', 'Gaidourcia' (Viala and Vermorel, 1909). The name derives from the Greek word gaidouri = donkey and refers to the high vigor and productivity of its big vines which, just like donkeys, can bear a heavy load [18].

Regarding, grapevine cultivars 'Mavro Kalavriton' and 'Mavrostifo' had the lowest degree of genetic similarity with all cultivars studied (mean values $I=0.74$ and $I=0.79$ respectively, compared to $I=0.82$, which was the mean value of all cultivars studied) and they were located in completely different branches of the dendrogram.

CONCLUSION

The knowledge and identification of grapevine varieties is necessary because they are the primary factors for a successful cultivation of grapevines and for a successful establishment of productive vineyards. This will lead to the production of viticultural products of high quality with stable quality characters.

At the same time, the importance of the knowledge of grapevine varieties, their identification, evaluation and propagation are of great importance for

modern viticulture, especially for the production of viticultural products of high quality and for the preservation of valuable genetic resources. In order to maintain this diversity, polyclonality and uniqueness of grapevine varieties, a coordinated and careful replantation of vines, with grapevine varieties with full ampelographic, genetic and phenolic profile is deemed necessary.

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GENETSKI DIVERZITET VINOVE LOZE U GRČKOJ

Sažetak

Vinogradi u Grčkoj predstavljaju jedne od najstarijih vinograda na svijetu. Iako mali po veličini, bogati su sortama vinove loze koje karakteriše značajna genetička raznolikost. Identifikacija i karakterizacija grčkih sorti vinove loze je prilično težak i komplikovan zadatak zbog: (a) velikog broja grčkih sorti vinove loze, od kojih većina predstavlja pojedinačne ili višestruke hibride, (b) poliklonske prirode sorti vinove loze, (c) mutacije, (d) velikog broja sinonima i homonima i njihovog grupisanja pod rodnim imenom (npr. *asproudia*, *mavroudia*).

Tokom proteklih nekoliko decenija, vinske kompanije se fokusiraju na manje tradicionalne grčke sorte vinove loze. Poliklonska sinteza i značajan broj sinonima ovih sorti čine izbor reprezentativnog uzorka teškim, čak i u ampelografskim kolekcijama. Za karakterizaciju grčkih sorti vinove loze, najčešće se koriste sljedeće metode: (a) ampelografski opis, (b) enzimski polimorfizmi koji se detektuju elektroforetički i (c) molekularne metode.

Mnoge istraživačke studije su realizovane za istraživanje genetskih veza između sinonima, homonima, tipova i varijacija sorte vinove loze *roditis*, sorti grupe *fileria* i nedavno sorti grupe *mavroudia*, između njih i sa vinovom lozom *pafsanije* (po imenu grčkog putnika i geografa iz drugog vijeka), veoma stare vinove loze koja ima sve tipične karakteristike *Vitis vinifera* spp. *sylvestris* Gmel.

Kada se proučavaju stare, poliklonalne i geografski vrlo rasprostranjene sorte vinove loze, instrumenti karakterizacije i identifikacije imaju presudnu ulogu u rješavanju problema vezanih za transliteraciju, zamjenu lokalnih ili regionalnih imena originalnim imenima sorti, prisustvom varijacija unutar sorti i mnogim sinonimima i homonimima, kao što je slučaj u grčkim vinogradima. Ampelografski opis, naročito kada se odradi tokom nekoliko uzastopnih godina i kada se koristi veliki broj deskriptora, u kombinaciji sa upotrebom molekularnih metoda, može biti pouzdan alat za otkrivanje genetičke raznovrsnosti i karakterizacije grčkih sorti vinove loze, klonova i biotipova.

Ključne riječi: grčke sorte vinove loze, tradicionalne, karakterizacija, ampelografski opis

